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LEAN SIX SIGMA PROJECT APPROACH IN FINANCE DEPARTMENT OF MULTINATIONAL COMPANY

VYUŽITÍ LEAN SIX SIGMA PROJEKTOVÉ METODOLOGIE V OBLASTÍ FINANCÍ
V MEZINÁRODNÍ SPOLEČNOSTI

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Introduction
Aim of the Thesis
Theoretical Background
Problem Analysis and Current Situation
Proposals and Contribution of Suggested Solutions
Conclusions
References

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Abstract

The master's thesis deals with an analysis of Lean Six Sigma Project approach used by financial department in chosen multinational company. A proposal for improvement of using LSS in the future is placed in the thesis as well. The thesis contains theoretical knowledge about LSS as well as sample of using this method in real. An analysis of its effective usage is provided based on data and investigation right from the company using LSS. In the end there is evaluation of the analysis as well as proposal of future process for improvement in using LSS.

Abstrakt

Diplomová práce se zabývá analýzou využití projektové metodologie Lean Six Sigma na finančním oddělení ve vybrané mezinárodní společnosti a návrhem postupu na jeho zlepšení. Jsou zde obsaženy teoretické poznatky týkající se metody Lean Six Sigma jako i praktická ukázka použití dané metody v praxi. Na základě údajů a zkoumání použití metody je provedená analýza efektivního využití. Následně je popsané zhodnocení dané analýzy a navržen postup pro zlepšení situace do budoucna.

Key words

Lean Six Sigma, finance, international business company

Klíčová slova

Lean Six Sigma, finance, mezinárodní společnost

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Declaration

I declare that the submitted master's thesis is original and has been written independently. I also declare that the list of references is complete and copyrights are not violated (pursuant to Act No. 121/2000 Coll., on Copyright Law and Rights Related to Copyright Act).

Brno, 31th August 2013

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Bc. Lucia Hudáková

CONTENTS

INTRODUCTION

The submitted master's thesis deals with the theme Lean Six Sigma project approach in Finance department of multinational company.

Nowadays, almost every organization in Industry sector can be considered project-based which means that it carries out projects to improve the current processes or to develop new products or services. Faster and faster changing world challenges companies to put greater emphasis on quality delivered to the customer while open markets causing enormous competition amongst sellers forces them to try to eliminate waste so that unnecessary costs are being reduced the most.

Big international organizations operating world-wide establish so called Centers of excellence in strategic locations of different parts of the world. These centers focus on specific works delivering it or serving other centers or departments in the rest of the world. They are linked together tightly so it is important that they operate as effectively as possible in order to make the process slight. However, as people are being employed and not replaced by robots, the human factor always plays significant role in mistakes occurred. This is the opportunity for project management to look for a specific problem in the process to mend.

In order to bring the best result it is necessary to choose reliable project approach methodology. One such methodology is considered Lean Six Sigma connecting lean practices focusing on removing waste, with Six Sigma aiming to reduce variations and defects from the process.

The author has chosen the topic because she wanted to learn something new about process improvement methodologies that are crucial in this world. As a part of the Lean Six Sigma team for three months she could have observe the use of this methodology in the Finance department of selected International business company. She was also collecting useful information to analyze the usage so that she could have much clearer overview of how does the methodology help improving the processes in the company.

AIM OF THE THESIS

The main aim of this master's thesis is to evaluate the situation of Finance Department of multinational company using Lean Six Sigma Project approach in its processes. Recommendations of further steps in using this method are aimed as well as proposals for future improvement.

In order to reach the main goal it is necessary to fulfill partial goals at first. These are description of Lean Six Sigma method from theoretical point of view, comparison of global and local effect, description of employees' training program, stating of methods and process of certification exams, and implementation of the method into the practice. The next partial aim is to describe actual situation of Finance Department to which the practical show of using Lean Six Sigma in multinational company will help.

The author uses two main methods to evaluate the current situation of using LSS in the selected International business company. These are documentary evidence analysis and interview. The primary data gained from the research will be analyzed to give the most efficient solutions proposals to the problems discovered by the research. The analysis of the current situation will be supported by personal interviews with the employees of the company.

The structure of master's thesis is as follows:

The first part provides a theoretical basis of the thesis as it involves literature review of terms and definitions which will be further used in the paper. Following part analysis the current state of the Finance department of selected IBC using an example of the project carried out using LSS methodology. In the end of the part two an interpretation of the results obtained by research can be found. The last part focusing on proposals for the future based on evaluation of the current situation in the Finance department.

1 THEORETICAL BACKGROUND

The first part of the master's thesis aims to offer a literature review related to the issues of Lean Six Sigma, which is methodology and approach which eliminates defects and changes the product in order to analyze causes of problems and defects in business as well as manufacturing.

1.1 Project management

In order to give proper look on Project management it is necessary to find out what the project is. In the literature many definitions of the project can be found for example: "project is a unique, transient endeavor undertaken to achieve a desired outcome" (Association for Project Management, 2004 in Maylor, 2010, p. 5) or "a project refers to a value creation undertaking based on a specific mission, which is completed in a given or agreed timeframe and under constraints, including resources and external circumstances" (Project Management Association of Japan, 2005 in Maylor, 2010, p. 5).

Despite different definitions, there are some common terms that characterize the process (Mayer, 2010, p. 5):

- Unique – each project is specific in terms of time, place, project team and product or services it provides.
- Temporary – the project has its start and its finish, it lasts for particular amount of time. When the project ends the team moves on and financial resources finite.
- Focused – each project aims to deliver specific product or service.
- Change – the project impacts people involved as well as organization it is carried out for. It should bring some change compared to the initial state.
- Uncertainty – it is not always sure what the project will really bring.
- Integrating – the project requires knowledge and resources to be brought together and activities to be interlinked.
- Social construction – it does not behave like a machine because it involves people and organization

As almost all organizations in the industry sector are project-based including public sector bodies, engineering, construction and much of the IT industry it is necessary for them to establish very well mastered Project management.

A project management is “the application of knowledge, skills and techniques to execute projects effectively and efficiently. It is a strategic competency for organizations, enabling them to tie project results to business goals — and thus, better compete in their markets” (Project Management Institute, 2013). The Picture 1 shows main differences between general management of the organization and project management. General management consists of lines on the top of which is the board of directors. Line managers (financial manager, quality manager, marketing manager,…) are responsible for the people working under them in their department. On contrary project manager may have one of line managers’ function but he is responsible for all people involved in the project regardless of the department they work at (Maylor, 2005).

General management	*Project management*
• Responsible for managing the status quo	• Responsible for overseeing change
• Authority defined by management structure	• Lines of authority ‘fuzzy’
• Consistent set of tasks	• Ever-changing set of tasks
• Responsibility limited to their own function	• Responsibility for cross-functional activities
• Works in ‘permanent’ organisational structures	• Operates within structures which exist for the life of the project
• Tasks described as ‘maintenance’	• Predominantly concerned with innovation
• Main task is optimisation	• Main task is the resolution of conflict
• Success determined by achievement of interim targets	• Success determined by achievement of stated end-goals
• Limited set of variables	• Contains intrinsic uncertainties

Pic. 1 Different roles of general and project management

(Maylor, 2005, p. 12)

The environment of the projects can be described using 5Cs. Context of the project contains general external influences influencing the organization in which the project is carried out. Complexity means the level of complications or difficulty of the project. Completeness looks at how much of planned achievements or desired state the project will fulfill. Competitiveness of the project means interest and efforts of competing organizations to deliver the same work. Customer focus is about trying to meet customers' expectations and needs in the end of the project. The project management should consider all these Cs and try to eliminate all potential risks emerging from them (Maylor, 2005).

The initial phase of the project process requires detail description of the whole process with definition of the problem, or the product or service to be created, time plan, responsibilities, tools used in each step and others. To describe the project Maylor (2005) suggests using 7-S framework (Picture 2). The framework describes key issues of the project and classifies tasks of the project manager and the team.

Element	*Description*
Strategy	The high-level requirements of the project and the means to achieve them
Structure	The organisational arrangement that will be used to carry out the project
Systems	The methods for work to be designed, monitored and controlled
Staff	The selection, recruitment, management and leadership of those working on the project
Skills	The managerial and technical tools available to the project manager and the staff, and how these are developed
Style/culture	The underlying way of working and inter-relating within the work team or organisation
Stakeholders	Individuals and groups with an interest in the project process or outcome

Pic. 2 7-S framework

(Maylor, 2005, p. 29)

The project lifecycle based on 4-D model consists of these phases: Define, Design, Do, Develop (Maylor, 2005). As the master's thesis deals with Lean Six Sigma project approach and individual stages of its process will be described below, the author will not discuss this model in detail in this chapter.

1.2 Quality management

One of the critical success factors of any organization is considered sustainable quality improvement of processes and subsequently maintaining acceptable levels of performance quality. While ensuring it a big role plays company’s concept of quality management.

Quality management’s roots can be found in the late nineteenth century when F.W. Taylor introduced the inspection of finished goods. More than a century later, the quality has a new concept, which is no longer only pure specification of products, it has become a method. Many so called quality leaders contributed to its evolution, such as Crosby, Deming, Ishikawa, Juran or Freigenbaum (Johannsen, Leist, Zellner, 2010, p.362).

Foley (2004) gives several possible different descriptions of quality management. These are for example revolution in management or its revolutionary philosophy, framework for competitive management, a new way of thinking about the management of organizations, a comprehensive way helping to reach an improvement of organizational performance. Actually, a good description of quality management can be found in Saxe’s famous fable “The Blind Men and the Elephant” which is about six blind men describing an elephant, of course, unsuccessfully. Each of them tries to describe what the animal feels like while touching only a part of it. One blind man says “the elephant feels like the snake” other describes it as “the elephant feels like a wall”. Foley (2004) compares this story to known description of quality management. Whilst each blind man describes the elephant based on touching only a part of it, promoters of quality management present different concepts, which are the parts or some “visions of the whole drawn from the knowledge of one or a few parts” (Andersson, Eriksson, Torstensson, 2006, p. 283).This is probably the reason why Foley (2004) says that even after several decades of quality management literature written, the definition of quality management has still not been unified. According to ISO 9000:2005 the definition of quality management is following: “Quality management coordinates activities to direct and control an organization with regard to quality.” These activities include formulation of quality policy as well as quality objectives, planning of quality, quality control, assurance of quality, and improving quality.

The concepts mentioned above written and presented by quality management's promoters are for example total quality management (TQM), Six Sigma, lean management, just-in-time, Business Excellence, Kaizen and business process re-engineering (Andersson, Eriksson, Torstensson, 2006, p. 283). Since these concepts are trying to describe or explain quality management each from different part, different point of view or different idea, it is clear that their definitions would vary. For purpose of this thesis we will further describe TQM, Six Sigma and lean manufacturing concepts so let us briefly see their definitions. Andersson, Eriksson and Torstensson (2006) introduce three definitions in the beginning of their article. For TQM they choose Hellsten and Klefsjo's definition: "…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". Six sigma is defined based on Magnusson et al.: "as a business process that allows companies to drastically improve their bottom line by designing and monitoring everyday business activities in ways that minimize waste and resources while increasing customer satisfaction by some of its proponents". The last but not least definition is about lean according to NIST: „...as a systematic approach to identifying and eliminating waste through continuous, flowing the product at the pull of the customer in pursuit of perfection"

Based on these definitions it can be seen, that the aim of TQM, Six Sigma and lean concepts seems to be similar. They all want to serve their customers in the best way and improve financial results of the companies while trying to minimize waste and resources needed to business process. According to Dahlgaard and Dahlgaard (2001) these three quality management concepts have also the same origin which can be found in Japan after the World War II (Andersson, Eriksson, Torstensson, 2006, p. 283). In the next few parts of the thesis, let us see where the real differences among these concepts, similar at first sight, lies.

1.2.1 Total quality management

Arrival of total quality management caused emphasizing importance of continuous improvement and movement of quality. This is the reason why TQM is considered "mother" of more recent quality concepts (Gershon, 2010, p. 62). However, it is not clear until now who exactly gave TQM its name as well as in which organization it is possible to find its roots. Moreover, not only unclear origin but even the definition or explanation what TQM really is has always been the subject of interest among scientists. Andersson et al. (2006) cite Boaden: "…attempting to define TQM is like shooting at a moving target. As it is more widely practiced, and other initiatives emerge, the emphasis on different aspects change." (Boaden, 1997, in Andersson, Eriksson, Torstensson, 2006, p. 285).Vague definition of TQM led to many failures of companies who were trying to implement it into their management system because when opinions about what TQM is differ then it is not unequivocal what it should result in. One solution for this problem proposed Pyzdek who states that people working with TQM should constantly improve their quality knowledge and methodologies how to reach it in order to manage changing concept of TQM (Andersson, Eriksson, Torstensson, 2006, p. 286).

In order to show main objectives of TQM, Andersson et al. (2006) cite Helsten and Klefsjo who say that TQM aims on increasing internal and external customer satisfaction using reduced amount of resources. Many researches and studies revealed positive correlation between customer satisfaction and customer loyalty as well as financial results of companies. Another benefit of successfully implemented TQM was increased market share (Andersson, Eriksson, Torstensson, 2006, p. 285).

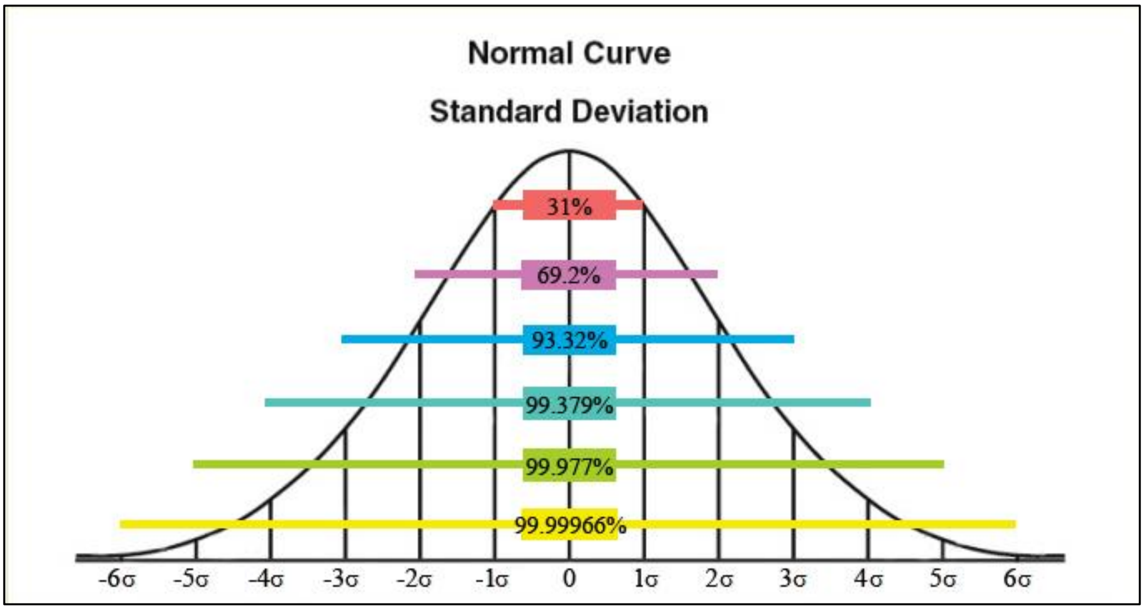
On the other hand, TQM has always been criticized by many authors as they succeeded in documenting failures while its implementation. Moreover, it is proved that only one-fifth, one-third at best, of American or European TQM programs achieved "significant or even tangible improvements in quality, productivity, competitiveness or financial results" (Andersson, Eriksson, Torstensson, 2006, p. 285). More reasons of TQM's failure can be found in Gershon's (2010) article where he claims no management participation in TQM and its back up, no group work on projects needed and that TQM does not define any complex process to follow in order to reach success as well as missing methodology for its implementation.

Following ordinary evolution process, it took approximately twenty years until business called for something new. Causing revolution in managerial thinking, having fans and opponents all over the world, TQM had evolved into Six Sigma (Gershon, 2010).

1.2.2 Six Sigma

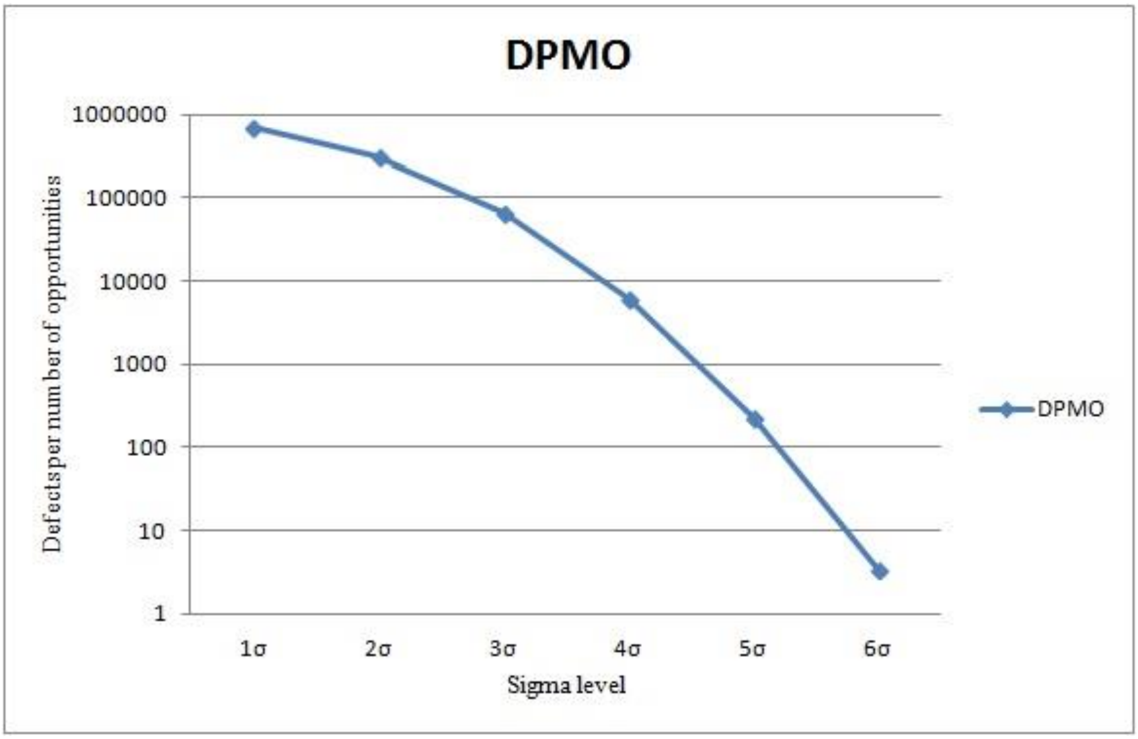
Six Sigma, another quality management concept or process improvement methodology, was developed by Motorola company in eight decade of last century by Bill Smith. The company had realized complexity of new technologies and deficiency of acceptable quality levels. The quality level a company is producing at is called sigma level which expresses the number of defects produced in one million opportunities. The level of quality Motorola could have perceived, which had been at 3 or 4 sigma levels at that time, has no longer been satisfying because modern business' requirements of quality level was near perfect (Gershon, 2010, p. 65). A solution to thousands of defect products in Motorola was defining new quality level accepted in the company at the level of six sigma. This step has meant lowering defects from thousands to only 3.4 in one million opportunities (Naslund, 2008, p. 272). Engaging Six Sigma methodology into the company's processes, Motorola saved $1.4 billion on manufacturing costs during 1987 to 1994 (iSixSigma, 2013). Noticeable savings and success in Motorola made Six Sigma popular all over the world and companies started to implement it into their own business. This popularity grew even more in 1990s through the work of Jack Welch, who led this methodology in General Electric as its CEO (Pepper and Spedding, 2010, p. 142).

According to Snee (1999) Six Sigma is defined as: "Six Sigma is a business improvement approach that seeks to find and eliminate causes of mistakes or defects in business processes by focusing on outputs that are of critical importance to customers." (Snee, 1999 in Dirgo, 2005, p. 58). However, six sigma has more than just one meaning. Sigma is a Greek letter which is a statistical unit for measurement. It is a measure of variation which each company should try to eliminate if it tends to satisfy its customers the most. Customers have expectations about the quality of products they pay a company for. Each variation from these expectations would dissatisfy the customer. Sigma is a measure of deviation and in statistical terminology can be interchange with standard deviation of a population. Sigma level expresses how many standard deviations we are from the mean value which is the distance between mean and the closest specification limit. In other words, it is a name given to indicate how much of the data falls within the customer's requirements. The higher the sigma level, the more of the process outputs, products and services, meet customers' requirements – or, the fewer the defects.



Pic. 3 Sigma level vs. percent acceptable

(Dirgo, 2005, author's own processing)



Pic. 4 Defects per million opportunities

(Taghizadegan, 2006, author's own processing)

Picture 3 shows probability distribution of satisfied customers while Picture 4 number of defect per million opportunities (DPMO). It can be seen that with higher sigma level the probability of producing goods of high quality rises. At the level of six sigma it is 99.99966% while producing only 3.4 defects in million products.

For better illustration of the difference between 99% quality and rate of Six Sigma Pande et al. (2000) gives us some examples from real life: if the post office was working at 99% of quality they would have 3,000 misdeliveries in 300,000 letters delivered in comparison to only one misdelivery when operating at Six Sigma level. The next example can be television station which during the week interrupts the broadcast for 1.68 hours with quality of 99% compared to just 1.8 second interruption working at Six Sigma level (Pande et al., 2000 in Pepper and Spedding, 2010, p. 142).

