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THE LEAN SIX SIGMA IMPROVEMENT PROGRAM CONCEPT AND THE STANDARD OPERATING PROCEDURE

Abstract. The speed of changes in manufacturing and service business increases year-on-year. Customer is getting more sophisticated, product / service features dramatically evolve, improvement is a matter of life and death of the company. In such environment, companies decide to invest in improvement teams and programs to hit the bottom line. In the majority of cases, these companies use Lean Six Sigma toolkit and infrastructure, as the current proven best approach.

The Lean Six Sigma implementation method is being well described in the literature, but with the common focus on CEO and executive board level. The organization levels below, process managers and project leaders, were, in most of the cases, left on their own to create and execute improvement programs in their respective areas. The purpose of this thesis is to extend the process improvement framework for this, frontline, organization level.

In this thesis, we will be reviewing first the basic Lean Six Sigma concepts along with complexity reduction tools, in order to set the foundation and the context for the improvement team activities. In the second chapter, we will combine Lean Six Sigma infrastructure with the project management methodology in order to develop standard operating procedure as the operation framework for the improvement teams acting in the medium and small size organization units (below 350 people). As a summary, this standard operating procedure is represented by the flowchart that serves as a single roadmap for all improvement teams in the organization.

Keywords: Improvement team, Lean Six Sigma, DMAIC, project management, standard operating procedure.

Chapter 1 gives the background and the overview of the Lean Six Sigma methodology and its toolkit, which is considered to be the current best approach for the organization transformation. In addition to traditional Lean Six Sigma concepts, we will also discuss complexity reduction methods, which, combined with Lean Six Sigma, give the highest contribution to a company success in the shortest period of time

The drive for improvement was ever present force since the early 20th century. Advanced thinkers of that time (Ford, Taylor) recognized the need for work division (Pascal, 2007) to series of single operations to make the product cheaper with less defects, at the lead time in line with market needs (mass production). Then there was one more milestone: Toyota way - Lean manufacturing and their focus on eliminating “muda”, non-added value work, to reduce cycle time, work-in-progress, inventory. Further breakthrough was made with Six Sigma (George, 2003) and their focus to reduce variations in process to achieve superior outcome quality. The last but not least, complexity reduction theories look critically over the business as a whole, trying to focus funds around most profitable products and their standardization.

Finally, there is a new direction that blends all the good sides of Lean, Six Sigma and standardization, simply called Lean Six Sigma method for rapid improvement that appears to be current best practice for organizational transformation. In the end of the 20th century, a new component is added to Lean Six Sigma blend. It is complexity reduction through product / service portfolio optimization We will be describing each component, in order to understand their strengths and weaknesses, prior to implementing Lean Six Sigma improvement toolkit to improvement teams in medium and small organization units.

Time. Quality. Cost (George, 2003). These simple words are corners of the magic business success triangle. Until recently, it was thought that it was not possible to achieve all these three goals

simultaneously. Two main approaches were practiced separately: either pure Lean or pure Six Sigma. Despite the results achieved, there is a deep mathematical connection between their fundamental ideas that could yield even more gain. A simple mathematical derivation shows that a 10% of defects incidence increases process cycle time by 38% and the work-in-process mi by 54% (George, 2003). Maximum speed cannot be achieved without improving quality, nor can maximum quality without also improving velocity. Therefore, methods are complementary and should be integrated to achieve maximum performance.

Control (George, 2003) is the last phase of DMAIC whose main purpose is to sustain changes made in the Improve phase. In this phase, knowledge of the project team is documented and handed over to users which are trained on the process changes. In order to preserve achievements, Control phase passes through six steps listed below:

- Changes documented and trainings delivered
- Change outcomes recalculated into financial figures
- Health check after the implementation
- Process performance monitoring system
- Implementation pilot
- Developing a process control plan

Each of these steps will be explained in more details in the paragraphs that follow.

Any change to the process made by the project team has to be formally documented through a procedure, work instruction or manual that is shared with all the stakeholders (George, 2003). Later changes to this documents have to be made in a controlled manner, with informing all the involved parties. Best practices have shown that these documents should be uploaded on a web portal with document change management, accessible to all the interested parties. Apart from documenting the change, in the majority of cases, a formal training needs to be executed with both the process owners and the execution level in order to ensure sustainability. A great tool to help in defining the training scope can be a training matrix that defines what the training requirements per position in an organization are.

Immediately after the project execution, it is responsibility of the project leader to ensure that the change is documented and the trainings are done. However, once the project is closed, it becomes the responsibility of the process owner to ensure up-to-date documentation and trainings of the new personnel.