As a methodology Six Sigma can be seen based on five stages the whole process consists of: define, measure, analyze, implement and control (DMAIC). Each stage has highly defined steps to assure a level of discipline in seeking a solution to any variation or defect present in a process. In Define stage the business opportunity is found and defined. Measuring of current state of process follows. In analyzing part the root cause of problem is determined followed by improvement of the process by eliminating waste and variations. The final step is control when the evidence of sustained results is provided (Opensourcesixsigma, 2008, p. 5).

Six Sigma is also considered as a goal for many companies, because of reaching near perfect quality using it. Production at Six Sigma level is very difficult but challenging as well – the higher quality the company offers, the more customers stay loyal. When reaching this level, Six Sigma is no longer a slogan or some cliché – GE talks about Six Sigma as the way they work, Honeywell describes it as an overall strategy applied to every function in the company and in Lockheed Martin it is understood as initiative of saving costs – these words upgrade Six Sigma to a philosophy of the whole organization (Opensourcesixsigma, 2008, p. 7).

For becoming the philosophy, Six Sigma offers companies many positive elements to experience continuous improvement. It’s method of DMAIC provides structure for process improvement. To each stage many corresponding tools and techniques can be found such as “statistical process control, design of experiments and response surface methodology” (Pepper, Spedding, 2010, p. 142). This vast toolbox of techniques is very useful for measuring, analyzing and improving critical processes in order to get them under control. When following DMAIC process everyone must know his roles and areas of responsibilities. For this purpose Six Sigma establishes an infrastructure of champions with its intensive training program for gaining “belt” qualifications: white, yellow, green, black and master black belt.

Furthermore, Six Sigma is able to improve company’s bottom lines by lowering the costs of poor quality. These are the costs which can be seen as unnecessary for example the costs of carrying excess inventories, rework, idle capacity costs or scrap. The incentive to implement Six Sigma should be the inverse relationship between profitability of the company and its costs of poor quality. Profitability will be higher if poor quality costs are lower. This can be seen at Table 1 which shows how many percent of sales the company spends on taking care of problems (Gershon, 2010, p.65).

Tab. 1 COPQ and sigma levels

Sigma level	DPMO	COPQ as % of sales
2	308,537	not applicable
3	66,807	25 - 40%
4	6,200	15 - 25%
5	233	5 - 15%
6	3.4	< 1%

(Denis, 2012, author’s own processing)

As an evidence of Six Sigma’s contribution in savings Swedish company Volvo Cars can be used with more than 55 million euro saved during 2000 and 2002 as well as the company Ericsson with approximately 200-300 million euro savings between 1997 and 2003. Six Sigma projects are designated to result in economical savings which means that all improvements made under the Six Sigma are economically justified. This is considered to be an advantage however Roe (2011) argues that Six Sigma projects do not serve customers to the same extent as TQM programs (Roe, 2011 in Andersson et al., 2006, p. 292). This is because prime emphasis is on economical savings in Six Sigma projects, followed by customer satisfaction at the second place. The next positive thing concerning Six Sigma is considered management involvement in the process. After members of the project have reduced the process' variations which have resulted in increasing profit or lowering the costs, the improvements are submitted to the top managers who support the project because of its positive economic impact (Andersson et al., 2006, p. 291). Antony (2004) warns against evolution of training efforts to bureaucratic menace by focusing only on number of belts in the company regardless performance issues (Antony, 2004 in Pepper and Spedding, 2010, p. 145).

Naslund (2008) introduces the list of eight characteristics contributing to Six Sigma's bottom line success:

1. "bottom-line results expected and delivered
2. senior management leadership
3. a disciplined approach (DMAIC)
4. rapid (3 – 6 months) project completion
5. clearly defined measures of success
6. infrastructure roles for Six Sigma practitioners and leadership
7. focus on customer and processes
8. sound statistical approach to improvement".

When we want to obtain a process improvement it is necessary to have a complex methodology to follow. TQM failed in this way being only a "philosophy". Associating quality improvements with specific business metrics, creating united easy-to-follow method with plenty of tools allowing accomplish the individual steps, establishing important expertise by creation of belts qualifications and providing intensive training program, Six Sigma has answered the critics of TQM and has been considered very successful process improvement methodology all over the world (Pepper and Spedding, 2010, p. 145)

1.2.3 Lean management

Lean management or lean production was developed on the base of Toyota Production System (TPS) in 1950s. Instructions from Eiji Toyoda to eliminate all waste in the company had caused the creation of new manufacturing concept mainly by Taiichi Ohno (Pepper and Spedding, 2010, p. 138). In that time waste was defined as: "anything other than the minimum amount of equipment, materials, parts, space and time which are absolutely essential to add value to the product" (Russell and Taylor, 2000, p. 737). The name "lean" became famous since its first mention in James Womack's book The Machine That Changed the World in 1990. The term "lean manufacturing" was published (Hawkins and Smith, 2004, p. 10).

In the literature, seven common types of waste can be found: overproduction, correction or defects, inventory, motion, over-processing, conveyance and waiting. Table 2 lists some examples of each type.

Tab. 2 Examples of waste types

Overproduction				
preparing extra reports	reports not even read	multiple copies in data storage	over-ordering materials	duplication of efforts/reports
Correction/defects				
incorrect data entry	paying the wrong vendor	phonetic errors in communication	making bad product	discarded material/labor during production
Inventory				
transactions not processed	bigger "in box" than "out box"	over-ordered materials consumed in-house	over-ordering raw materials	
Motion				
extra steps	extra data entry	having to look for something		
Over-processing				
sign-offs	reports with more information than needed	reports, emails, etc. with more than necessary points	too long voice mails	
Conveyance				
extra steps in the process	distance traveled	moving paper from place to place		
Waiting				
processing once a month instead as the work comes in	showing up on time for a meeting starting late	delayed work due to lack of communication from another internal group		

(Opensourcesixsigma, 2008, author's own processing)

Overproduction leads to creation of idle capital by producing more than necessary parts demanded by customers or creating work-in-progress queue because of faster rate production than required. It is making more than needed in the next step or than customer buys. Waste of correction includes the waste of handling and fixing mistakes. It creates unnecessary costs because of additional equipment or labor expenses for example costs on scheduling employees to work overtime to correct defects. Waste of inventory is created by obtaining raw material before it is really needed. Minimization of inventory leads to higher flexibility to customer's requirements. Next type of waste, motion, covers unnecessary movement of people and equipment, for example programming delay times and excessive walking distance between operations. It is a movement which does not add any value to the product. Over-processing as another type of waste arises from wrong understanding what customers really want or from poor design of products and tools, for example painting internal components of the equipment. Conveyance means moving material or people despite time and expense incurred does not produce product or service characteristic that customer sees. The last but not least type of waste is waiting which means nonproductive time due to lack of material, people or equipment, it is cost of an idle resource. As an example can be an employee who waits for machine to finish its cycle, or a machine waiting for the operator to load new parts (Opensourcesixsigma, 2008)

Lean can be defined as "the systematic removal of waste by all members of the organization from all areas of the values stream (Womack and Jones, 1994 in Naslund, 2008, p. 273).Furthermore, Naslund (2008) connects findings of many authors and concludes that lean increases efficiency, decreases costs by elimination of the steps that do not add value to the process, reduces cycle time as well as increases organization's profit so it makes a company more competitive in the market. Lean focuses on identifying and removing all waste from process in order to make it faster at lower costs. Because many companies spend up to 90 percent to non-value-adding activities and only remaining 10 percent bring some value to the product or the customer, lean aims to increase the percentage of value-added work (Opensourcesixsigma, 2008, p. 66).

Mapping and analyzing all the activities in the processes covers value stream mapping (VSM). As value stream includes all the activities needed to make a product, VSM identifies value adding and non-value adding (waste) activities. If used correctly VSM can be really reliable qualitative analysis tool. It can be done either with paper and pen or in some software which is faster and gives user dynamic view of the value stream (Pepper and Spedding, 2010, p. 139; Naslund, 2008, p. 274)

It is recommended to map a value stream before applying other tools lean uses for example single minute exchange of die or 5S, in order to achieve truly lean operation. Probably the most commonly used lean tool is 5S (Pepper and Spedding, 2010, p. 140). It is a process designed to organize the workplace, keep it clean, maintain standardized conditions, and instill the discipline required to enable each employee to achieve and maintain a world class work environment. It consists of 5 Japanese words (with English translation) starting with S:

- **Seiri** (Sort) – put things in order
- **Seiton** (Straighten) – proper arrangement
- **Seiso** (Shine) – clean
- **Seiketsu** (Standardize) – purity
- **Shitsuke** (Sustain or Self-discipline) – commitment

Seiri means separation of needed tools and instructions from those unneeded materials and removing the latter. Seiton talks about arranging and identifying tools and materials for ease of use. Seiso means leading a cleanup campaign. Seiketsu is about conduction seiri, seiton and seiso as frequent as possible, indeed daily, to maintain a workplace in perfect condition. Shitsuke means to form a habit of always following first four S's. 5S is simply about clean and arranged working environment which helps to achieve high quality and high productivity work (Opensourcesixsigma, 2008, p. 73).

Andersson et al. (2006) state that lean increases customers' satisfaction because of analysis customer's demands of the process when selecting a lead-time reducing project. As more effects they see reduced inventory as well as increased productivity. Top management involvement is also positively evaluated as lean approach requires “effective company-wide communication and feedback” (Lynds, 2000 in Pepper and Spedding, 2010, p. 141).

Criticism against lean lies in its non-pro-employee oriented approach. Lowering costs by cutting number of employees may be threatening to them. As Spear (2004) states: “management tend to concentrate on tools and practices, rather than viewing lean as philosophy, aiming to teach new improvement tools to employees, rather than immersing them in the practical side of solving opportunities for improvement with a lean approach” (Spear, 2004 in Pepper and Spedding, 2010, p. 142).

When implementing lean, the systematic approach has to be adopted with focus on whole system optimization and usage of right strategies at the right places. It is not possible to cut inventories in high volatile company. This could lead to even higher exposure risk and do unwanted inconvenience.

1.3 Lean Six Sigma

While Six Sigma and Lean methodologies have both been used for many years, their integration can be observed in the late 1990s and early 2000s (Antony and Laureani, 2011, p. 111). As observed with other quality management concepts, opinions on Lean and Six Sigma's combination in the literature differ as well.

As we have already mentioned, Six Sigma focuses on improving quality and Lean aims to reduce flow time. They are both oriented on customers' satisfaction, lean by ensuring smooth and uninterrupted product flow as well as producing only what customer demands and Six Sigma by cutting costs by reducing variability and properly choosing projects strategically relevant to company and customer (Greatbanks, 2012, p. 11). Assarlind, Backman and Gremyr (2012) add that companies operating only with Six Sigma may risk providing poor service for customers because of long lead time even if producing at Six Sigma level which can be supported by George (2002) who says that Six Sigma does not directly focuses on process speed. On the other hand, Six Sigma offers lean with more scientific approach to quality, tools and know-how to solve specific problems (Pepper and Spedding, 2010, p. 146).

Bendell argues that in spite of many consultancy models throughout the internet freely available, there is no logical explanation of merging Lean and Six Sigma together. Moreover, choice of techniques used in LSS models has no theoretical underpinning or explanation (Bendell, 2006 in Pepper and Spedding, 2010, p. 148). Mika states that these methodologies are not even compatible because not every worker in the company can adopt Six Sigma, while lean is accessible to them and maintains effective teamwork (Mika, 2006 in Pepper and Spedding, 2010, p. 148). On the other hand these differences can contribute to each other by integration of Six Sigma and Lean when it provides employees with empowerment also "at higher-level process analysis stages", so that they feel like really owning the process. When applying separately it can bring rivalry to the company while competing for the same resources (Peppers and Spedding, 2010, p. 147).

Kumar et al. (2006) provides us with key points about LSS from their work of developing LSS framework to implement at an Indian SME (Kumar et al., 2006 in Pepper and Spedding, 2010, p. 150):

- there is no standard framework for Lean Six Sigma;
- there is no clear understanding concerning the usage of tools, etc., within the LSS framework; and
- with the framework presented, there is no clear direction as to which strategy should be selected at the early stages of a project.

It is not clear which methodology to apply in the beginning of LSS implementation. In the literature there can be found that some authors recommend bringing Lean to Six Sigma’s analysis phase, others see Lean as a standard in the company and use Six Sigma for investigation and elimination of variations in such a standard (Assarlind, Backman and Gremyr, 2012, p. 23).

Assarlind, Backman and Gremyr (2012) state that the term Lean Six Sigma refers to either two methodologies integrated into one concept, or using both separately in the company. They use an example of two managers whose companies use LSS. One views LSS as the simultaneous use of both methodologies while the second talks about mixing tools from both and using the appropriate parts from each methodology. Another comparison is about black belt using Six Sigma way of thinking complemented with free usage of lean tools and ideas. Opposite to this is the idea of CPS manager who uses Six Sigma for larger projects and lean for everyday continuous improvements – the more the employees operate on lean with only some influences of Six Sigma (Assarlind, Backman and Gremyr, 2012, p. 28).

However, when combining Lean and Six Sigma, the balance should be kept in the use of both. When being too lean, there is a risk of being inflexible to the market changing conditions. On the other hand, orientation on variation reduction to zero level can cause waste of unnecessary resources. “The balance lies in creating sufficient value from the customer’s viewpoint, so that market share is maintained, while at the same time reducing variation to acceptable levels so as to lower costs incurred without over-engineering the processes” (Pepper and Spedding, 2010, p. 147).

When implemented successfully, LSS can bring many potential benefits to the organization. These can be for example: “improved cross-functional teamwork across the organization; increased employee morale; improved consistent level of service through systematic reduction of variability in processes and effective management decisions due to reliance on data and facts rather than assumptions and gut feelings” (Antony, 2004a in Greatbanks et al., 2012, p. 11). These benefits may ensure valuable results to the company in the world where customers expect no defects and fast delivery at the minimum costs.

1.4 Lean Six Sigma certification

Lean Six Sigma methodology ranks its practitioners as colored "belts". Color depends on level of knowledge, skills and amount of projects done with appropriate financial savings. There are four colors a person is able to gain – white (WB), yellow (YB), green (GB), black (BB) and master black belt (MBB) (Antony and Laureani, 2012, p. 113).

As LSS exists for about twenty years it has no globally accepted standards for certification of belts. It is possible to find some organizations providing such certification, but it is not favorable amongst employers. The reason is simple – at these courses one only pays fee, attends some lectures and gains certificate without working on the real project. Consequently, many companies have set up their own standards for LSS certification, containing number of hours of training needed, passing adequate exams and saving certain amount of money with particular project (Antony and Laureani, 2012, p. 110).

However, Antony and Laureani (2012) introduce some commonly accepted definitions of the belts, with number of training hours, competencies and money saved with the project run:

- *White belt*: 40 hours of training, up to 12 projects a year with the financial return of $25,000 per each, participation on GB and BB projects
- *Yellow belt*: similar to WB, along their other job responsibilities participate on GB and BB projects
- *Green belt*: 80 hours of training, one or two projects with savings of $25,000, participate at BB projects or can lead their own, using many of the same tools as BB, focus on project within a single location or division
- *Black belt*: 160 hours of training, large projects with saving up to $300,000, using sophisticated tools and statistical techniques
- *Master Black belt*: BB experienced enough with few years of LSS practice, full time practitioners of LSS, mentors to GB and BB.

As mentioned above, these requirements and responsibilities of different belt ranks may change depending on company's own certification system. 84 per cent of Black belts state they are required to pass an exam for certification, complete two projects which save at least $181,563 each on average. To illustrate differences in certification standards here are some major companies' examples: candidates at Motorola and Microsoft have to pass the exam to obtain their belt while people in DuPont do not have to. Motorola has project specific targets at certain level of belt hierarchy in contrary to DuPont which has financial targets. Moreover, candidates in GE are told what projects to work on while those in Motorola can come up with their own project beneficial for the company (Antony and Laureani, 2012, p. 115).

Research of Hilton and Sohal (2012) shows attributes of BB and MBB. Certified BB should use their strong statistical knowledge, apply advanced statistical tools and use information gained to solve the problem in the company. They should also have minimum of leadership skills because they work on large projects where they need to guide GB and BB as well as they should prove their knowledge and understanding of project management. BBs are "full-time project leaders improving processes within their organizations" (Hilton and Sohal, 2012, p. 58). Strong leadership skills are needed even at MBBs as they will couch several BBs within their own projects. They should also deliver training for BBs, carry out certification for GBs and BBs, provide technical advice, and develop or refine methodology (Hilton and Sohal, 2012, p. 57).

Antony and Laureani (2012) highlight consequences of different standards for LSS certification among companies. It is difficult to hire LSS practitioner because of different preparation standards in the company where he or she got belt. Difficulty can be seen also when comparing effectiveness of consulting and training partners. Last, but not least, companies need to build their own certification process as there is no standard for LSS certification in the world.

1.5 DMAIC

Lean Six Sigma uses two methodologies for the process improvement, each consisting of five stages. These methodologies are DMAIC (for already existing processes which need improvement) and DMADV (for projects creating new product or process design). This part will focus on DMAIC and bring more detailed description of each stage of the methodology.

1.5.1 Define

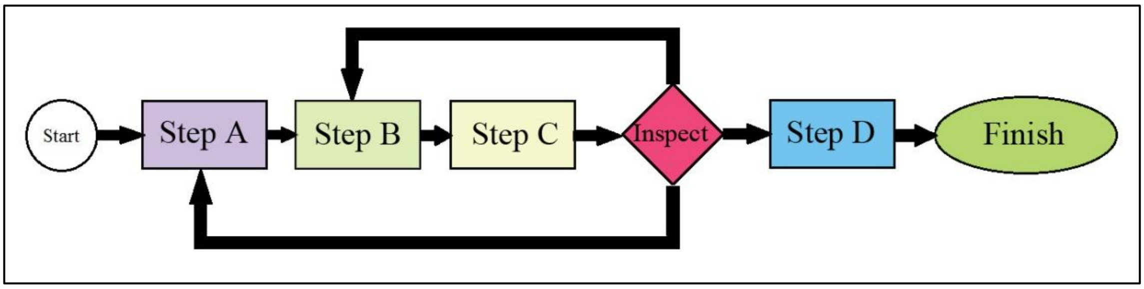
As the first phase of DMAIC, define phase aims to provide LSS project team with very well developed and articulated project. This is very important as it is known that well refined definition of a project can ensure even 50% of a project's success. It is very important for all the team members to know what the project is about, what its goals are, which steps will it consist of, what are their tasks and who is responsible for what, which tools to use and so. Detailed preparation of the project should avoid all misunderstandings during its complementation.

In the beginning is the equation $Y=f(X_i)$ where Y is the process' problem caused by many variables X. The crucial for Lean Six Sigma is to choose one to three X which are critical causes of the problem chosen to be solved. For discovering these Xs, Pareto analysis can be used. This is why LSS is problem solving methodology because it understands the relationship between dependent and independent variables and by optimizing critical independent variables it allows control of dependent variable followed by controlling optimized independents in order to prevent repeated problems (Opensourcesixsigma, 2008, p. 11).

For Lean Six Sigma it is important to focus on the so called voice of the customer (VOC), business (VOB) and employees (VOE). These three voices provide companies awareness of the critical to quality needs of their products and services, identify differences between the real situation and the desired one, identify defects in processes and which processes are the most b2008en and also they uncover company's costs of poor quality. VOC is probably the most important of the triad because sales of the firm depend only on customers' preferences and needs, but meeting business' needs ensure the company to stay in business while VOE tells the company how it meets employees' needs so they stay employed within and are always inspired and productive. VOC helps the company to understand its internal and external customers' requirements and finding information that are critical to quality (CTQ) such as product's performance, features, reliability, durability, etc. (Opensourcesixsigma, 2008, p. 15). These CTQ must be collected and translate into measurable requirements providing the team with possibilities of improving the process or solving the problem (Goleansixsigma, 2013a). Another important factor is to determine costs of poor quality (COPQ) which are defined as financial opportunity of the project team's improvement efforts (VOB). COPQ is a symptom resulting from defective process. LSS project aims to fix those defects in order to improve symptoms. Over time COPQ has been changed by reduction of waste because waste covers poor quality together with other costs not integral to the product or services the company provides (Opeansourcesixsigma, 2008, p. 31).

When selecting a project three main components have to be present: business case, project charter and benefit analysis. Business case is a high level of articulation of the area of concern. It answers two questions – what is the business motivation for considering the project and what does the company focuses on most to improve? Project charter can be considered as more detailed version of the business case. The document further focuses on improvement efforts. It contains two main sections – basic information about the project and simple project performance metrics – primary and secondary. Primary metrics are the actual measures of the project's defects or errors, secondary metrics are measures of potential consequences after changing the process. Benefit analysis is a comprehensive financial evaluation of the project. It is concerned with the detail of the benefits in regard to costs and revenues expected as a result of the project (Opensourcesixsigma, 2008, p. 44).

One more thing in the Define phase of the DMAIC methodology needs to be created. It is a high-level process map which shows how the process will look like with its start and end points, all process steps, all decision points and directional flow. A process map helps all members to understand their responsibilities in the process and how their process fits into the bigger picture. It helps to see where problems occur and what may cause them. It visualizes the whole process needed to be done during the run of LSS project. Process map is "live" document which means it has to be updated as the process changes. Picture 5 shows a structure of Process map which is made of different shapes, each means different parts of the process. For example a rectangle indicates an activity, a diamond signifies a decision point emerging by only two possible paths: YES or NO. These paths are drawn as arrows symbolizing connection or direction of the process flow. A parallelogram shows that there are data. An ellipse determines start and end of the process. These are only examples of commonly used symbols. Process map can show involvement of more than one department into the whole process. Such map is called Cross functional process map and has all departments involved divided by drawn horizontal lines (Opensourcesixsigma, 2008, p. 26).



Pic. 5 Simplified Process map

(author's own processing)

The Define phase is the first of the Lean Six Sigma improvement process. The output of this phase should be a Process charter, high-level process map, fully understood customers' needs and requirements so the whole project is properly described. This is the critical part of LSS by mastering which 50% success of the project should be reached.

1.5.2 Measure

After defining the problem, its main causes, all the critical to quality features required by customers as well as the design of the whole process of completing LSS project the LSS team is able to start measure phase of the project. In the measure phase the team will find out the real state of the problem, its measures and values, they will calculate Sigma level of the project and other important calculations.

For finding out which three causes of the problem are mostly relevant the team uses process mapping, fishbone analysis and basic data analysis. In fishbone analysis Ishikawa diagram (or Cause and effect diagram) is created where all the potential causes (which came up during the brainstorming method for example) resulting in a single effect or output, are captured. They are arranged into categories according to the needs of the project, for the administration and services sectors there are mostly four categories: equipment, policies, procedures and people. The next what should be done is detailed high-level process map as it was described in the define phase. By mapping processes very important characteristics can be identified and important information for other analytical tools should be developed: process inputs and outputs, supplier requirements, actual customer's needs, all value adding and non-value adding steps and tasks, data collection points, decision points, problems with immediate fixes or process control needs. There are different types of process maps, for example SIPOC (Supplier-Input-Process-Output-Customer) or Value stream map. The final stage is to create X-Y diagram which is a tool for identifying potential X's (problem causes) and assessing their relative impact on multiple Y's (problems). By adding weight according to the scale chosen to all potential and real causes assigned to Y's the team obtains all the X's ranking so it is clear which three are the most essentials (Opensourcesixsigma, 2008).

In the next step after determining root causes of the problem the LSS team considers where to get the right data which will further be used in the analyzing phase. For this step the tool called Data collection plan should be used. Data collection plan includes information about the source and location of data needed, size of a sample, when the data will be collected and by using which method, who is responsible for collecting them and whether there exist other data that should be collected at the same time. Such plan has to be created for each performance metric and includes its operational definition and sampling plans (Goleansixsigma, 2013b).

By using various statistical tools LSS team will choose an appropriate measurement sample and carry out all the calculations and measurements needed to ensure that next steps action will be based on real data and facts not only some estimations or assumptions. Moreover, actual sigma level of the problem performance should be calculated to get information about how effectively the company or the department performs.

When all the important and relevant data are obtained the LSS team can start the analyze phase of the DMAIC methodology.

1.5.3 Analyze

In analyze phase the team uses various statistical tools in order to analyze and evaluate all the data obtained and measured in the previous phase. The goal of this phase is to track down the cause and effect relationships producing targeted defects, delays of process, and to answer the question “Why?” about the existence of the problem. Analyze phase explores the relationships between input and output of the process (George, 2002, p. 175).

Each step of the detailed high-level process map created in the Measure phase should be analyzed, because only seeing where exactly the problems appear is not sufficient. So the process analysis should be done which consists of three parts: time analysis, value added analysis and value stream mapping. Time analysis provides detection of the time wasted during the whole process. The team finds out how much time is being spent on each step and whether this time is spent for contribution to the process itself or spent by waiting which is considered as waste (see chapter 1.1.3 Lean Management). Value added analysis encourages the team looking at the process through the eyes of the customer. It helps to realize the costs of doing the business and improve the process by enhancing the attributed critical to quality or important to customers. Value stream map is used for eliminating waste from the process. It maps the flow of all steps, process delays and information needed to deliver the product to the customer (Goleansixsigma, 2013c).

For better understanding and further communication among the team members and team members towards the leaders it is recommended to visualize all the data and relationships obtained. For this purpose it is possible to use Pareto analysis, various diagrams and graphs (Goleansixsigma, 2013c).

There are many tools to be possibly used, for example Simple line regression which is used to make prediction of how the data will perform based on the line established and it gives us a confidence about the prediction based on closeness with they fit the line. Next tool is Correlation coefficient which calculates the impact of the two different factors on each other. Its value ranges from -1 to +1 and the closer it is to the upper or lower limit the correlation of the two factors is stronger, either positive or negative. As other tool can be used hypothesis testing. It is based on acceptation or rejection of a null hypothesis and alternative hypothesis contrary to the null one. In this way means, variances or proportions for example can be tested. Hypothesis testing helps the team find out verity about their assumptions deduced from measured data (Dirgo, 2005, p. 67).

However, Opensourcesixsigma (2008) warns about various possible roadblocks which may arise during the Analyze phase. These are:

- lack of data
- data presented is the best guess by functional managers
- team members do not have time to collect data
- process participants do not participate in the analysis planning
- lack of access to the process.

It is very important to be careful of such roadblocks and prevent them or remedy them if they already emerged because the Analyze phase makes a basement for the most important phase of the whole project – Improve phase. When there is lack of analysis and findings about the root causes of the problem targeted, it is hard to propose some improvement process.

1.5.4 Improve

The Improve phase of LSS project focuses on finding solutions how to eliminate causes of defects, delays and problems found out as significant in previous phases. Dirgo (2005) offers three methods team members may find useful during the Improve phase: design of experiments, response surface methodology and evolutionary operations. In more detail he explains experiment designing as factor providing information about interaction between proposed factors in the experiment as well as optimal combination of factors levels. He mentions various possible types of experimental design, for example “randomized and randomized block designs, full factorial designs, fractional factorial designs, mixture experiments, and Taguchi designs” (Dirgo, 2005, p. 68). Moreover, the author proposes methodical approach to experiment designing. Starting with identification of desired design output and process to study, following by brainstorming method to figure out many possible input and output factor. Then picking up the most appropriate design of the experiment and execute it with recording all results. It is possible that the experiment will need to be rearranged by replacing some factors with other ones, adjusting factors' levels, etc. so that the team obtains the best results for creating the best possible solution of the project problem.

Steps of all phases are quite similar among many authors. For example Goleansixsigma (2013d) suggests starting with brainstorming in order to get as many ideas for solutions as possible. After collecting all the possibilities selection of the most appropriate ones is the lead. When project leaders are not able to employ all the solutions and it comes to choose between conflicting options, they can use a tool called Weighted criteria matrix which helps them to choose better one. This matrix assigns weights to criteria based on their importance. Then possible solutions get scores resulting from points they got in each criterion multiplied by criterion weight. After that solutions are ranked according to scores they obtained and LSS team leaders and members are able to see which criterion is more important to be implemented as first. When having all the practical solutions chosen the team should create so called To-Be Map. This is the new process map displaying the future state of the process after removing all waste, or non-value adding activities from the current process. Following by experiments of the possible solutions, the best ones should be chosen to be implemented. Successful implementation, as the last step of the Improvement phase, requires careful and detailed planning. In this step of the fourth phase it is necessary to plan "logistics, training, documentation and communication plan" (Goleansixsigma, 2013d). The author suggests that the more times spent on planning the implementation the faster total adaptation to implementation will be reached by all team participants.

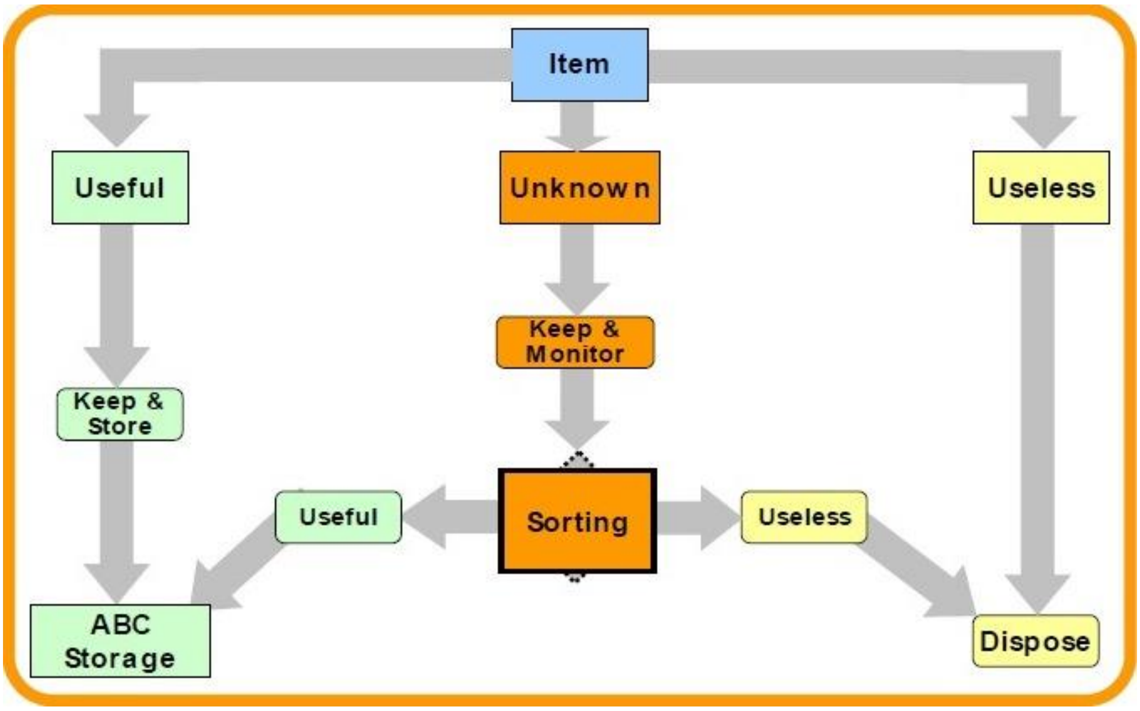
1.5.5 Control

Finally, after having implemented the best chosen solutions to the particular project, LSS team has to ensure and provide control of the new process. The objective of Control phase is to institutionalize the process changes and ensure that the gains are sustainable over time. This can be done by implementation of continuous measurement system.

In order to sustain all proposed and implemented improvements Dirgo (2005), Goleansixsigma (2013e) and Opensourcesixsigma (2008) agree that it is necessary to use tools and disciplines of Lean management. According to Opensourcesixsigma

(2008) these are 5S, Visual factory, Standardized work, Kaizen and Kanban. The author suggests using and achieving them in the order because they will not work implemented without previous ones.

5S tools (see chapter 1.2.3 Lean management) being used for workplace organization contain Sorting, Straightening, Shining, Standardizing and Sustaining. Sorting as first step of reorganization process aims to sort out necessary and unnecessary items of tools and material as well as solve storage of items. It often starts with great cleaning during which all items are classified as useful, useless or undetermined if it is not known whether such item is useful or not. It remains at the workplace for observation for some time. Items classified as useful are then stored, useless ones are disposed (see process map at Picture 6). The philosophy of storage place according to frequency of using particular item is shown in Table 3 below.



Pic. 6 Sorting process map

(Opensourcesixsigma, 2008)

Tab. 3 Storage philosophy of items according to usage frequency

Frequency of utilization	Keep within arm's reach	Keep in local location	Keep in remote location
Daily	YES	MAYBE	NO
Weekly	MAYBE	YES	NO
Monthly/quarterly	NO	NO	YES

(Opensourcesixsigma, 2008, author's own processing)

Straightening as next step tells about arranging necessary items at their own determined places visible and accessible to people using them. Thing which are used together should be also kept together. It is recommended to use various tapes, markers, or signs to label storage places in order to easier finding it. Moreover, sharable items should be kept at a central location. Shining as the third of 5S aims to maintain workplace clean and swept. Cleaning should be everyday work's part as prevention against mess should be very important part of "shining". The fourth of 5S, Standardizing, creates consistent approach for carrying out tasks and procedures. In order to sustain first three S's it is necessary to keep the whole workplace at a level where it is simple to uncover any hidden problem, however, in such workplace problems occurred should be visible to everyone working there. The last S "Sustaining" learns to sustain the first four S and make it a habit used in everyday life of employees in a company. It is necessary to sustain the workplace in order to prevent failing into dirt and chaos again. Clean and organized environment contributes to how one feels about company he works for, about a product, process and themselves. "When employees take pride in their work and workplace it can lead to greater job satisfaction and higher productivity." (Opensourcesixsigma, 2008, p. 567).

These 5S standards are the basis and foundation of Visual factory which is defined as "a workplace where recently hired supervisor can easily identify inventory levels, extra tools or supplies, scrap issues, downtime concerns or even issues with setups or changeovers" (Opensourcesixsigma, 2008, p. 567). To make it possible the workplace must be well organized and kept clean and opportunities must be clearly indicated.

When 5S are implemented and Visual factory is reached the company is able to move on to the next step which is Standardized work. It suggests creating a standard of each operation and performing according to this standard. In order to maintain standard work operators must know where needed tools or materials are, they need visual signals to keep the work standard and in-process stock has to be replenished as the inventory lowers. These conditions assume effective usage of 5S and functional Visual factory (Opensourcesixsigma, 2008).

After working and producing according to standard the company should aim to embrace Kaizen. It can be defined as “the philosophy of continual improvement, that every process can and should be continually evaluated and improved in terms of time required, resources used, resultant quality, and other aspects relevant to the process” (Miller and William, 2006, p. 75). Kaizen suggests that it is very important for a company to have management support at workplace among workers. Managers should try to remove obstacles from workers’ success. Employees are value-adding parts of the process so they need to feel management support in order to be willing to work for them. Strong process orientation, high standardization and little innovations or improvements are key elements to success. Kaizen assumes elimination of waste in the company while using 5S (Moore, 2007).

The last philosophy of Lean is Kanban which originates from Japanese word which means “visible sign” or card. Al-Turki, Gupta and Perry (1999) suggest that one of Kanban’s advantages is its ability to control production and Opensourcesixsigma (2008) sees it as the best control method for inventory. Kanban “pulls” products and material through and into the Lean manufacturing system. It works on principles of signal such as empty container or small card. For example if the container of material is empty a competent worker fills it up or calls a supplier to get new parts. It is possible to consider some other advantages of this philosophy such as simplicity in production scheduling, reduction in paper work, easy identification of parts by the kanbans attached to the containers (Al-Turki, Gupta and Perry, 1999, p. 1066). However it is necessary to adhere presumptions for successful Kanban existence in organization. These are relative stable demand cycle, consistent cycle times defined by standardized work, small amount of variation and nearly zero defect sent to the assembly process as well as strictly standard number of parts per kanban which should be kept as few as possible parts per card. Kaban should help the company to smooth out inventory and keep product flowing but it has to be used continuously. It is not a tool for quick fixes and moreover all four previous steps must be accomplished so that it won’t backfire.

After implementation of Lean control tools defect controls should be set up because defects may appear even after implementation of solutions to the process and sustainable improvement will not be able to reach until defects are under control. Defect prevention aims being permanent by eliminating severely defining human intervention in the process. In order to provide such control a company will use a software calculating regression to determine tolerance range for the input. Furthermore introducing process automation can help to control the process. There are various automation types known for example full automation, process interruption and mistake proofing (Poka-Yoke). Full automation covers processes which monitor the process and automatically adjusting critical inputs to correct settings. On the other hand mechanisms installed to interrupt the process in order to prevent further operation when a variation from standardized process occurs are parts of process interruption. For a re-launch of the process required action has to be performed. The last example of automation is mistake proofing which aims to prevent mistakes either before they occur or even after. It is very effective prevention against defects and usually inexpensive and can be defined as “using wisdom, ingenuity, or serendipity to create devices allowing 100 percent defect free step 100 percent of the time” (Opensourcesixsigma, 2008, p. 580). Defect proofing devices should be designed simply, inexpensive, giving prompt feedback and action, with focused application and right people’s input. Best of them should make creating a defect impossible. Main advantages of mistake proofing as a control method are simple training programs required, elimination of inspection operations, promotion of value-adding activities, operators do not have to repeat tasks of visual inspection, etc. (Opensourcesixsigma, 2008).

Furthermore, control chart and control plan as another control phase tools are used to ensure that the process is monitored and managed properly. Control charts fall under statistical process control and are charts capturing special cause variation which indicates that process is not under control. They consist of all samples collected during the process and showing whether they fall into control limits. There are many types of control charts: I-MR charts combining individual charts with average moving range chart, XBar-R charts used mainly for monitoring and controlling the stability of the average value, C and U charts tracking defects, NP and P charts tracking defectives. On the other hand, control plan is living document allowing team to formally document all control methods used to meet project goal. It must be updated as new control methods and measurement systems are added to the process of continuous improvement. Control plan is good control tool because it ensures product quality by requiring all people participating in the process to follow designed control methods, allows belts to move on to the next project, and so on. It consists of five elements: documentation, monitoring, training, response and aligning systems and structures (Opensourcesixsigma, 2008).

1.6 Theory of interview

An interview as a research method can be defined as an exchange of views between two people who are talking about topic of their common interest. One of these people is interviewer who is in the role of researcher and the second is interviewee (Kvale, 2007 in Avital and Schultze, 2011). Interview is considered unnatural kind of conversation as the rules of such conversation are explicit – it is determined in advance what will be discussed, for how long, and each party's role during the interview. Ethical rules concerning consent for the interview, recording and retaining subject's anonymity and respondent confidentiality has to be adhered because interviewee is a person not running the research and he might not be willing to provide researcher with some kind of information as well as some information might be secret. However, interview allows researcher see the problem through respondent's eyes, know his feelings, opinions and values while being an interactive method allowing researcher clarifying questions and identifying unexpected themes (Hammont and Wellington, 2013). The main difference between interview and questionnaire lies in interview's open questions where interviewee determines his own answers in contrary to questionnaire's predefined answers "in some sort of choice format" (Gillham, 2005, p. 3).

In the literature there are many types of interviews known classified according to different factors such as distance between subjects and interview's structure. According to distance interviews can be divided to:

- *Face-to-face interview* – meeting respondent face-to-face. This type is more familiar, by coming to respondent's home or work researcher shows kind of commitment in accessing his voice. Responding questions is spontaneous and there is no worry about the functionality and knowing of technology (Hammont and Wellington, 2013).
- *Distant interview* – reaching interviewee at a distance by some type of technology, e.g. telephone, fax, e-mail. These types are provided because of lower costs or impossibility to meet with respondent face-to-face (Gillham, 2005). However, written communication is slower than speech and both subjects need to be comfortable with keyboard typing and Internet or even have an access to such technologies (Hammont and Wellington, 2013).

- *Online interview* – type of interviews using online technologies with video call possibility, for example Skype video call. It merges previous two types by being at different places, overcoming time barrier if needed and being able to see each other, so being face-to-face.

According to structure interviews can be divided to:

- *Unstructured interview* – questions are quite wide and general, less predictable with no strict list of questions (Hammont and Wellington, 2013), e.g. "What is it like working here?" (Gillham, 2005, p. 24). This respondent an opportunity to talk about what he wants and to lead conversation where he prefers.
- *Semi-structured interview* – this type is considered more manageable than the first one because of researcher's prepared reminders for what topics to talk about, e.g. relationship with managers, relationships amongst employees, working environment, benefits. When having appropriate amount of information to one such hint, interviewer can jump to the next topic he knows he will need (Gillham, 2005). Semi-structured type is more flexible than fully structured interview type (Hammont and Wellington, 2013).
- *Structured interview* – in this type of interview all questions are pre-prepared and specific. However, additional questions can be added during the interview when some answer is not clear to interviewer or respondent mentions some interesting topic which can be helpful carrying the research (Gillham, 2005).

After finishing the interview it is necessary to do a transcription of it in order to get "valid record transcription of the interview" (Gillham, 2005, p.121). Transcription is being done of face-to-face interviews, telephone interviews when the call has been recorded and all other types where the record has been made. On the other hand, interviews consisting of textural data do not have to be transcript. In the process of transcription, however, important aspects can be lost such as "dimensions of speech (emphasis, pace, tone)" altering the meaning of the words. For this reason, all records should be included in researcher's final work. Transcription should be done as soon as possible after making an interview, but no sooner than the day after because of setting up a pattern of interview followed by transcription and being fresh and interested to do it (Gillham, 2005).

Additionally, Hammont and Wellington (2013) suggest that interviewing is best doing in one-to-one situations. They argue that group interviews may cause only dominant participants would speak and the degree of agreement would be difficult to find out. On the other hand, greater confidence and safety may be perceived by respondents. Finally, to carry out good interview, it is recommended being well prepared in advance, to find out information about the person interviewed and the topics discussed as well as considering costs and time possibilities both subjects have.

1.7 Analysis of documentary evidence theory

Documentary evidence analysis is a method analyzing different documents available being very valuable source of data when access to the subjects of research is difficult or even impossible or when staff members are no longer employed in organization researched (Bell, 2010). Document can be defined as "any source of information, in material form, capable of being used for reference or study or as an authority" (Buckland, 1997). However, as digital technology has spread all over the world, documents can also have a digital form, not only material. Examples of documents can be journals, annual reports, photographs, slides, CDs, emails, etc.

There are two approaches to starting work with documents (Bell, 2010, p. 125):

- *Source-oriented approach* – content and amount of extant documents determine project and help generating research questions.
- *Problem-oriented approach* – an investigation of what had already been discovered about the subject of research is firstly done following by study of appropriate documents. Questions of research are formulated using other research methods.