Lean Six Sigma is highly data oriented method. This is valid as well when it comes to benefits evaluation (George, 2003). In all cases where possible, it is required to calculate benefits into financial impact verified by the company finance and approved by the CEO or other equivalent function. Apart from calculating financial impact of the change to the business before the project is executed, actual financial results are being tracked to check whether promised gains are achieved. At this point project team and finance department have to agree on the method of tracking and quantifying improvements through cost saving, cost avoidance, additional income etc. Of course, some improvements are easy to be quantified (example: new production line replacing the manual work of two people), but some are not so tangible (example: benefits of the new workspace organization to productivity). For those non-measurable cases, usually metrics defined in the measure phase can help in determining how the improvement was successful. One of the typical methods to quantify success of some initiative could be a survey comparison before and after the change (a customer survey, a process owner survey etc.). However, as an ultimate goal, we should try to quantify and convert to financials whatever we can, even being it completely out of conventional financial thinking.

For every change there is a transition period for the organization to transfer from one way of working to another (George, 2003). This time frame is usually embedded in the project plan like a hyper care period, when project team time is dedicated to full support to the organization to integrate changes. Immediately after this period is finished, organization is given to perform one process cycle independently, usually one to two months, after which a process health check is performed. The health check is a predefined questionnaire designed to formally measure success of the change acceptance and organizational ability to operate independently. When dealing with larger scale changes, affecting several parts of the organization, health check questionnaires can be developed for each part of the organization. Based on these checks further measures to can be taken to improve aspects of the change implementation identified through health check. Going further and depending on the nature of the change, several months

to one year after change implementation, management might decide to perform formal audits of the compliance with the new procedures. These audits can be conducted by internal or external audit teams. Audits are being followed by action plans for non-conformities correction or prevention with clearly defined responsibilities and deadlines.

After the change is implemented and process improvement put in place, it is necessary to establish a system that would monitor process performances and prevent performance deterioration (George, 2003). Usual means of control are IT solutions that automatically generate control charts of the key parameters or send out alerts or emails if the process gets out of specified boundaries. It is important to book time and resources for development of the performance monitoring solution in the process improvement plan in order to prevent process and staff to return to the previous low performance level and to ensure sustainability of the changes. At the later implementation stages, management should show focus and commitment on the control system alerts and staff reaction upon them. Performance monitoring systems functionality and staff reaction should be mandatory parts of the health check questionnaire mentioned in the previous paragraph.

Latest developments and start-ups, especially in the IT area, have proven the advantage of running a pilot (George, 2003) wherever possible before a process change or process improvement is being implemented on a larger scale. A pilot is a real-life simulation of the change run on a single equipment, facility, department or test version of the software. It can reveal solution issues in the early stages, before major investment is being done, so that modifications can be done on time, without replicating mistakes or defects. Also, a pilot is a real life proof of the benefits, which can increase management and staff buy-in and facilitate further change implementation. Before running the pilot, it is important to agree and embed into the project plan time needed for piloting so that the data gathered is relevant for the further decision making. One of the worldwide known example of piloting is Uber app for taxi services, which was tested only on the two vehicles in New York to check whether taxi drivers and customers will find it useful and accept it. After positive test results, app was commercialized on a wide scale and today used worldwide.

The process control (George, 2003) plan is the last step when implementing the process improvement. Similarly to the previous step, the ultimate goal of this step is to ensure changes sustainability over time. Unlike previous step that was focused on the IT solutions, here project team is focused on defining ownership and responsibilities for the process performance. In this phase, metrics of the process performance is being clarified and agreed with the process owners, as well as visualization tools that will be used. Responsibilities, metrics and visuals are being formally shared via procedures, manuals or other written forms, so that they remain available to the process owners after the project closure.

Control charts, described in the Measure chapters, represent one well known tool for the Control phase, as well. Second widely known and used tool is Mistake Proofing (Poka-Yoke)

The basic principles of Mistake Proofing (Mistake Proofing, 2019), (George, 2003) are

- Preventing the defects 100 % if possible
- If the first is not possible, detecting 100 % of the defects that occurred.
- If the second is not possible, reduce the severity of defects that will reach customer or the process step that follows.

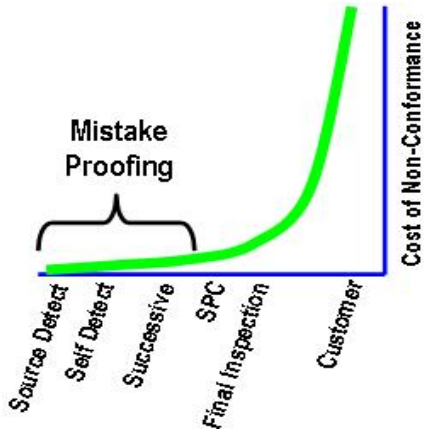
Improvement teams may decide to use one of the principles or to combine all of them depending on the issue they are working on, with the aim to attack the root causes of the defects.

There are three Mistake Proofing concepts depending on the defects checkpoint place in the process:

- Successive control - control point is placed in the process step that follows current step. This control is reactive as it allows defective work item to propagate to the next step. Feedback on the defect comes, therefore, from the next process step.
- Self-control - control point is placed at the current process step. In this way, feedback on the defect occurrence is quicker and problem is being solved at the source.
- Control at the source - control point is set to check operating conditions before the work item is being processed. This is proactive option, preventing defect occurrence and decreasing losses in time and money.

As mentioned before, these control concepts can be combined depending on the particular issue, budget and available resources. What is important to mention is that, as shown on the Figure 13 (Mistake

Proofing, 2019), the later the defect is found in the process, the greater the cost incurred, since the more material and labour is being invested as the process approaches its end. Even worse, if the defect reaches final customer, the reputation and customer loss may exceed the pure processing cost. Thus, it makes sense to include defect control at every process step, the earlier the better. Of course, the investment in Poka-Yoke has to be justified by the gain coming from defect rate reduction ("Poka-Yoke ROI"). The second thing to be considered is the impact of these additional controls to the process velocity i.e. once the additional controls are being introduced, the time needed to perform additional inspection has to be taken into account.



Source: (Mistake Proofing, 2019)

Figure 1 - Cost of defects found at different points of the process

When it comes to the action that control points needs to perform in the case defect is detected, there are two directions:

- Warnings / alarms / messages to the operator or process owners that defect occurred
- Process action - rejecting defective product / work item and / or stopping the process (equipment or workflow)

Some solutions may combine both approaches, for example:

- System might send out messages and rejects defective products, while the process continues - so called "yellow messages"
- If the same defect is being detected error on X consecutive products, system will stop the equipment ("red message") and the operator should perform a detailed inspection to find the root cause of the issue.

At the end of this discussion we will mention some Poka-Yoke examples that we can find every day at our home or work. (Mistake Proofing, 2019)

- Spelling and Grammar Checker in the document editors
- Field Value Checkers - we cannot enter letters into field that requires phone number, ZIP code, bank account number etc.
- Parts that can be assembled in a single, correct way
- LOTO safety procedure - main drive of the machine is locked and tagged, so no one can start machine as long as maintenance work is being performed
- "Lights on" beeper once the car engine is stopped
- "Ink level low" message on the printers
- Second vent preventing a bathtub overflow
- Purchase order not being approved in full cannot be sent out to the supplier
- Bar code scanners that saves time and prevents mistakes of the manual entry

In the Control phase, it is no longer the project team playing the key role. It is the process owner that takes over the improved process and gets responsible for sustaining its performance (George, 2003). This is why, at this handoff, it is critical to make sure that process owner understands the change and his/her

responsibility to sustain it. This is why it is crucial, apart from formal training, to leave full process documentation available to the process owner after the project team is being adjoined. In many companies, for the bigger project there is a sign-off procedure, formally pointing the moment of responsibility transfer to the process owner. This whole process is much easier if the process owners have been involved in all DMAIC phases and actively participated in improvement design and implementation.

Second important aspect of this phase is to identify all relevant indirect process participants and inform them about the changes affecting their activities, so that they are aligned with the process owners. There are many examples how skipping this step can affect negatively improvement results. Here is one example. One worldwide known company introduced reusable finished goods packaging. The project was providing significant cost cut to the company and waste disposal cost saving and environmental responsibility at the customers' end. But one off-shore customer service office, serving Eastern Europe, was forgotten to be kept in the information loop. Therefore, this service point operated without informing customers that the packaging is reusable and, therefore, should be collected and returned back. It took more than one year to discover this issue, and all that time customers were throwing the expensive reusable packaging immediately to garbage. The benefits the project was supposed to bring were decreased and, for this group of the customers, delayed by one year.

In the paragraphs above we have discussed about DMAIC methodology and some key tools used in every phase. As a conclusion (George, 2003), it should point out key watch outs, in order to have improvement projects rolling out as planned.