According to intention of creating a document they can be divided to (Bell, 2010, p. 129):

- *Deliberate sources* – documents produced for purpose of other future researchers.
- *Inadvertent sources* – documents intended for other initial purpose than researchers use it for.

After deciding to use this method for the research it is necessary to collect the documents needed. Bell (2010) suggests that the amount of documents selected for study depends on the time available for this stage of the research. Researcher should familiarize himself with documents categories so he or she finds out which are fundamental for the research. In order to not miss any category a controlled selection of available evidence is needed to be done.

As the next step in the process of documentary evidence analysis is the analysis itself. Such analysis can be either external or internal. External criticism should find out whether a document is genuine and authentic and aims to be sure that the author created the document himself. In order to discover it questions about document's structure and form compared to similar documents should be posed, as well as about consistency of document with facts about the author or of place of author's being and issuing the document. Internal criticism investigates the content of the researched document. It is necessary to consider and detect information about what kind of document it is, who the author is, for what purpose it was created, what was the author's intention, under which circumstances it was created, how long after the event was it produced, is it already compete, is the author expert in what he or she describes, etc. However, not all these questions may always be applicable to all kinds of documents, but critical analysis is very important for not accepting them only at face value (Bell, 2010).

Very important step of document evidence analysis is deciding whether it contains facts or bias. When detecting a bias researcher should not make early conclusions but try to look for contrary evidence which could test the truthfulness of the document. Such documents can still be valuable and do not necessarily need to be discarded, they should only be analyzed carefully and compared to other reliable sources (Bell, 2010).

1.8 Summary of Theoretical part

The aim of the Theoretical part was to offer a literature review of Lean Six Sigma, its evolution, methodology it uses to carry out a project.

The first and second chapters deal with project and quality management as Lean Six Sigma can be seen as one of its tolls and concepts. The three preceding concepts of quality management, Total quality management, Six Sigma and Lean management were described because they are part of LSS evolution.

Third chapter is dedicated to creation and usage of Lean Six Sigma methodology. Opinions of various authors are presented, showing advantages and disadvantages of merging Six Sigma and Lean concepts or using them in parallel. In the end of the chapter potential benefits of using LSS are listed.

Fourth chapter is related to the process of certifying people under the concept of Lean Six Sigma. In spite of no unified and globally accepted standards and almost each company having established its own, the most commonly used belt rankings are listed including tentative requirements to obtain them. Examples of such differences are shown as well as possible consequences of such disparities. Description of responsibilities and supposed skills of Black and Master Black belts are also described.

The following chapter explains DMAIC methodology of Lean Six Sigma. Each step of the methodology is described in a separate sub-chapter showing adequate processing of LSS project using appropriate tools.

Sixth and seventh chapters deal with research methods used to carry out the research in the company in order to analyze the current situation. Sixth chapter describes theory of interview while seventh chapter covers theory of documentary evidence analysis.

2 PROBLEM ANALYSIS AND CURRENT SITUATION

The second part of this master's thesis will bring the analysis of current situation in the selected international business company (IBC) – ABC[1]. In the beginning the company with its international business activities will be introduced as well as Slovak financial department where the research was carried out. Secondly, using of Lean Six Sigma project approach in this department will be analyzed based on the research findings supported by particular project illustration.

2.1 Research

In order to obtain data for description of selected IBC and its Finance department, as well as provide an analysis of the current state with proposals to potential problems which may be discovered the author had carried out a research in Finance department using two research methods.

The first one was interview to find out current state of the company. Based on the contract with the company signed to get a permission to carry out the research, only one person to providing author with information has been chosen – Financial manager of Nordic IMT. The interview has therefore been quite long as he was the only one to get information and own ideas from. The interview was followed by document evidence analysis, using huge amount of company's documents to analyze. The approach taken to this analysis was problem oriented as the problems and areas to get more information were found out during the interview. Documents analyzed were inadvertent (see chapter 1.7 Analysis of documentary evidence theory) as they had been created for other purposes than this research (financial statements, annual reports, project statements,…).

The results and information gained are summarized below.

[1] For purpose of this master's thesis the name of the company and its employees had to be changed based on the contract with the company. All the information about its activities, projects, operations or LSS usage are true and based on real data, only the names have to be different from reality.

2.2 ABC – company profile

Created in 1911 by merge of three companies to found Computing-Tabulating-Recording Company (the name changed in 1924 as it has been growing on international levels) selected IBC is present on the market for 102 years now. Since its creation this company has defined its core values being forward-thinking culture and management practices. Operating in more than 170 countries world-wide and generating thousands of patents each year the company is real global innovating organization.

Selected IBC is one of the biggest IT companies in the world serving clients all over the world for decades of years and employing approximately 400,000 people around the globe. Each year the company extends its boundaries by entering new markets. Mission of the company is to help its customers to reduce costs and increase their competitiveness on the market by integrated, flexible and effective solutions. This mission is being accomplished by offering wide spectrum of IT technologies and solutions ranging from servers and data storage systems to software and IT services including consulting and implementing services. Since 2008 the company has launched global campaign called Smarter planet which connects business strategy with strategy of social responsibility. The aim of the campaign is contribution to sustainable development and building intelligent planet using smart solutions in conveyance, medical services, banking sector, public administration or energetics. There are five segments of operation of selected IBC: Global Technology Services, Global Business Services, Software, Systems and Technology, and Global Financing.

In 2012 the company reached the records in operating earnings per share ($15.25), free cash flow ($18.2 billion) and net income ($17.6 billion). These values have increasing trend which can be seen on pictures in Appendix 1 showing their development during last twelve years. The company's goal is to reach $20 Earning per share by 2015 while 50% of profit is expected to come from segment of Software.

Selected IBC as global international company drives process improvements across all functions, mostly focusing on business analytics optimization. It started decades ago with Six Sigma in manufacturing and later when it moved more to services sectors the Lean Six Sigma was used in transactional business. However, as LSS cannot be used everywhere mainly for rather bigger and more strategic projects, traditional project management is applied across selected IBC.

2.3 ABC ISC, s.r.o.

Until middle 90's of the 20^{th} century company ABC was decentralized despite its world-wide presence. Each branch was running its own business, managing its own processes. General headquarter was issuing requirements about desired revenues, costs, profits, number of employees, etc. for all branches. Requirements were set and it was each branch's own business how to reach required values and goals. Sharing ideas was not the matter until 1990's as was not developing of common programs, tools or strategies as well.

A reversion occurred in the last decade of the 20^{th} century when the first centers of excellence (CoE) came in. The purpose of creating such centers has been to centralize managing of processes, merge system strategies or financial support into one center, sharing of knowledge between the countries ABC had been operating in. Each center got some responsibility and its task was to execute it for branches it was determined to cover or support. These centers are for example Center of Finance, Customer care center, Center of Treasury Operation. They have been established in location according to costs amount, workforce qualification, strategic position, and others. As a result of creating CoE costs savings were gained, better flow of knowledge as well as higher efficiency of work as each center centralizes specialists for particular processes.

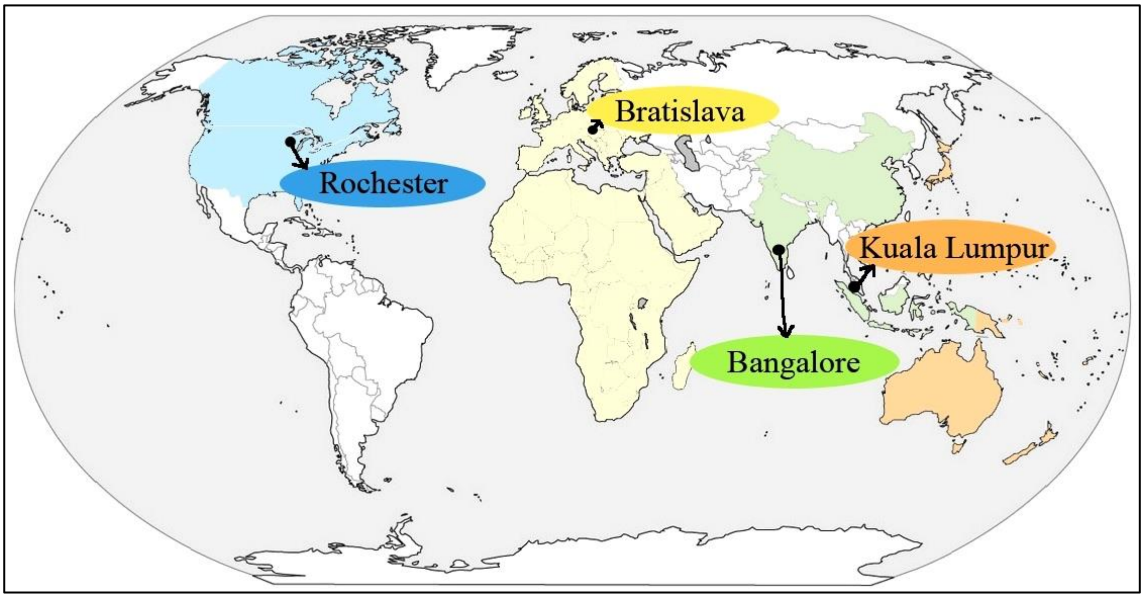
One of these centers is located in Bratislava, founded in 2003 as ABC ISC (International Services Centers), s.r.o. It concentrates about thirty centers each responsible for different activity provided for assigned branches. Founding conditions were positive in Bratislava because as the research revealed annual number of absolvents of universities of engineering was almost 6,000 and increases each year. Also wages conditions are friendly in the sector of information technology and communication in Slovakia compared to Germany where they are almost double (see Appendix 2). In Slovak site of selected IBC approximately 5,000 workers are employed.

2.3.1 Finance department of ABC ISC, s.r.o.

Founded in 2000 by setting up a center of accounting in Bratislava, Finance department of ABC ISC, s.r.o. was extended of finance and planning center in 2006. Until now it consists of seven major centers – finance and planning, accounting, pricing, tax, incentives and commissions. Finance department in Slovakia employs approximately 1,800 employees which is more than one sixth of total of approximately 11,000 employees in ABC worldwide.

Seven centers of Finance departments mentioned above are responsible for financial support of all ABC branches in the whole Europe. These are countries like Sweden, Greece, Switzerland, France and others. Slovak's department responsibility lies in creating and monitoring of income statements, balance sheets, cash flows as well as managing projects, monitoring inventory balance, receivables, costs, revenues, profits and other financial indicators.

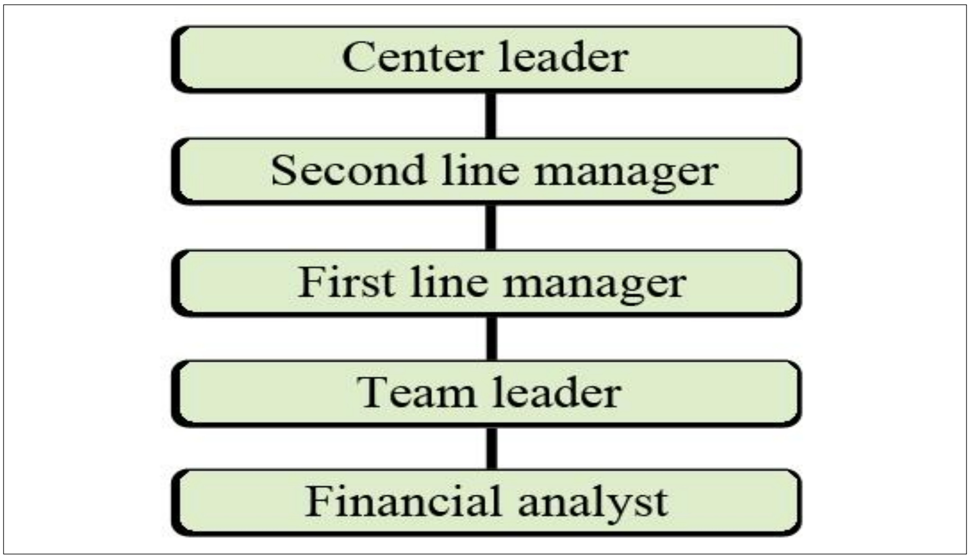
Moreover, selected IBC has four major Finance departments all over the world. They are located in Rochester (Minnesota, USA), Bratislava (Slovakia), Bangalore (India) and Kuala Lumpur (Malaysia). Each of these major departments supports different region (as can be seen on Picture 3 below) – Rochester gives support to USA and Canada, Bratislava covers Middle East, Europe and Africa, department in Bangalore is responsible for India and China, and Kuala Lumpur supports region of Australia, Japan and Oceania.



Pic. 7 Map of major Finance departments of selected IBC

(author's own processing)

Organizational structure of Finance department in Slovakia is as shown in Picture 8 – on the very top of the department there is Center leader under whom is Second line manager. The next position is First line manager followed by Team leaders and the lowest position is Financial analyst.



Pic. 8 Organizational structure of Finance department of selected IBC

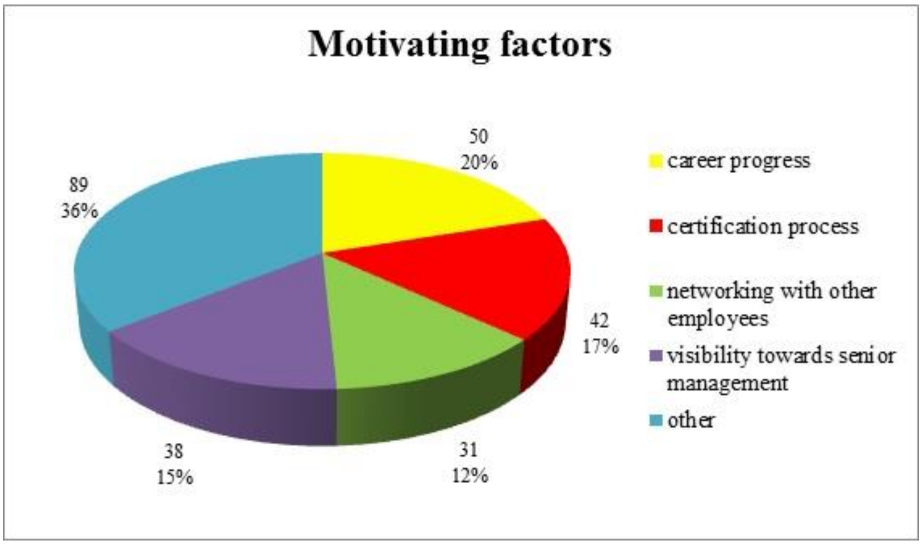
(author's own processing)

2.4 LSS in Finance department of ABC Slovakia

Since 2008 Finance department of selected multinational company has been applying Lean Six Sigma methodology to improve organization's financial processes. As described in chapter 1.3 Lean Six Sigma using this methodology can be seen in two ways – either as two methodologies used separately or as one methodology merging them together. Researched Finance department considers it one methodology simply because the projects they run require lean thinking and Six Sigma defects correction at the same time.

According to findings from analysis of company's materials Finance department operates at three to four sigma levels. The interviewed manager explains that to run some process on 6 sigma level huge amount of money has to be invested in order to be able to implement all improving solutions decreasing variations and removing defects and waste. It is possible in sectors where life is in menace such as pharmaceutical and surgery, or sectors like aerospace or company's center of chips and nanotechnology where projects are so expensive that everything has to be as perfect as possible when investing such amount of money. Those sectors try to operate on five to six sigma levels. He further adds that the goal of Finance department is to constantly improve within the budget of investment assigned.

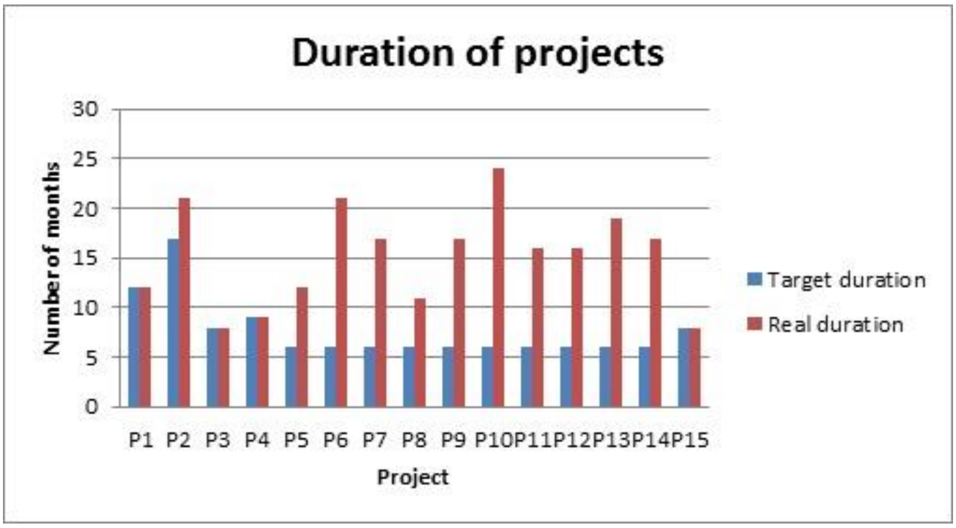
Employees of the department ranked as belts work in teams carrying out different Lean Six Sigma projects. Each team member contributes to the whole process according to his knowledge and skills depending on the belt he or she has already obtain as will be described in the separate chapter below. These employees are employed as full-time financial analysts and focus on LSS at the top of their activities. In order to find out the main factors of employees' motivation to participate in LSS projects and to proceed in their certification a sample of 100 employees was chosen and asked to tell their own motivating factors. Total of 236 factors was collected. As the research revealed the most common factors are faster career progress (20%), certification process (seen as an opportunity to get better and appreciation of their improvement efforts as the result of their work is visible by obtaining a belt) (16.8%), visibility towards senior management (15.2%) and networking with other employees from different units (12.4%). These findings are shown in Picture 9 below.



Pic. 9 Motivating factors to be involved in Lean Six Sigma

(author's own processing)

So far, total of fifteen projects were completed successfully as can be seen in Picture 21 (see Appendix 3). The table shows particular projects run by Finance department with the targeted and real duration of each (see also Picture 10 below). It is significant that almost each project's completion took from four to eighteen months much longer than supposed length. The interviewed manager sees the reason in absence of full-time LSS employees having LSS projects as their only work focus. The other reasons are problems arising during the LSS process as well as insufficient amount of money available.



Pic. 10 Duration of LSS projects carried out in Finance department of selected IBC in Bratislava

(internal materials of selected IBC, author's own processing)

In spite of duration longer than planned Lean Six Sigma projects carried out by Finance department in Bratislava contributed with approximately one million USD savings to total of approximately seven million USD saved by all Finance departments of selected IBC world-wide since introduction of LSS.

2.4.1 Local and global effect of using LSS

This master's thesis deals with using Lean Six Sigma methodology to improve processes in Finance department of selected IBC operating in Bratislava. The department uses LSS for its own purposes. Improvements achieved using LSS methodology increase quality of processes of the department itself as well as processes of all business units it manages. These are units in countries of European region, Middle East and Africa as mentioned in chapter 2.3.1 Finance department of ABC ISC, s.r.o.

LSS projects aim to save company's costs and improve processes by reducing variations, defects and waste. LSS team chooses a project of a process needed to be improved and then executes DMAIC process where root causes of problems are measured and analyzed and solutions are proposed, measured and implemented in order to reach a process of higher value. Completing LSS projects in Bratislava (or any other Centre of Excellence) the local effect is created.

Improving solutions of LSS implemented to defect processes are being tested and examined for some time. If visible and measurable improvement is achieved and costs are being saved in the particular department of one CoE in the world, those improving solutions can be used in other Centers of excellence in the rest of the world. For example when Finance department in Bratislava improves the process of order processing by using LSS methodology improving solutions proposed by locate team can be implemented in the rest three Finance departments in USA, India and Malaysia if the process of order processing is the same or very similar (depends on legislation of different regions of the world). By doing so, the global effect of using LSS will be achieved.

Moreover, the global effect of LSS creates higher costs savings by implementing improving solutions world-wide in the company. Costs of running such LSS projects are also saved by spending them only once in one CoE compared to option when each CoE would carry out its own LSS project regarding the same defect process. Using the example of Finance departments of selected IBC maximum of ¾ of operating costs (to carry out LSS project) can be saved as selected IBC operates four major Finance departments all over the world.

2.4.2 LSS certification

As presented in Theoretical part of this master's thesis, if an employee (or person in general) wants to work on LSS projects and to be a part of LSS teams helping a company to eliminate waste and lowering defect rate of processes, he or she needs to be qualified and certified within the belt ranking system. Having one of the world's best Lean Six Sigma programs at the same time with Dell, DuPont, Honeywell or GE, ABCD has also its own certification system.

Training system of ABC Finance department employees are provided by classroom and online training facilities. Lectures are being taught by internally trained Master Black belts, green belts are trained by Black belts. Overall, there is World Wide Process Excellence Department which overlooks on training of MBBs and BBs.

In Slovak Finance department it is essential that all employees go through initial introduction of Lean Six Sigma course after which being awarded with White belt. Six months later, if the employee would like to obtain Yellow belt he or she needs to attend one day LSS classroom and be a member of LSS project team which completed successful LSS project. After finishing the project, employee is certified as Yellow belt. Yellow belt holder should demonstrate quick hits and work as quality improvement catalyst.