After researching many real life improvement projects, DMAIC phase that most often slips out of schedule is Improve - selecting, applying and validating solutions. Main causes why project teams get surprized here can be:

- Wrongly selected improvement project
- Project management issues (lack of resources, late sponsor involvement, extending the project scope compared to the initial project charter)

This is why many companies are adding project management package to the basic Lean Six Sigma training module. Mentioned issues are also pointing out focus on the Define phase:

- Project selection should be done based on Return-on-Investment (ROI) and impact to the customer. These two should be reassessed before the Improve phase as, at this point of time, project team has a much better insight of the problem that is to be solved than in the Define phase.
- Clear communication on the parties' involvement expectations and the resources needed. Of course, the prerequisite is to have alignment within the entire organization on the project goals and priorities.

Further, there are literally hundreds of tools available to support improvement efforts. But, project teams are usually using several most common tools, for example: 5 Why, Kaizen events, control charts etc. If these tools are sufficient to get to the root cause of the issue, there is no need to insist on using full set of tools, as long as there is project leader awareness of these tools in the case common techniques fail. Also, project leaders should be practical and efficient in leading the team through the DMAIC phases. Their ultimate goal is being to contribute to the company bottom line and to sustain that contribution over time. If they reach this goal, nobody will question whether they fully respected or not the predefined improvement models.

Vice versa, now we will see some Six Sigma gaps that can be complemented with Lean tools (George, 2003).

1. Identifying waste. Six Sigma uses process mapping but it does not take into account setup time, completion rate, waiting time etc. is which are critical in defining non-value-added activities and their cost. Instead, Six Sigma focuses on eliminating variation and, if this is not possible, takes process redesign into account. Lean is improvement oriented and process redesign for Lean is natural thing, done by default.
2. Using proven Lean Tools. Lead time and process effectiveness are outside Six Sigma focus. Since there is a natural, mathematical relation between quality and speed (10% of defects incidence increases process cycle time by 38% and the work-in-process by 54%), it is clear that reduction of defects rate will increase the speed. However, Six Sigma is not using Little's Law and, therefore, misses the opportunity to

apply some well-known and proven Lean tools to improve the process performance (Pull system for WIP limitation, Total Productive Maintenance, 5S, waste recognition).

3. One important Lean tool is a Kaizen event - intensive improvement event that gathers all stakeholders or certain process for several days session with the aim of achieving tangible results in a shortest time period. Action-orientation of these events can serve as a real power cord for DMAIC methodology.

4. Quality is achieved faster after eliminating non-value-added activities. Six Sigma focuses on value added process steps trying to minimize variation. However, once Lean eliminates unneeded activities, the process itself becomes simpler, with less possibilities to create non-quality. Thus, combining Lean and Six Sigma tools yields in better results, faster, then application of Six Sigma by the book.

During Lean Six Sigma application, an often dilemma is what to apply first: optimize process output with Six Sigma or simplify the process through Lean. As discussed in previous chapters, there is organic, mathematical relationship between quality and speed, therefore both Lean and Six Sigma tools are contributing to the common goal - improvement effort according to the highest ROIC.

According to the discussion in the previous chapters, Lean Six Sigma is the current best practice to cope with business challenges and complexity (George, 2003). In today's competitive environment, improvement programme is not only “nice-to-have” interest of the CEO, but an instrument of company or organizational unit survival.

As a short summary at the end of the section we will list key principles of both methods, that, when combined together, bring complete transformation (not step-by-step evolution) of the organization.

1. Customer First: Customer basic quality requirement define customer sensitive defects which are priority one for improvement, being more important than the ROIC.

2. Flexibility: The velocity and the flexibility (ability to answer the most urgent customer needs) of the process are proportional

3. Pareto Principle: 20% of the activities cause 80% of the delay.

4. Little’s Law: The higher the WIP, the slower the process. The WIP is impacted by long changeover time, defects / errors, demand variations, product portfolio complexity.

5. Complexity: the complexity of the offering portfolio can add more non-added-value cost than slow or defective process, as described in the next chapter. Thus complexity needs to be reviewed and reduced along with Lean and Six Sigma implementation.

For a very long time, a prevalent marketing and product development premise was to offer wide variety of products or services to attract highest possible number of customers (George, 2003). The wider, the better. It was indeed wider, but was it wiser at the same time?