Further certification is also possible as the company runs one week long (forty hours) Green belt course each year. However, only thirty employees out of 1800 are able to attend it at once. When having more than thirty people registered a process of selection must be established. After attending one week classroom training led by Black belt employee, an adept for Green belt have to lead one project which saves at least 50,000 USD for the company. After finishing the project, candidate must complete an exam followed by presentation of his project in front of committee of Master Black belts. The committee subsequently decides whether the certification will be awarded. The employee awarded with Green belt is supposed to accurately identify the most significant data and variances, make recommendations or changes to improve process performance. He also needs to facilitate his LSS team members to obtain appropriate data and resources for the project completion.

Next step in Lean Six Sigma certification in Finance department of selected IBC is Black belt. When Green belt decides to continue his certification process, he can apply to Black belt course. This course lasts for 240 hours and is taught by Master Black belt employee. Moreover, candidate for Black belt is supposed to accomplish two projects, each saving at least 250,000 USD, while he or she has to be a leader of these project, not only a team member. When the projects are successfully completed, GB needs to pass an exam and present his both projects to the Master Black belts committee which will decide on granting him the Black belt or not. Subsequently, Black belt leads and manages process-wide projects leading to improved productivity and satisfaction of internal and external stakeholders. He should also support, coach, encourage and motivate Green belts while developing and/or tracking financial and other quantitative measures of projects. Moreover, he provides LSS training and guidance on methodology and tools.

Finally, certification of Master Black belt does not require fixed number of training hours, projects to complete or even amount of savings contributed to the company. MBBs are considered to be “guru” of all BBs. Process of their certification regards number of years being BB, number of project led as BB, how long he or she has been spreading awareness of LLS in the company or how long have they been teaching educational courses of other belts in the company. The exact numbers at every particular condition are confidential so cannot be disclosed. All these conditions are reviewed by World Wide Process Excellence Department which decides whether and when to award the aspirant with MBB certification. MBB must demonstrate the ability to facilitate idea generation and key decision making. He or she should maintain the business team’s focus on key customer satisfaction factors and should review projects’ progress. They also deliver LSS trainings and coach the LSS teams.

Table 4 shows all belts being able to be found in LSS certification system in selected international business company together with requirements needed to be fulfilled in order to obtain particular belt.

Tab. 4 List of belts with respective requirements to obtain them

Belt	Hours of training	Project	Savings	Exam
White belt	Obtained after attendance of initial introduction LSS course			
Yellow belt	2 days (16 hours)	1 team member	Doesn't matter	No
Green belt	1 week (40 hours)	1 project leader	At least 50,000 USD	Yes
Black belt	240 hours	2 project leader	Each 250,000 USD	Yes
Master B belt	Has to be BB for some years, lead various BB projects, provide various LSS education courses.			

(internal materials of selected IBC, author's own processing)

2.4.3 Choosing LSS projects

Finance department of selected IBC in Slovakia runs LSS projects in "waves". At the moment, each such wave lasts for one year. During that year the training courses for new belts are held and chosen LSS projects are being run. Senior management is in charge of projects selection and for each wave it chooses five to six projects out of approximately fifteen. Proposed projects are being selected based on criteria like amount of savings, resources required, completion time and dependency on other units of the company. Selection is being done based on Weighted criteria matrix as described in chapter 1.5.4 Improve. Each criterion has determined weight and each project is awarded with appropriate amount of points in each criterion. Projects are then ranked according to number of points they obtained by multiplying criteria weights and points. Based on resources available senior management will decide how many project of the list to choose to run in current wave. After realizing one wave, the next one can start.

Every proposed and selected project is run by LSS team, each consisting of five to six members. The team leader is later Green belt of Black belt while remaining team members are later Yellow belts.

2.5 Example of LSS project of Finance department of ABC Slovakia

In the last chapter of Analyze part a particular project is analyzed to find out how the Finance department uses Lean Six Sigma in order to improve their processes. The project was called GTS ITD Nordics DFI Process Optimization (Global Technology Services IT Delivery Nordics Direct File Input Process Optimization) and dealt with the process of sending inputs from finance and planning center to accounting to process Nordic clients' requirements. The problem was that plenty of inputs were returning because of being defect. This project was carried out since November 2008 to August 2009.

2.5.1 Define

In the Define phase of the Lean Six Sigma project, the LSS team was collecting data about potential problems from customers. The Business case, Opportunity statement, Goal statement, Project scope, Project plan and Project team selection were defined as following:

- Business case – "Currently ITD Finance and Planning (F&P) members are spending too much time consuming activities to create DFI inputs for Accounting. DFI are based on different input formats (xls, txt, brio) from different sources (IMTs[2]). Sources are not standardized. Current tools and applications do not cover all "business as usual" activities, with manual work behind. There are 9 CoE and 15 IMT members affected by the process but focus will be on CoE only now. Financial benefit will equal to approximately 80 saved hours per month with direct cost reduction of $45,000 per year for Nordics team and improved quality of process." (Finance COE of selected IBC, 2010).
- Opportunity statement – "The estimated average time spent on one DFI during the closing activity is approximately 45 minutes. We would like to decrease this average time to 20 minutes. Also with decreasing number of DFIs by half and reducing number of errors to zero we can save 60 hours per month of non-value adding processes." (Finance COE of selected IBC, 2010).

[2] IMT indicates a region, for example Nordic IMT, Germany IMT,…

- Goal statement – contains two goals: “reduce DFI preparation time to max. 30 minutes per single voucher and reduce number of errors (rejections) caused during DFI processing >5%” (Finance COE of selected IBC, 2010).
- Project scope – Project scope was defined as GTS ITD Nordic IMT focusing on “no-brain using” activities to be minimized. Start point was defined IMT/country input for DFI and stop point as input for Accounting/ledger entries. Other IMTs were excluded as they would have been replicated once the Nordic process was implemented (Finance COE of selected IBC, 2010).
- Project plan – can be seen in Table 5 below.

Tab. 5 Project plan of GTD IDS DFI process optimisation

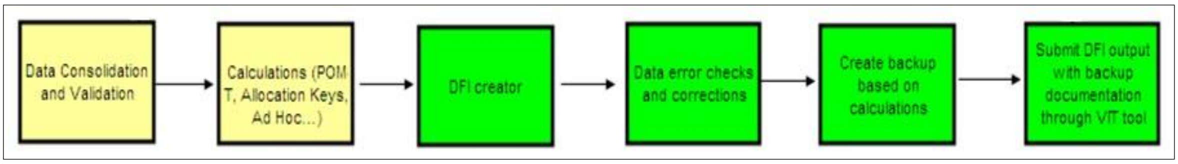
Process	End date	Deliverables
Kick-Off	November 2008	Draft Charter, Resources
Define	December 2008	Charter, Workplan, SIPOC
Measure	January 2009	Project Y, Data Plan, Sigma calc.
Analyze	March 2009	Data Analysis, Root Cause, Benefit
Improve	May 2009	ID Sol, FEMA, Imp. Plan, Costs/Benefits Analys.
Control	August 2009	Control Plan, Implement, Closure

(Finance COE of selected IBC, 2010)

- Project team selection – the team’s Sponsor, Business Process Owner and Black belt coach were chosen. The team itself consisted of one Green belt the leader of the team and four Yellow belts. Also two Subject Matter Experts (SMEs) were chosen.

The Business case describes the process problem and supposed financial benefit the LSS project would bring. Opportunity statement shows the current problem in detail and desired results achieved by improvement. The goal statement shows the aim of reducing vouchers preparation time and rejections during DFI processing. Project scope defines the field of project, start and stop point and the indication of global effect can be noticed in replication of improvements to other IMTs after Nordic project implementation of improving solutions. In project plan a planned period for the project is nine months. The goal statement is supported by two picture showed in Appendix 4. Picture 22 illustrates graph showing number of rejected DFIs in one year with the goal of decreasing them to zero level. At the Picture 23 an average time spent by seven employees on processing 247 vouchers in November can be seen.

As the next step of Define phase the LSS team created SIPOC (Appendix 5). SIPOC describes all suppliers of the process, inputs, the process itself, outputs from the process and internal and external customers. In this case, the LSS project focused on only one customer from the three listed – Accounting center of Finance department. The Process part of SIPOC is shown at Picture 11 below. It contains six sub-processes but the project focused on last four of them because the first two sub-processes are changing within the scope and the team was not able to optimize them in that time. Four focused sub-processes remain same.



Pic. 11 Process part of SIPOC

(Finance COE of selected IBC, 2010)

Next step of Define phase was creation of as-is process map or process map showing the current state of the process. The team created three top-down charts each containing major SIPOC steps with their sub-processes (see Appendix 6). These charts can be considered as an evidence of changing first two steps. Charts bring detailed process overview. After creating top-down charts the team had to create Functional deployment map showing each step of the process showing detailed process information of creating and submitting DFIs (see Appendix 7). Communication plan as the next step provides reference for necessary communications throughout the project. Picture 27 (see Appendix 8) shows initial message to each LSS project member, vehicle to contact them, frequency of communication, responsible person and mechanism by which the feedback will be delivered. Initial project data and charter needed to be presented to Process owners, SMEs and COE ITD teams so they understand the goals LSS team would like to achieve with the project. Most communication was done through face to face and teleconferences as the team needed to communicate with people working in other departments and Centers of excellence.

As the next step Voice of the customer and Voice of the business were defined. Various issues were investigate: what does the customer/business wants from the F&P team with proper identification of issues preventing the team from satisfying them, what are critical to quality requirements of the customer/business, stating the metrics to be measured in the next phase, and customer/business desired end state of the metrics. The LSS team communicated with ten Accounting Analysts and twenty F&P IMT Analysts. Accounting Analysts feedback from Budapest, UK and Bratislava was important for defining VOC while F&P IMT Analysts feedback from Denmark, Norway, Sweden and Finland was base for VOB. Finally, Critical customer requirements were defined based on data collected:

- VOC – Accounting needs to sell all 5 backup documentation available as per agreement. The DFI output file needs to meet accounting technical requirements.
- VOB – FA needs to include supporting information relevant to business and needs to focus on closing activities only.

When having defined all the necessary issues the LSS team followed to Measure phase of LSS project.

2.5.2 Measure

In the Measure phase the LSS team started with Data collection plan dealing with the whole process of collecting data to three performance metrics – time of preparing vouchers and backup, number of processed/rejected vouchers, and reasons for rejections. The plan contained information about where to find the data needed, who will be responsible for collection, the size of the sample to collect, when and how to collect the data. Sample size of number of rejected DFIs was calculated by Sample Size Calculator based on Nordics KPI measurement from April 2008 to December 2008 to 385 vouchers, but the team decided to use full data available, means 2,849 vouchers. Based on data collected via DFI measurement template created by LSS team from November to December 2008 the Calculator calculated minimum sample of time spent on DFI creation to 553 vouchers. However, LSS team measured 610 single DFI requests/vouchers. The data were further used to calculate Baseline sigma performance and to analyze root causes in the Analyze phase.

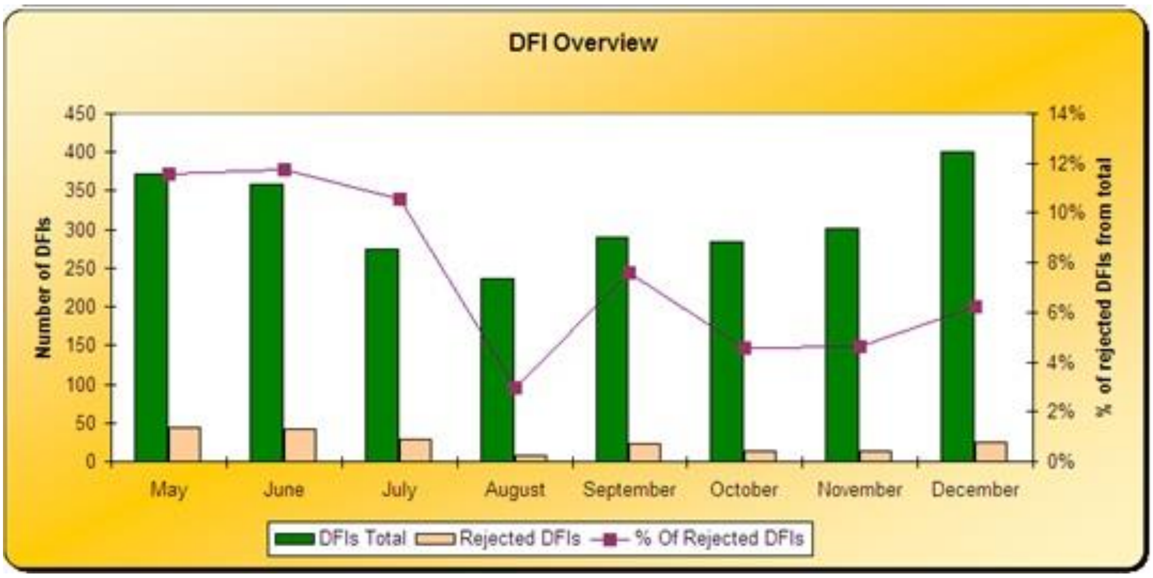
Based on the data collected Baseline sigma calculations were done using Sigma calculator. With the sample of 2,849 requests from which 245 were defects sigma level of 3.6 was calculated for number of rejected DFIs, defect rate was 1.7199% and yield was 99.28%. Current performance of the process was 172,000 defects per million in comparison to 3.4 DPMO operating at six sigma level (see chapter 1.2.2 Six Sigma). Critical customer requirement was set to zero which means that 1.7% was missing to meet the target. When calculating sigma level of time spent on DFI sample of 610 vouchers was used with 212 defectives. Sigma level was calculated as 0.4, defect rate as 35% and yield as only 65%. These data means that the current performance of the process was 347,000 defects per million opportunities compared to 3.4 DPMO operating at six sigma level. Critical customer requirement of 30 minutes per single DFI was not being met at all.

Measuring the process variation the LSS team obtained various results. Percent of DFI rejections can be seen in Table 6 below. This value varies from 3 to 12% per month. Picture 12 shows results obtained using graph comparing total DFIs, rejected DFIs and percentage of rejected ones. Increasing trend in all three values can be observed since October 2008. Moreover, using X and Moving range chart the average of rejection was calculated as 27.2 defect vouchers per month.

Tab. 6 DFI overview

Overall trend	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Total DFI	372	358	274	236	290	285	302	400
Rejected DFI	43	42	29	7	22	13	14	25
% of rejected	12%	12%	11%	3%	8%	5%	5%	6%

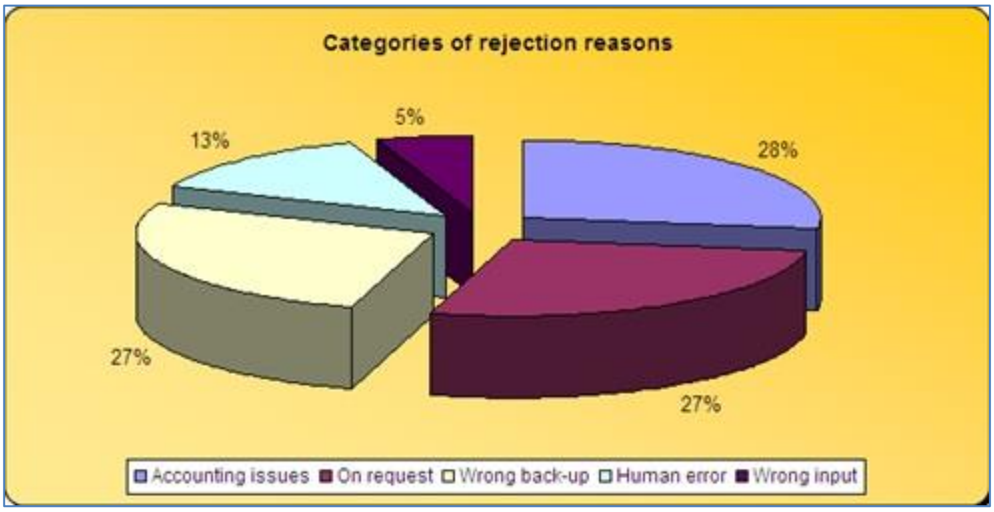
(internal materials of selected IBC, author’s own processing)



Pic. 12 DFI overview

(internal materials of selected IBC, author's own processing)

Finally, five major rejection reasons categories to be focused on were created based on measuring various proposed rejection reasons (see Picture 28 in Appendix 9). These categories include Accounting issues, On request, Wrong backup, Human error and Wrong input and their percentage can be seen on Picture 13.



Pic. 13 Categories of rejection reasons

(internal materials of selected IBC, author's own processing)

In the end of Measure phase, the Problem statement was defined as following: "In period May 2008 - January 2009, a total of 2,718 manual DFI requests were sent to accounting by ITD personnel. Of these requests 203 were rejected due to defects causing ITD teams spending unnecessary time re-doing the requests. Our goal is to reduce the number of rejected DFI requests from 203 to zero by 2Q 2009. During testing period Nov 2008 – Jan 2009 on average ITD personnel in Nordics spent 42 min on entire process (without financial process 31 min). The preparation time after given deadline (30 min) resulted into 37% defects and goal is to reduce to 25%." (Finance COE of selected IBC, 2010).

2.5.3 Analyze

In the Analyze phase the Root cause validation matrix was created based on analysis of selected reasons of rejections. This matrix contains main rejection reasons categories with their sub-categories, validation test method, LSS team observation and conclusion whether the sub-category is the root cause or not. In Rejected vouchers problem the root causes were:

- **By accounting error** (Accounting issues category) – carelessness of the Accountant
- **Insufficient back-up** (Back-up category) – Financial analyst did not create appropriate back-up/unclear back-up was provided to Accounting
- **On request** (On request category) – carelessness of the Financial analyst/one DFI was rejected, all the other DFIs to be rejected as well

In Preparation time problem the root causes were:

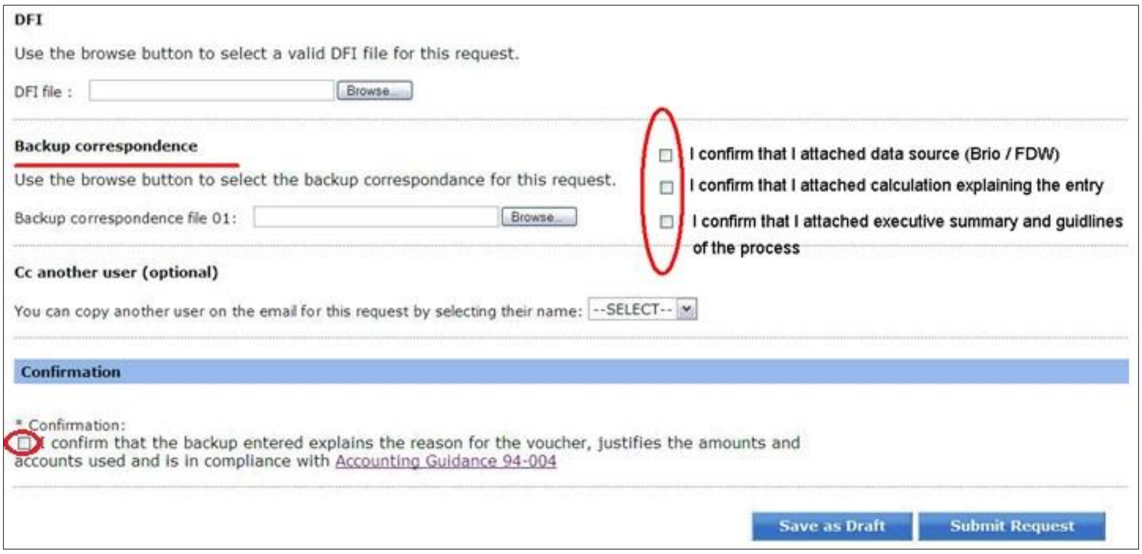
- **Pre-loading** (Preparation category) – overload of the system – batch run needs to be implemented
- **Obtaining data** (Obtain data category) – Financial analyst needs to visit various queries
- **Create DFI Input/Output/Correcting errors** (DFI Creator category) – working with DFI Creator tool – booking is not allowed on closed accounts IDs thus Financial analyst needs to invest heavily his time to obtain correct account ID

In order to obtain these results various analysis were done, for example Pareto analysis (see Appendix 10).

2.5.4 Improve

In the Improve phase four major solutions (with particular solutions) were proposed – Self assessment checklist (Voucher submission SAC, Accounting bulletin), System changes (VIT tool update, Windows batch run scheduler, SPAT, Account ID check tool), Information flow matrix (Focal points implementation, Review late requests, Task/Workload matrix), and Voucher audit committee. Root causes solution matrix (see Appendix 11) was created in order to show supposed percentage of improvement achieved in each root cause by implementing solutions proposed.

VIT tool is intern tool used by Financial analysts of Financial department for submitting vouchers of the DFI process to Accounting center. Before the LSS project was carried out anybody could submit anything based on guidelines into the system. Improving solution proposed implementation of four checkboxes to the Backup correspondence section and Confirmation which required VIT tool programming (Picture 14). These checkboxes are considered explicit reminder to Financial analysts about what to insert into VIT tool helping to prevent defect vouchers.



Pic. 14 VIT tool update

(Finance COE of selected IBC, 2010)

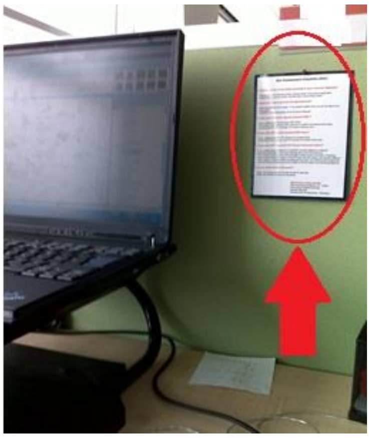
The second system change proposed was creation of Windows batch run scheduler which is a program running queries and producing and sending reports automatically if the computer is on standby mode. This improvement would be used during the night to remove morning running of long time consuming queries. Using Windows scheduler should save approximately one to two hours in the morning process.

The next proposed solution was creation of SPAT (Service Pools Allocations Tool) helping to allocate accounts with their IDs really fast. This tool consists of seven sections:

- Input DFI – this tab goes as an input to DFI Creator tool
- To allocate – used as a set up with appropriate DFI input field. Create DFI Input button created DFI Input in couple of seconds reducing non-value adding work to minimum.
- Data – includes all information about Account IDs for specific country
- Account ID's check – checks open and closed accounts IDs
- Close vs. Open – shows closed Account IDs and gives replacement option
- Replacement report – informs which closed Account ID has been replaced by which Open one
- Allocation key template – includes key calculation, recoveries calculation, Brio screenshot from Ledger needed for Accounting

SPAT brings various benefits to the process members, for example standardized back-up documentation, better access to Accounts IDs, significantly reduces the time spent on analysis of the allocations or reduction in number of vouchers submitted to Accounting because of only one DFI Input as an output from the system.

Self-assessment checklist (Picture 15), as another potential solution, is an official paper with six questions necessary to answer positively in order to complete the process without defects. Each question contains helping procedure to follow in order to eliminate defects while creating vouchers. It should serve as a reminder of important steps and characteristics of the voucher and help the Financial analyst to find out whether he missed something or not.



Pic. 15 Self-assessment checklist location

(Finance COE of selected IBC, 2010, author's own processing)

As the LSS team proposed 12 solutions in total they needed to get some rank of those. For this purpose the team used Solution selection matrix (weighted scale) and rated solutions based on their impact on sigma level increase, time impact (how time consuming it is to implement specific solution) and cost vs. benefit impact. The three solutions with the best score were Creation of Windows batch run scheduler to produce results during the night, Preparing emails/instructions to all Financial analysts about deadline guidelines an special after-approval requirement from F&P CoE Management, and Education and Self-assessment checklist on back-up, accruals, file too long, wrong minors, rejections on requests, incorrect template used. The whole Solution selection matrix can be found in Appendix 12.

Finally, after successful identification of solutions and their effects on root causes the team prepared detailed Implementation plan showing desired result of each solution, who was responsible for the solution, what actions remain to be done and by when.

2.5.5 Control

After defining, measuring, analyzing the process and proposing and testing twelve improving solutions, the last but not least phase of the DMAIC methodology, Control phase, came. In this phase the new Process map (Final process flow) was created as can be seen in Picture 32 (see Appendix 13). Various steps were could have been cancelled due to implementation of new improving solutions which simplify the process and make it much clearer. Introduction of new SPA Tool eliminated manual allocations searching and entering in Major 835 (the program used until that time), new Account ID check automated the Account ID validation sub-process, and new version of DFI Creator automated account combination against ledger. Other processes were not removed, but the time spent on the individual activities and accuracy of the process increased.

Significant contributions of SPAT were calculated. Using this tool requires only 200 minutes to complete the request in contrary to previous 850 minutes when doing manually which means savings of total 650 minutes. As SPAT was supposed to decrease the number of DFI vouchers sent to Accounting these savings were calculated in the Control phase. Using SPAT the team sent only five vouchers compared to twelve vouchers using previous tools. Moreover, time savings of using new Windows batch run scheduler were calculated to 1491 minutes (25 hours) during one DFI closing.

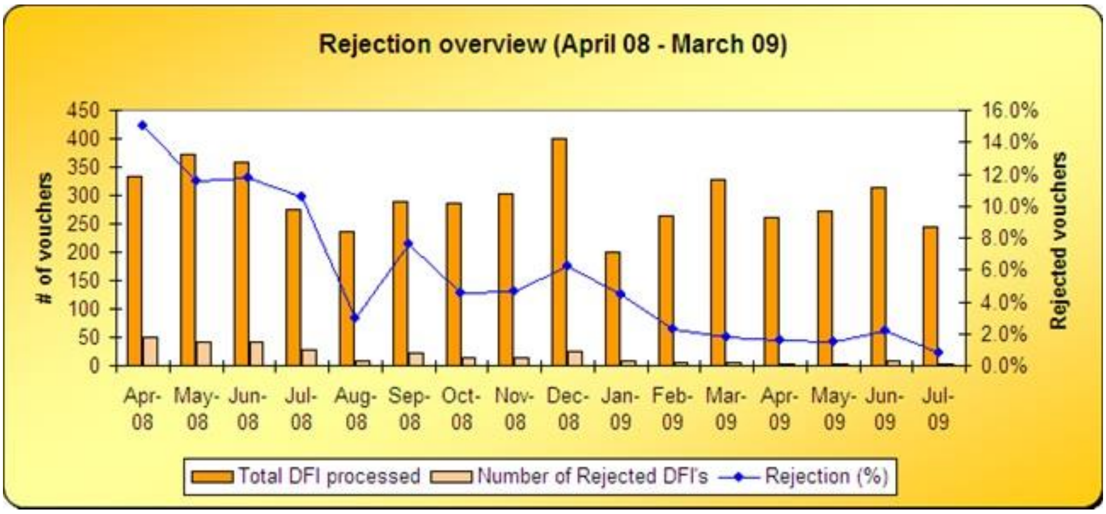
Self-assessment checklist available to all Financial analysts processing the DFI vouchers contributed in reduction of rejections as especially newcomers could check whether all documentation is completed when submitting vouchers. The tool brought clarity to the process by summarizing all important steps of the process and necessary characteristics of the vouchers.

As the next step the new sigma calculations were made. For the problem of time spent on creation of DFIs in the first three months of 2009 from all 599 samples 265 were defective (44.24%) and sigma level was 1.645, while during the period of June and July 2009 from 481 samples only 146 were defective (30.35%) moving sigma level to 2.014 compared to 0.4 sigma obtained in Measure phase (see Picture 33 in Appendix 14). The problem of number of rejected requests contained 560 samples in period of June and July 2009 of which only 9 were defective. This improvement caused sigma level being 4.225 compared to 3.615 in the period of second to fourth term 2008 (see Picture 34 in Appendix 14). The Table 7 and Picture 16 below show decreasing trend in number of rejected requests from December 2008 to July 2009. Moreover, using X chart and Moving range chart the LSS team obtained evidence of desired reduction of average amount of rejected vouchers per month from 27.2 from April 2008 to December 2008 to 18.7 from April 2009 to July 2009.

Tab. 7 Rejected requests overview

Period	2Q 08 – 4Q 08	1Q 09	2Q 09	June-July 09
Completed DFIs	2604	773	832	551
Rejected DFIs	245	21	15	9
Total DFIs	2849	794	847	560
% of defect DFIs	1.72%	0.53%	0.3%	0.23%
Opportunities/unit	5	5	6	7
Sigma level	3.6154	4.0563	4.2531	4.3344

(Finance COE of selected IBC, 2010, author's own processing)



Pic. 16 Rejected requests overview from April 2008 to July 2009

(Finance COE of selected IBC, 2010, author's own processing)

Moreover, the detailed financial calculation of project's savings and internal return was made. Total reduction of time per closing per month was calculated to be 96.66 hours making annual savings of 1160.16 hours and creating $3,742.45 savings monthly. FTE was calculated to be 0.62 and IRR 19.18%. The Picture 35 shows these calculations and can be found in Appendix 15.

Finally, the Replications opportunities (see Picture 36 in Appendix 16) were considered and examined. The result was that 4 out of 5 recommended solutions could be replicated world-wide locations of business. The feedback from Financial analysts using the tools was very positive and potential opportunity to certify SPA Tool by ASCA so that it could be used world-wide emerged.

2.6 Analysis Summary

The aim of the Analysis part was to bring detailed overview on the selected IBC with its Finance department in Slovakia where the research was carried out. In order to find out how Lean Six Sigma project approach is being used in Finance department research was investigating big amount of company's internal data, provided an interview as well as various personal interviews. The research has found out following data:

Lean Six Sigma methodology is being used in Finance department of selected international business company since 2008. During these five years fifteen projects have been completed successfully of the total number of 31 planned projects. Number of completed projects is only a half of those planned. This is because four projects were cancelled due to lack of resources or technical problems and remaining twelve are still being processed.

LSS projects are run in waves at different departments. One wave lasts approximately one year and various projects are carried out in it. The first and the second waves run five projects from which one was cancelled in each wave. The third wave run seven projects while the fourth increased this amount to eight, however, one project from each was cancelled again. The last wave so far, starting in July 2013 opened six projects from which none have been completed so far.

Moreover, the analysis of projects completed shows that twelve of fifteen projects exceeded targeted duration. Length of these overshoots varies from four to eighteen months which is even triple time desired. The reason of this problem is emergence of unexpected problems occurring during LSS project process. These are either technical or lack of resources in terms of time, money, people,… The next reason is that LSS projects require full-time LSS workers in order to complete particular project in approximately six to nine months as targeted in Finance department of selected IBC as well. However, LSS team members are full-time employed as Financial analysts, Team members or even managers, and so these responsibilities have to be set in front of LSS project completion.

On the other hand, the company provides LSS qualification itself. It trains own employees as well as provides training for people outside of the company. Training possibilities are available to all Belts ranks so the comfort of employees is ensured. Having own training facilities and trainers saves costs that would be paid to external company being approximately 1700€ per person. Furthermore, to obtain a Belt a candidate completes a specific training in amount of hours required after which he or she needs to carry out specific LSS project either as a team member (YB candidate) or project leader (GB, BB, MBB candidates) in order to fulfill all requirements.

All employees of Finance department take part in LSS training and complete their White belt certification. Further qualification is optional, but according to research, employees see it motivational and beneficial in terms of faster career growth, learning something new, networking with other centers' teams, and getting visible to senior management.

In order to get better view on using LSS in Finance department the research used an example of successfully completed LSS project to decrease number of rejected vouchers submitted to Accounting center by Finance & Planning. In Define phase of the project the project team was established consisting of one Green belt adept who was a leader and four Yellow belt adepts. During this phase LSS project team collects all aspects of the problems the project deals with and ideas of possible solutions from customers and people involved in the process. Problem statement, goal statement, communication plan, time plan, financial plan and other plans are defined. In Measure phase the team measures and finds out whether and which ideas obtained in the previous phase are relevant and also investigates the current state of the problems. Analyze phase brings clear view on root causes of the problems found out based on various analysis executed, for example Pareto analysis. In Improve phase the LSS project team proposes improving solutions based on many calculations and usage various statistical tools. In the last phase of LSS project completion process the team tests implemented solutions, it calculates sigma level of improved processes, creates financial calculations of savings, and compare obtained results to those targeted in Define phase. According to observations of the exampled project, Sigma level was increased significantly by elimination of mistakes occurred in vouchers creation process and time spent on completing each voucher. Significant savings were created due to creation and implementation of new software tools making the process much clearer and more efficient. These savings were even better than expected in the beginning of the project.

Finally, the local and global effects have been researched. By implementation of improving solutions created by one CoE to other Centers of excellence with the same or similar responsibilities and steps of processes the international company may save huge amounts of money. The initial costs to run LSS project are spent in one CoE and others spend resources only to implement these solutions. This amount of resources is much less than to run a project. The global effect of these implementations is happening in real as found out by the research. Process optimization project by Finance department proposed five improving solutions to be implemented world-wide which would cause cumulative savings for the whole company.

3 PROPOSALS AND CONTRIBUTION OF SUGGESTED SOLUTIONS

Based on the research carried out in the Finance department of selected IBC and analysis of its current state supported by example of LSS project from the department following problem has been noticed:

- Duration of LSS projects carried out by Finance department is doubling or even tripling targeted length.

As the research revealed all team members involved in carrying out the LSS projects in Finance department of selected IBC are having their full-time responsibilities as Financial analysts in different centers of Finance department. This is considered to be the main reason for exceeded planned duration of LSS projects of this part of the company.

Hiring of full-time LSS consultants, project leaders and team members could solve the problem of exceeding targeted time plans. Various calculations to confirm this idea are provided below.

Based on research the following values were obtained:

Tab. 8 Costs of employees based on research

Annual cost per employee	$45,000
Monthly cost per employee	$3,750
Costs of wages per month per employee	$1,700
Other costs per month per employee	$2,050

(author's own research)

Tab. 9 Project savings, length, team members

Average annual savings per GB project	$56,800
Average annual savings per BB project	$250,000
Length of 1 project	6 months
1 team	4 members

(author's own research)

Cost of one employee per month is approximately $3,750 while average annual savings per projects are approximately $56,800 (calculated of successfully completed projects of Finance department, excluding the second project which was causing significant deviation). Average annual savings per BB project were taken from conditions required to fulfill in order to become BB. Determined length of each project was 6 months and it was said that each LSS project team would need to have 4 members (1 leader and 3 team members).

Costs of employees according to different Belt ranks were estimated as follow:

Tab. 10 Estimated costs of different Belt ranks

Belt	Cost of wage	Other costs	Total costs
White belt	$1,800	$1,900	$3,700
Yellow belt	$2,000	$1,900	$3,900
Green belt	$2,500	$1,900	$4,400
Back belt	$3,000	$1,900	$4,900

(author’s own research)

Costs of wage are wages given to LSS full-time employees according to the Belt rank they have obtained. Other costs include taxes, energies, network, and so on. Total costs are obtained after adding costs of wage to other costs.

Training costs were estimated as following: to obtain YB it costs $100, to obtain GB it costs $300, and to obtain BB it costs $600 per employee. These costs are only once payable per employee.

Following table shows estimation of teams’ compositions carrying out particular projects, estimated savings of each project, estimation of employees having training for particular Belt rank.

Tab. 11 Proposed frame of LSS projects

Period	Number of project	Leader	Team	Annual savings ($)	Training
½ Y1	1.	YB	3 WB	56,800	9 for YB
	2.	YB	3 WB	56,800	
	3.	YB	3 WB	56,800	
2/2 Y1	1.	GB	3 YB	250,000	3 for BB, 9 for GB
	2.	YB	GB + 2 YB	56,800	
	3.	YB	GB + 2 YB	56,800	
½ Y2	1.	GB	GB + 2 YB	250,000	2 for BB
	2.	GB	GB + 2 YB	250,000	
	3.	YB	GB + 2 YB	56,800	
2/2 Y2	1.	GB	3 YB	250,000	1 for BB, 1 for YB
	2.	GB	2 GB + WB	250,000	
	3.	YB	GB + 2 YB	56,800	
½ Y3	1.	GB	3 YB	250,000	1 for GB, 1 for YB
	2.	GB	GB + YB + WB	250,000	
	3.	YB	2 GB + YB	56,800	
2/2 Y3	1.	BB	2 GB + YB	250,000	1 for BB, 1 for GB
	2.	GB	3 YB	250,000	
	3.	YB	2 GB + YB	250,000	
½ Y4	1.	GB	BB + 2 YB	250,000	2 for BB, 1 for GB
	2.	GB	BB + GB + YB	250,000	
	3.	YB	2 GB + YB	56,800	
2/2 Y4	1.	BB	2 GB + YB	250,000	1 for GB
	2.	GB	GB + 2 YB	250,000	
	3.	YB	BB + 2 GB	56,800	

(author's own research)

Based on setting up projects to be carried on in each six months period during the four years following costs and saving were obtained:

Tab. 12 Costs and savings estimation of LSS projects during 4 years

($)	½ Y1	2/2 Y1	½ Y2	2/2 Y2	½ Y3	2/2 Y3	½ Y4	2/2 Y4
S	0	85,200	267,000	460,200	556,800	556,800	556,800	556,800
C	270,900	373,500	297,000	324,700	354,400	332,100	338,700	340,500
Total	-270,900	-288,300	-30,000	135,500	202,400	224,700	218,100	216,300
Cum.	-270,900	-559,200	-589,200	-453,700	-251,300	-26,600	191,500	407,800

(author's own research)

Total of 9 full-time LSS project members should be hired in the beginning of the first year. During the first half of the first year they would undertake YB training and would be members of projects teams led by YBs being certified previously. According to requirements to obtain a belt, they would obtain YB after this period and go to the second half of the first year as candidates to GB. The training and certification process would be compulsory for these employees. Each 6 months total of 3 LSS projects would be completed which makes the total number of 6 LSS projects per year. After the first year one GB and two BB projects were estimated to be completed. Each half a year savings consist of half of the previous half a year plus half of its preceding half a year. Costs were calculated based on progress of each project member in his certification process, consisting of wages costs and optional training costs if happened. Total profit and loss were calculated and show that after first three halves a years each following half would be profitable. Moreover cumulative profit was calculated and it is clear that after three years the process starts being remunerative.

Research findings confirm the idea of employing the whole LSS team of full-time LSS workers only. Initial costs would be very high but the second year savings would exceed costs and after three years LSS projects would be only saving costs of the processes.

Moreover, full-time LSS employees would save overtime costs paid to employees working on LSS projects nowadays as they do not have much time to completing it during their working hours. Also remuneration would not be paid in that big amount as these employees would be getting appropriate wages reflecting the work they do. In addition, costs of energies would be reduced as employees would not stay in the office after working hours as the situation is nowadays to complete his part of LSS project.

Despite proposing this solution the author sees this problem as possible next issue to deal with in LSS project.

CONCLUSIONS

The main objective of the master's thesis was to evaluate the situation of Finance Department of selected international business company using Lean Six Sigma Project approach to improve its processes. Recommendations of further steps in using this method were aimed as well as proposals for future improvement.

In order to reach these goals, the research was carried out in the Finance department of ABC ISC, s.r.o. As the research methods the interview was used together with document evidence analysis. Researched manager provided the author with useful information as he could have been the only one to be researched according to contract with the company. Carrying out the document evidence analysis, the problem-oriented approach had been chosen and many inadvertent documents had been researched.

The first part of the thesis focused on literature review of Project and Quality management as Lean Six Sigma is methodology using to carry out a project and aiming to improve quality and efficiency of the processes in the company. Lean Six Sigma literature review is also involved in the first part explaining its evolution, process of certification and DMAIC methodology.

In the following part the description of selected IBC can be found together with analysis of using LSS project approach in its Finance department. One successfully completed project had been selected to be an example of the analysis. The second part of the thesis deals with analysis findings as well.

The last but not least part suggests recommendations of LSS further usage in Finance department, while offering steps how to improve the current situation. These suggestions were proposed based on research results. As the author is not certified in Lean Six Sigma and so she does not have sufficient amount of appropriate knowledge, the suggestions may not be willing to be accepted.

The main and partial objectives of the master's thesis were fulfilled by that.

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LIST OF ABBREVIATIONS

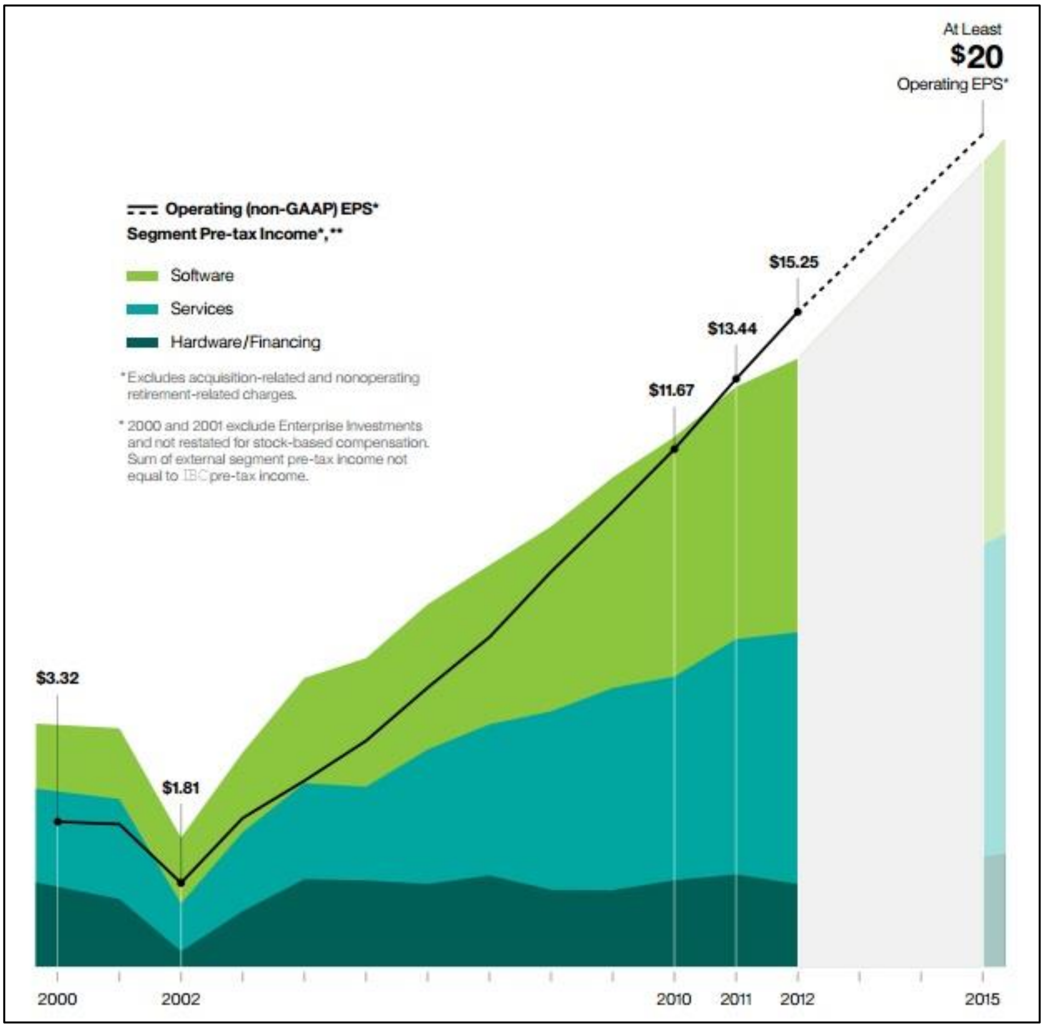
BB	Black belt
CEO	Chief executive officer
CoE	Center of excellence
COPQ	Costs of poor quality
CPS	Company production system
CTQ	Critical to quality
DMADV	Define, Measure, Analyze, Design, Verify
DMAIC	Define, Measure, Analyze, Improve, Control
DPMO	Defects per million opportunities
GB	Green belt
GE	General Electric
IBC	International business company
LSS	Lean Six Sigma
MBB	Master Black belt
TQM	Total quality management
USD	United States dollar
VOB	Voice of business
VOC	Voice of customer
VOE	Voice of employees
VSM	Value stream mapping
WB	White belt
YB	Yellow belt

LISTS OF TABLES

LIST OF PICTURES

LIST OF APPENDICES

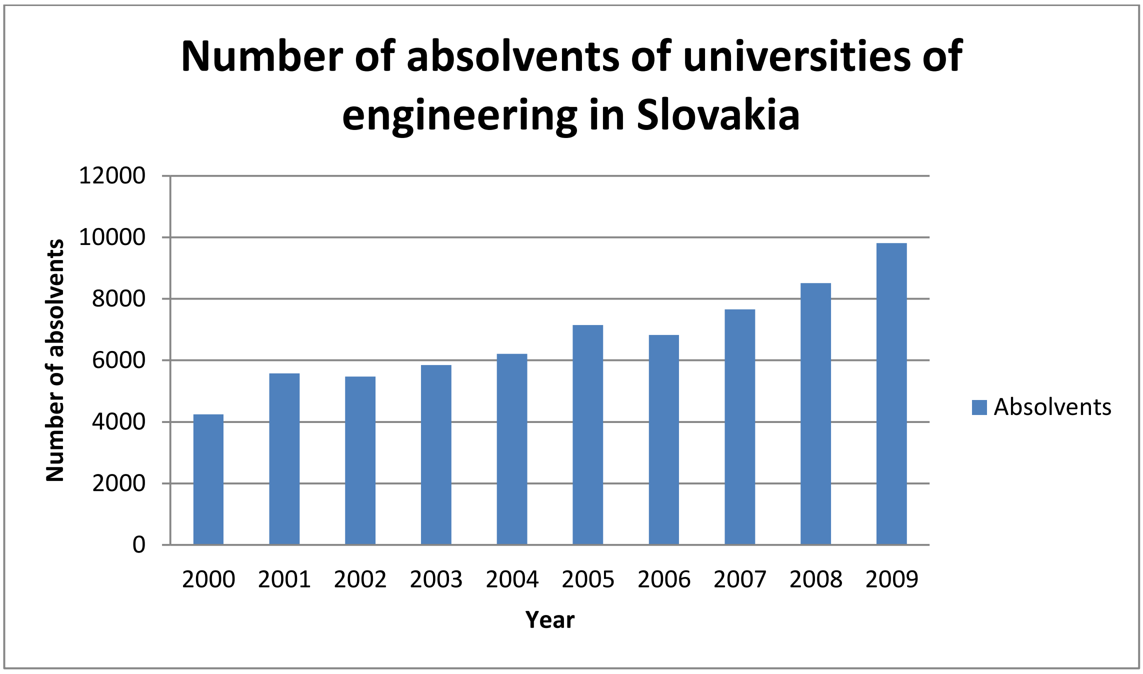
Appendix 1: Increasing trend of selected IBC's indicators



Pic. 17 Development of selected indicators of selected IBC

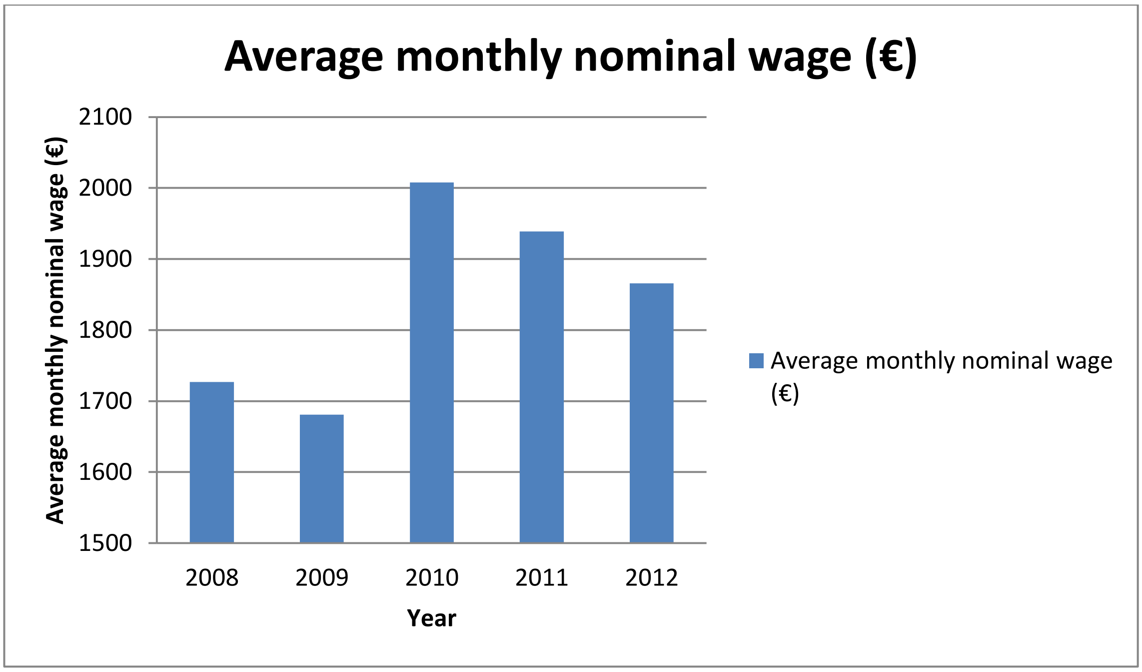
(internal materials of selected IBC)

Appendix 2: Employees data



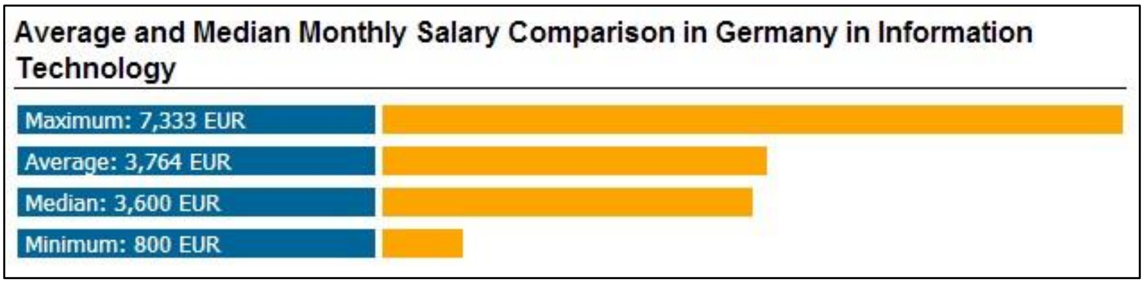
Pic. 18 Number of absolvents of universities of engineering in Slovakia in 2000-2009

(Štatistický úrad SR, 2013)



Pic. 19 Average monthly nominal wage in information and communications in Slovakia

(Štatistický úrad SR, 2013)



Pic. 20 Average and median monthly salaries in Information and Technology sector of Germany in 2012

(Salaryexplorer, 2013)

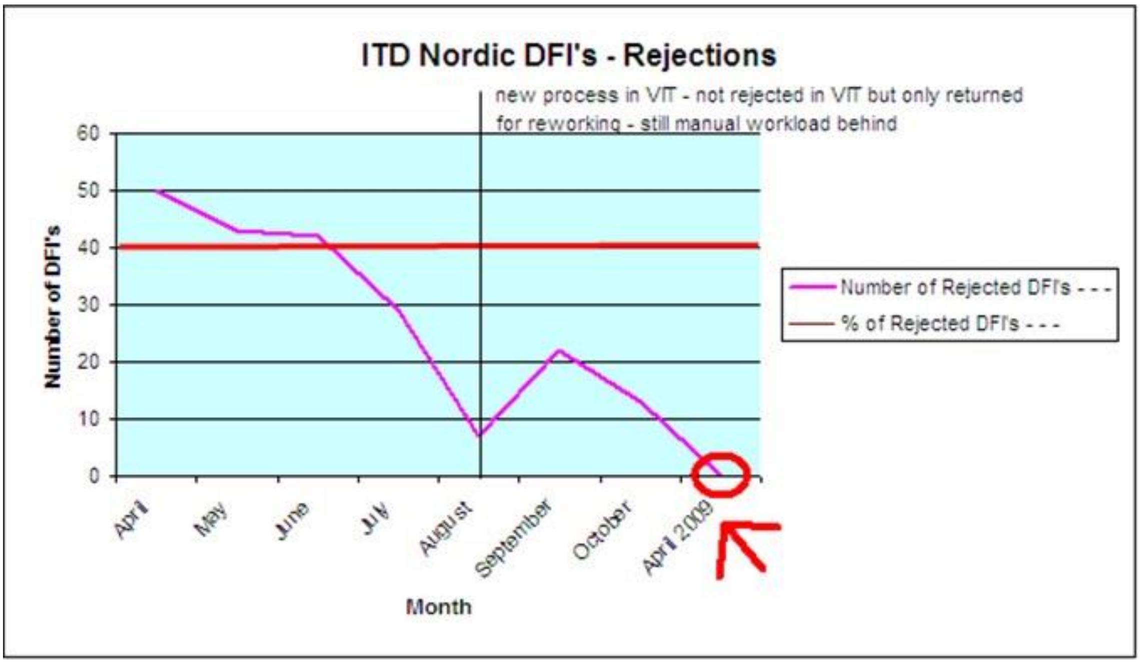
Appendix 3: Project information input sheet

Project Name	Site	Wave	Project Type	Launch Date	Target Implementation	Close Date	Complete	Cancelled	In Process	Savings Metric	FTE Savings	USD Savings	Project Year	Completion Year
Capital Commits	Bratislava	1	GB	Nov-2008	Nov-2009	Nov-2009	Y			Efficiency	1,65	74 250,00	2008	2009
DSO PO Mismatch	Bratislava	1	GB	Nov-2008	Apr-2010	Aug-2010	Y			Efficiency	8,85	398 250,00	2008	2010
GBS Backlog Certification	Bratislava	1	GB	Nov-2008	Jul-2009	Jul-2009	Y			Efficiency	0,85	38 250,00	2008	2009
GTS Signings Adjustments	Bratislava	1	GB	Nov-2008	N/A	Cancelled		Y		N/A	0,00	0,00	2008	
ITD DFI Optimization	Bratislava	1	GB	Nov-2008	Aug-2009	Aug-2009	Y			Efficiency	0,80	36 000,00	2008	2009
HW Revenue Cost Match Process	Bratislava	2	GB	Jul-2010	Jan-2011	Jul-2011	Y			Efficiency	1,20	54 216,87	2010	2011
GBS Bond Approval	Bratislava	2	GB	Jul-2010	Jan-2011	May-2012		Y		Efficiency	0,84	37 951,81	2010	2012
GBS Contract Analysis	Bratislava	2	GB	Jul-2010	Jan-2011	Apr-2012	Y			Efficiency	1,28	57 469,88	2010	2012
GBS DSO Mgmt	Bratislava	2	GB	Jul-2010	Jan-2011	Dec-2011	Y			Efficiency	1,69	75 903,61	2010	2011
GTS AZ Billing	Bratislava	2	GB	Jul-2010	Jan-2011	Jun-2011	Y			Efficiency	1,20	54 216,87	2010	2011
GTS Aged Accruals	Bratislava	3	GB	Jul-2011	Jan-2012	Dec-2012	Y			Efficiency	1,00	45 000,00	2011	2012
GTS BCP	Bratislava	3	GB	Jul-2011	Jan-2012			Y		Efficiency	1,00	45 000,00	2011	
GBS E2E	Bratislava	3	GB	Jul-2011	Jan-2012	Jul-2013	Y			Efficiency	1,00	45 000,00	2011	2013
IF&PM Manual Achievements	Bratislava	3	GB	Jul-2011	Jan-2012	Nov-2012	Y			Efficiency	1,00	45 000,00	2011	2012
IF&PM Challenges	Bratislava	3	GB	Jul-2011	Jan-2012	Nov-2012	Y			Efficiency	2,00	90 000,00	2011	2012
Marketing Channels	Bratislava	3	GB	Jul-2011	Jan-2012	Feb-2013	Y			Efficiency	1,00	45 000,00	2011	2013
S&D Departments	Bratislava	3	GB	Jul-2011	Jan-2012	Dec-2012	Y			Efficiency	1,00	45 000,00	2011	2012
MAA Automated Loads	Bratislava	4	GB	Nov-2012	Jul-2013	Jul-2013	Y			Efficiency	2,00	90 000,00	2012	2013
GTS SO ITO Nordics Harmonization	Bratislava	4	GB	Sep-2012	Dec-2013				Y				2012	
Effective Reporting Management	Bratislava	4	GB	Sep-2012					Y				2012	
Centeralized Dashboard Reporting	Bratislava	4	GB	Sep-2012	Dec-2013				Y				2012	
UKI GTS SO Re-Price Reduction	Bratislava	4	GB	Sep-2012	Dec-2013				Y				2012	
Allocation Process Improvement	Bratislava	4	GB	Sep-2012	N/A	Cancelled		Y					2012	
Territory Validation Enhancements	Bratislava	4	GB	Sep-2012					Y				2012	
Site Utilization Optimization	Bratislava	4	BB	Sep-2012					Y				2012	
Manual Payout Calculator	Bratislava	5	GB	Jul-2013	Dec-2013				Y				2013	
MFR Progressive Spending	Bratislava	5	GB	Jul-2013					Y				2013	
Funding Flag HR	Bratislava	5	GB	Jul-2013					Y				2013	
Continuos Self Assessment	Bratislava	5	GB	Jul-2013	Dec-2013				Y				2013	
Closed Account IDs & Recovery	Bratislava	5	GB	Jul-2013					Y				2013	
Entity Liquidation	Bratislava	5	GB	Jul-2013					Y				2013	

Pic. 21 Project information input sheet

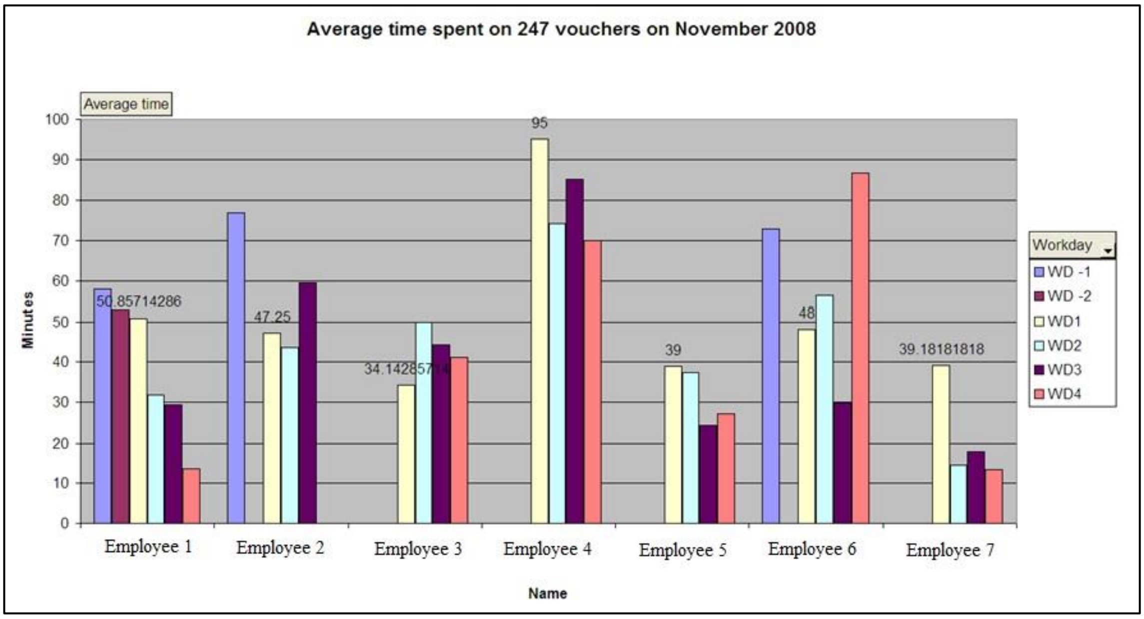
(internal materials of selected IBC, author's own processing)

Appendix 4: Goal statement supporting graphs



Pic. 22 Amount of rejected requests of ITD Nordic DFI

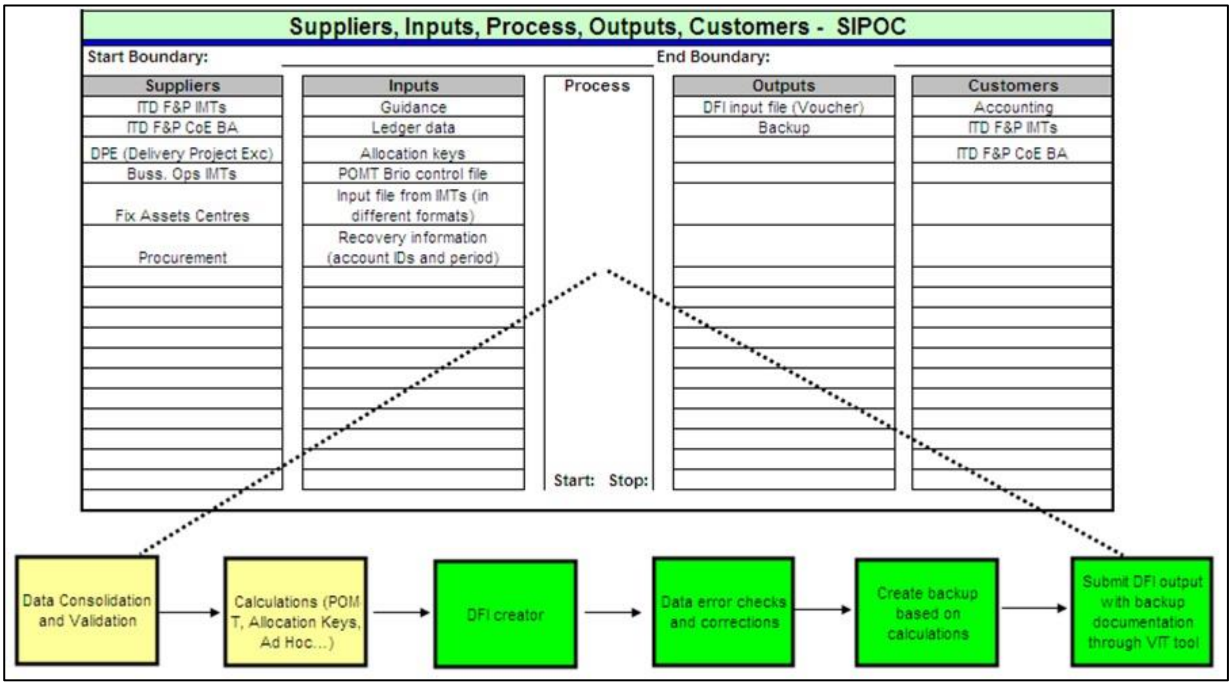
(internal materials of selected IBC, author's own processing)



Pic. 23 Average time spent on processing of 247 vouchers in November 2008

(internal materials of selected IBC, author's own processing)

Appendix 5: SIPOC



Pic. 24 SIPOC

(internal materials of selected IBC, author's own processing)

Appendix 6: Top-Down process maps

Project: GTS ITD DFI Project Bratislava F&P CoE
Black Belt: Jeremy Horner
Date: November 11, 2008

Top Down Charting

Process: POM-t

Sub-Processes

Sub-Process 1 Data consolidation and validation	Sub-Process 2 Calculations	Sub-Process 3 use of DFI creator	Sub-Process 4 Data error check and correction	Sub-Process 5 Create back-up based on calculations	Sub-Process 6 Submit voucher via VIT
Review the Desc procedure	Download the required data	Download data from BMS and FIV	Account check process	Create back-up documentation 1	Attach DFI output to VIT
Ask IMT members for missing data	Process POM-T control sheet:	Create input file for DFI creator	Correct the errors	Create back-up documentation 2	Attach back-up documentation to VIT
	PO recoveries	Create the output file via DFI creator (process the input file)		Create back-up documentation 3	Submit voucher
	BCP calculation	Reviewing errors in the output file		Create back-up documentation 4	Check the satus of the voucher
	FAC depreciation calculation	Correcting the errors			Control the entry in the Ledger
	ICA				
	Review/correct errors in POM-T output sheet				

Process: Calculation of multi-recoveries

Sub-Processes

Sub-Process 1 Data consolidation and validation	Sub-Process 2 Calculations	Sub-Process 3 use of DFI creator	Sub-Process 4 Data error check and correction	Sub-Process 5 Create back-up based on calculations	Sub-Process 6 Submit voucher via VIT
Review the Desc procedure	Calc of % split using allocation keys	Download data from BMS and FIV	Account check process	Create back-up documentation 1	Attach DFI output to VIT
Download all the required data		Create input file for DFI creator	Correct the errors	Create back-up documentation 2	Attach back-up documentation to VIT
Ask IMT members for missing data		Create the output file via DFI creator		Create back-up documentation 3	Submit voucher
		Reviewing errors in the output file		Create back-up documentation 4	Check the satus of the voucher
		Correcting the errors			Control the entry in the Ledger

Process: Ad-hoc Dfi creating

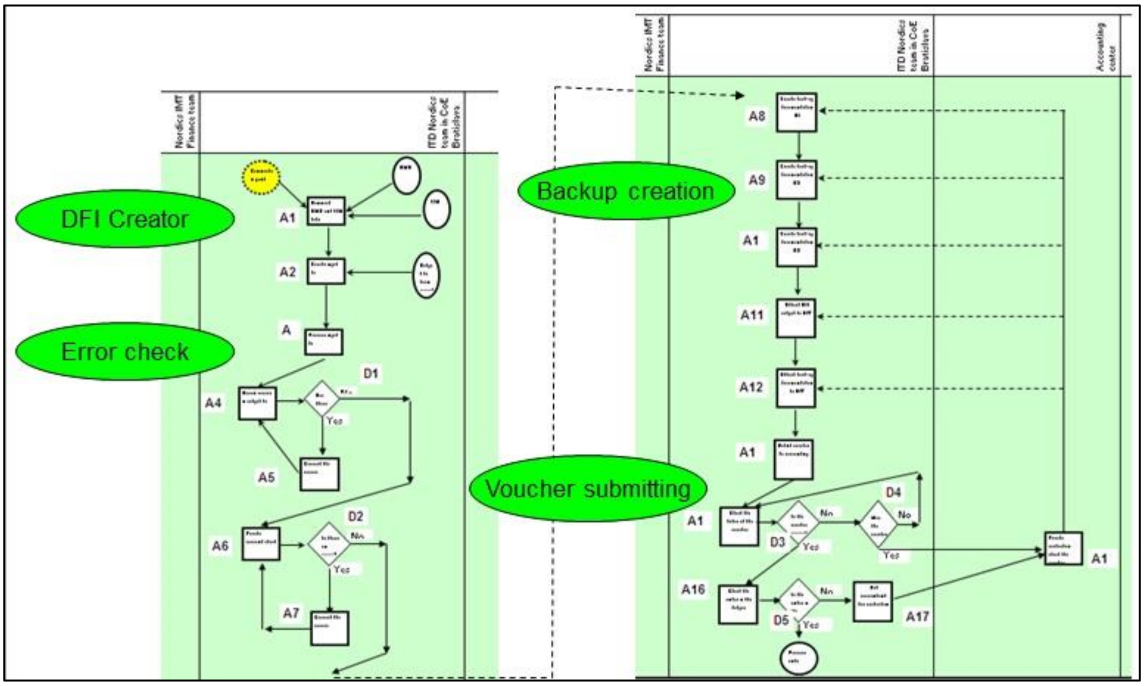
Sub-Processes

Sub-Process 1 Data consolidation and validation	Sub-Process 2 Calculations	Sub-Process 3 use of DFI creator	Sub-Process 4 Data error check and correction	Sub-Process 5 Create back-up based on calculations	Sub-Process 6 Submit voucher via VIT
Review the Desc procedure	N/A - All calculations and data are already avaible	Download data from BMS and FIV	Account check process	Create back-up documentation 1	Attach DFI output to VIT
Control the Nordic DFI teamroom		Create input file for DFI creator	Correct the errors	Create back-up documentation 2	Attach back-up documentation to VIT
		Create the output file via DFI creator		Create back-up documentation 3	Submit voucher
		Reviewing errors in the output file		Create back-up documentation 4	Check the satus of the voucher
		Correcting the errors			Control the entry in the Ledger

Pic. 25 Top-down process maps

(internal materials of selected IBC, author's own processing)

Appendix 7: Functional deployment map



Pic. 26 Functional deployment map

(Finance COE of selected IBC, 2010)

Appendix 8: Communication plan

Communications Plan for Key Messages					
Target Audience	Primary Message	Vehicle	Frequency	Responsibility	Feedback Mechanism
Project Sponsor	Project status	Meetings, Email, Tollgate reviews	bi-weekly	Alex Sigma Team	Email, Face to Face
Project MBB	Project status	Meetings, E-mail	Weekly	Alex	Phone, Email
Project BB	Project status	Meetings, E-mail	Weekly	Alex	Phone, Email
Lean Six Sigma deployment Champion	Project status	Lean Sigma DB	Monthly	Sigma Team	Tollgate review
Business Process Owner	Team Goals/Key Deliverables	Meetings, Email, Lean Sigma DB	Monthly	Sigma Team	Email, Face to Face
LSS core team members	Update/Feedback	Meetings, Email	twice a week	Alex, Sigma Team	Face to Face, Email
Subject Matter Experts	Update/Feedback	Meetings, Email	Ad hoc, as per need	Sigma Team	Face to Face, Email
GTS Bratislava ITD team	Update/Feedback	Meetings, Email	Ad hoc, as per need	Sigma Team	Face to Face, Email
Expense Accounting Bratislava	Update/Feedback	Meetings, Email	Monthly	Sigma Team	Face to Face, Email
IMT F&P IT Nordic Team	Update/Feedback	Meetings, Email	Monthly	Sigma Team	Phone, Email
Expense Accounting Budapest	Update/Feedback	Meetings, Email	Monthly	Sigma Team	Phone, Email

Pic. 27 Communication plan

(internal materials of selected IBC, author’s own processing)

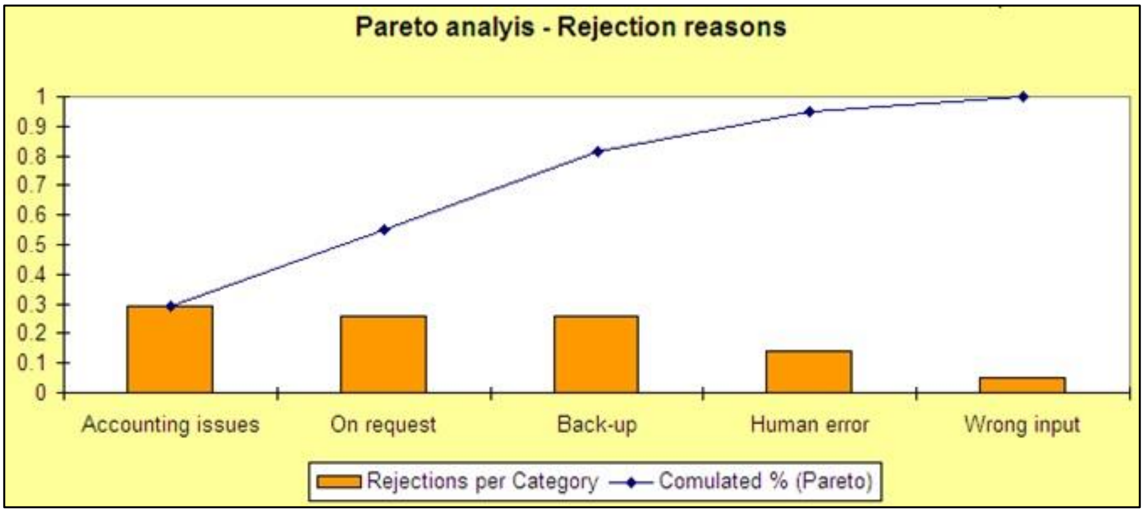
Appendix 9: Rejection reasons categories

Rejection Reason	# of DFIs	Rejection reason (categories)
On request	52	On request
Insufficient back-up	31	Back-up
Back-up (DFI input) and DFI output do not match	21	Back-up
By accounting error	19	Accounting issues
Submitted more than once	12	Human error
Entry below accounting clip level	10	Accounting issues
Wrong input	10	Wrong input
Intracompany issue (LERUS, tie-out, LC's)	9	Accounting issues
Submitted to incorrect person/department	9	Human error
Wrong account combination	8	Accounting issues
Accruals & deferrals (B/S codes, periods,...)	5	Accounting issues
Debit vs Credit swizzles	2	Human error
Incorrect input template used	2	Human error
File too long	2	Accounting issues
More DFI inputs submitted in one request	1	Human error
Wrong minor used	1	Human error
Incorrect country code	1	Human error

Pic. 28 Categories of rejection reasons

(internal materials of selected IBC, author's own processing)

Appendix 10: Pareto analysis



Pic. 29 Pareto analysis of rejection reasons

(internal materials of selected IBC, author's own processing)

Appendix 11: Root cause solutions matrix

Root Cause Solution Matrix					
Solutions / % Contribution of Root Cause to Process Deficiency	Root Cause 1	Root Cause 2	Root Cause 3	Root Cause 4	Root Cause 5
	On Own (or IMT) Request	Insufficient Backup	Accounting Issues	Human Error	DFI Related - data and prerparation
	30%	30%	10%	10%	20%
Self Assessment Checklist	30%	30%	70%	50%	
- Voucher Submission SAC					
- Accounting Bulletin					
System Changes		40%		30%	70%
- VIT Tool update					
- Windows Batch Run Scheduler					
- SPAT					
- Account ID Check tool					
Information Flow Matrix	70%	10%		20%	30%
- Focal Points Implementation					
- Review late requests					
- Task / Workload Matrix					
Voucher Audit Committee		20%	30%		

Pic. 30 Root cause solution matrix

(internal materials of selected IBC, author's own processing)

Appendix 12: Solution selection matrix

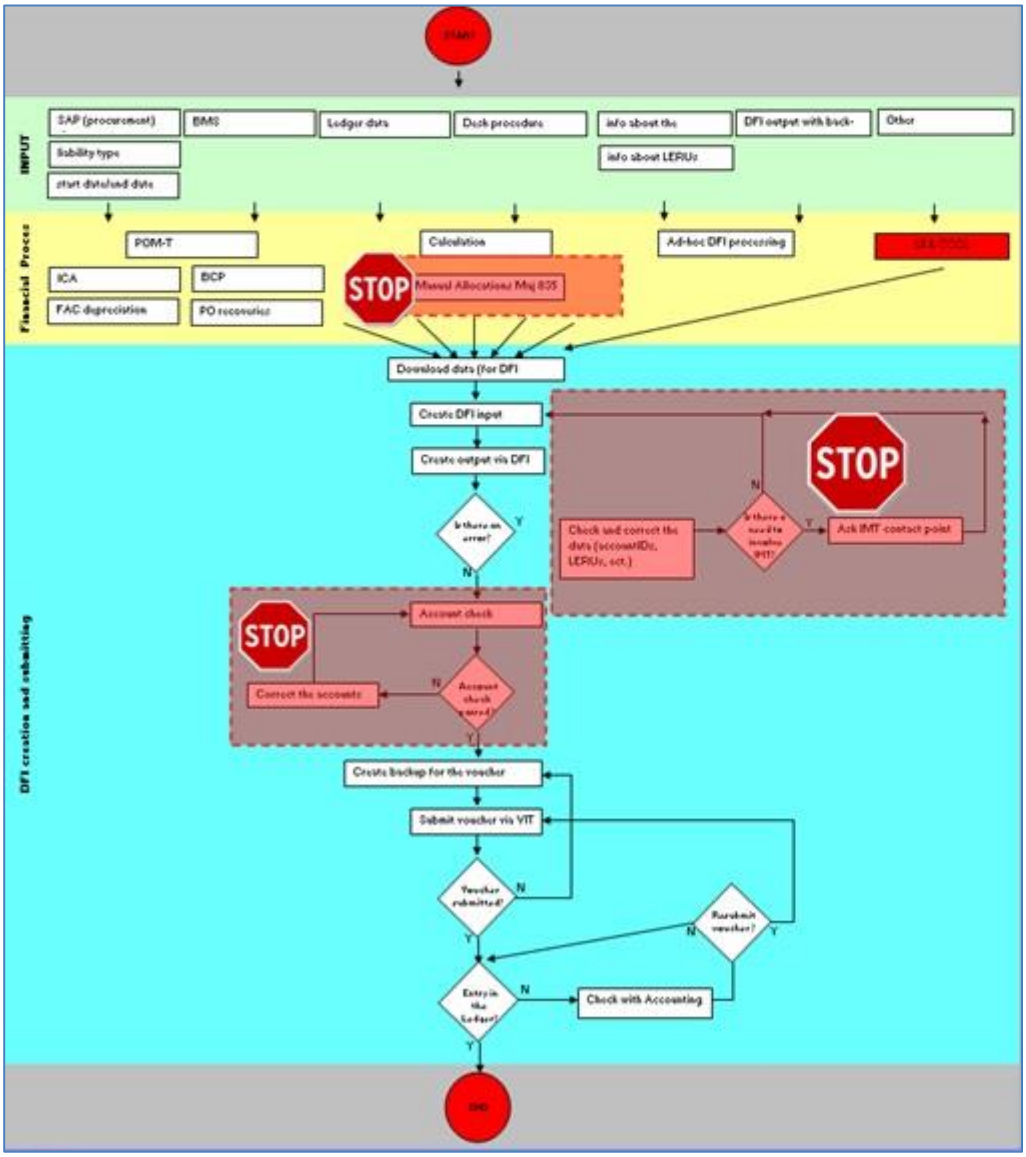
	Solution	Solution Description	Root cause addressed	Sigma Impact	Time Impact	Cost-Benefit Impact	Other Impacts	Total	Rank
				4	3	2	1	Weight	
1	System changes	Create Brio Batch Run query to produce results during night	DFI related - data and preparation	3	3	3	3	30	1
2	Information flow matrix	Prepare email / instruction for all FA (IMT and COE) about deadline guidelines and special after-approval requirement from F&P CoE Management	Rejections on own request	3	3	2	2	27	2
3	Self Assessment Checklist	Education and Self assessment checklist (SAC) on : Backup, accruals, file too long, wrong minors, rejections on requests, incorrect template used	Insufficient Backup	3	2	3	2	26	3
4	System changes	Account IDs replacement tool	DFI related - data and preparation	3	3	2	0	25	4
5	System changes	Implement changes into VIT tool - programming	Insufficient Backup	3	1	3	2	23	5
6	System changes	Service Pool tool - macro based sheet	DFI related - data and preparation	3	2	2	0	22	6
7	Information flow matrix	Send out to IMT list of FAs with tasks to handle	Rejections on own request	2	3	2	0	21	7
8	Information flow matrix	Implement contact points in accounting and distribute to all FAs	Human Error	2	3	2	0	21	8
9	Information flow matrix	Implement score card for IMT inputs	Rejection on own request	2	2	2	1	19	9
10	Information flow matrix	Accounting team to be informed after each month-end close - create score card report or email	Accounting error	1	2	2	0	14	10
11	Information flow matrix	Implement score card for deviation on double requests or late minute cancellations	Rejection on own request	1	1	1	0	9	11
	Special solution in control phase as part of replicating other CoE projects								
12	Voucher Audit Committee	Replication of LSS Voucher Documentation project in Rochester and setup of centralized audit team in CoE	Backup	3	1	3	3	24	n/a

High - 3
Medium - 2
Low - 1
No impact - 0

Pic. 31 Solution selection matrix

(internal materials of selected IBC, author's own processing)

Appendix 13: New Process map



Pic. 32 Process map after implementation of improving solutions

(Finance COE of selected IBC, 2010)

Appendix 14: New sigma level calculations

Sigma Calculation - Time spent on DFI creating	1Q09	Jun-July 2009
ENTER YOUR TOTAL NUMBER OF DEFECTS (D) HERE:	265	146
ENTER YOUR NUMBER OF UNITS OF PRODUCT OR SERVICE (N) HERE:	599	481
ENTER YOUR NUMBER OF OPPORTUNITIES FOR A DEFECT TO OCCUR PER UNIT OF PRODUCT OR SERVICE (O) HERE:	1	1
THIS IS YOUR DEFECT %:	44.2404%	30.3534%
THIS IS YOUR YIELD %:	55.7596%	69.6466%
THIS IS YOUR DEFECTS PER MILLION OPPORTUNITIES (DPMO):	442,404	303,534
THIS IS YOUR SIGMA*:	1.645	2.014

Pic. 33 Sigma level calculation with improving solutions implemented (time spent on DFI creation)

(internal materials of selected IBC, author's own processing)

Sigma Calculation - Number of Rejected DFIs	2Q08-4Q08	Jun-July 2009
ENTER YOUR TOTAL NUMBER OF DEFECTS (D) HERE:	245	9
ENTER YOUR NUMBER OF UNITS OF PRODUCT OR SERVICE (N) HERE:	2,849	560
ENTER YOUR NUMBER OF OPPORTUNITIES FOR A DEFECT TO OCCUR PER UNIT OF PRODUCT OR SERVICE (O) HERE:	5	5
THIS IS YOUR DEFECT %:	1.7199%	0.3214%
THIS IS YOUR YIELD %:	98.2801%	99.6786%
THIS IS YOUR DEFECTS PER MILLION OPPORTUNITIES (DPMO):	17,199	3,214
THIS IS YOUR SIGMA*:	3.615	4.225

Pic. 34 Sigma level calculation with improving solutions implemented (rejected DFIs)

(internal materials of selected IBC, author's own processing)

Appendix 15: Calculation of savings and IRR

	Reduction (in minutes) Per closing/month	Reduction (in hours) Per closing/month	Reduction (in hours) Annual	FTE reduction	Monthly $ Saving
Reduce DFI preparation time per single voucher	3 569,50	59,49	713,90	0,38	$2 302,90
Reduction of errors (vouchers rejection and reworking time)	100,30	1,67	20,06	0,01	$64,71
Service Pool Allocation Tool (Finland only)	650,00	10,83	130,00	0,07	$419,35
Windows BRIO Shceduler (whole ITD Nordics)	1 481,00	24,68	296,20	0,16	$955,48
Total	5 800,80	96,68	1 160,16	0,62	$3 742,45

Voucher rejection reduction	minutes
Time spent on reworking 1Q09 (Step 6 - If rejected)	0,36
Time spent on reworking June-July 2009 (Step 6 - If rejected)	0,02
Delta	0,34
Average # of vocuhers sent per closing/month	295
Saved minutes	100,3
Brio Scheduler	minutes
Time spent on Brio Query running before introduction of Brio Scheduler	1491
Time spent on Brio Query running after implementation of Brio Scheduler	10
Delta	1481
Saving per closing/month	1481
Voucher preparation time reduction	minutes
Time spent on DFI preparation 1Q09 (Step 0,1, 3-6 - see process map)	40,74
Time spent on DFI preparation June-July 2009 (Step 0,1, 3-6 - see process map)	28,64
Delta	12,1
Average # of vocuhers sent per closing/month	295
Saved minutes	3569,5
SPAT	minutes
Time spemt of Service pool allocations before intorduction of SPAT	850
Time spemt of Service pool allocations with SPAT (June-July 2009)	200
Delta	650
Saving per closing/month (Finland only)	650
Saving per closing/month (whole ITD Nordics, educated estimation)	2600
Financial calculations - Internal Rate of Return	
FTE reduction	0,62
Cost of 1 HC (FTE)	$6 000,00
Cash flow	$3 742,45
Number of years	5
Initial project related costs	-$19 509,68
Internal Rate of Return (effective interest rate)	19,18%
NPV	$0,00

Pic. 35 Calculation of savings and IRR

(Finance COE of selected IBC, 2010)

Appendix 16: Replication opportunities

Solution Focus	Replication: Pilot	Replication: Center	Replication: Business-Unit-Wide	Standardization: Similar Process	Replicated?
SPA Tool: Solution to reduce manual service pool allocation time of major 836 by using automated excel tool	Finland (+other Nordics countries)	All GTS ITD	All LoBs which use allocation keys to split one pot into several smaller pots using special keys (e.g. quantity, revenue, m2, space etc…)	Candidate for ASCA certified excel tool - to be used worldwide	NO (So far works in Finland, need to upload data for other countries)
ART (Account ID replacement tool) - Solution to reduce manual checking of closed account IDs and finding a replacement for them	Nordics	All GTS ITD	All LoBs which send voucher requests using account ID structure	N/A	YES - already works in several GTS ITD IMTs
Brio Query Scheduler - Solution to reduce waiting time during closing days of running long and time consuming queries	Nordics	All CoEs	All LoBs which run Brio queries during closing time	This process works by setting up automated brio scheduler agent on PC and can be replicated to all personnel who uses large time consuming queries	NO
VRC-G (Voucher Random Check) Generator - Solution to be used by KPI coordinator / Business Controller to select randomly given vouchers for checking	Nordics	All CoEs	All LoBs + Accounting	All business controls personnel which select vouchers for SOX or CSA purposes, audit committee	NO
LSS Project GTS ITD DFI Optimization: Solution to replicate ITD Nordics findings and implement solutions also in other IMTs	Nordics	All GTS ITD IMTs	N/A	Since the root causes and solutions to these problems are known it will be easy to replicate in other IMTs now	NO

Pic. 36 Replication opportunities

(internal materials of selected IBC, author's own processing)