This hunger for differentiation started around the early 20s of last century, with the famous story of Model-T, a product available in one colour and with single feature set, with a single purpose: to satisfy transportation needs at low cost due to eliminated complexity of mass production. And at the beginning, it succeeded, gaining tremendous portion of the market share. However, the success was not sustainable, as in the few years customers were ready to pay a little bit more to get colour, power or feature they like. So, the volume share of Model T started to fall, until 1928, when it finally became part of the automotive history. Until the beginning of the 21st century, key marketing principle was differentiation and wide variety of features to accustom all possible customers’ needs.

One well known international company was following this policy for decades. It spent millions to launch products in new packaging, offer all possible sizes and features to fit all the tastes. What their marketing and product development were not able to see is that every single of their invention required a new piece of equipment or modification of the existing one. Setup times were higher, together with the number of changeovers. In the end its production centres were full of equipment below 20% of utilization with slow moving stock of spare parts and functional knowledge rather related to the person than to maintenance systems and practices. There was a massive and slow organization created to support life cycle management of such complex offering. On the other hand, the impact on the customer was below expectations and the total sold volume was slightly declining. Did they know the cost of keeping all this complexity in house? What would be the most logical move to keep the market share?

Since the beginning of 21st century, many companies with long history started to have a critical look over their offerings and take the learnings from emerging IT giants (Google, Apple, Microsoft). Instead of

trying to serve each and every need (basic, functional and nice to have), focus was on customer sensitive features for the products / services bringing the highest income. Consequently, products with low income and market share started to be withdrawn from the market.

Coming back to our Lean Six Sigma discussion, let's have a look what would be the outcome of the Lean Six Sigma implementation over a process that is suffering from complexity. Lean Six Sigma will definitely contribute in achieving stable outcome (George, 2003) at a shorter cycle time (second chart on the same figure). But, the results will be only partial as the root cause of the problem was missed. If the process can be re-engineered in a way that only value added activities are kept, a tremendous improvement level can be reached.

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АЛТЫН СИГМА ЖАБДЫҚТЫ БАСҚАРУ БАҒДАРЛАМАСЫНЫҢ ҚҰРЫЛЫМЫ ЖӘНЕ СТАНДАРТТЫ ЖҰМЫС ТӘРТІБІ

Аннотация. Өндірістік және сервистік бизнестің өзгеру қарқыны жылдан-жылға артып келеді. Клиент жетілдірілуде, өнім / қызмет мүмкіндіктері күрт кеңейіп келеді. Жақсарту – бұл компания-ның өмірі мен өлімі. Мұндай ортада компаниялар практикалық нәтижелерге қол жеткізу үшін жақсарту топтары мен бағдарламаларына қаражат салуды шешеді. Көп жағдайда бұл компаниялар Lean Six Sigma құралдар жиынтығын және инфрақұрылымды қазіргі уақыттағы ең жақсы тәсіл ретінде пайдаланады.

Lean Six Sigma әдісі әдебиетте жақсы суреттелген, бірақ бас директор мен атқарушы кеңестің деңгейіне баса назар аударылады. Төмендегі ұйымдастырушылық деңгейлер, процесс менеджерлері мен жоба менеджерлері көп жағдайда тиісті салаларда жақсарту бағдарламаларын құрумен және іске асырумен ғана қалды. Диссертациялық жұмыстың мақсаты – ұйымның осы алдыңғы деңгейінде процесті жетілдіру құрылымын кеңейту.

Бұл тезисте біз алдымен Lean Six Sigma негізгі ұғымдарын, сондай-ақ жақсарту тобының жұмысының негізі мен мазмұнын құру үшін күрделілікті азайту құралдарын қарастырамыз. Екінші тарауда біз Lean Six Sigma инфрақұрылымын жобаны басқару әдіснамасымен біріктіріп, орта және кіші ұйымдастырушылық топтарда (350 адамнан кем) жұмыс жасайтын топтардың жұмыс құрылымы ретінде стандартты жұмыс тәртібін әзірлейміз. Осылайша, осы стандартты жұмыс процедурасы ұйымдағы барлық жақсарту топтары үшін бірыңғай жол картасы ретінде қызмет ететін кесте түрінде ұсынылған.

Қорыта келе, бір белгілі халықаралық компания ондаған жылдар бойы бұл саясатты ұстанып келе жатқаны анықталды. Ол миллиондаған өнімді жаңа қаптамада шығаруға жұмсады, әр түрлі мөлшерде және әр түрлі талғамға сай мүмкіндіктер ұсынады. Маркетинг пен өнімді әзірлеу олардың әрбір өнертабысы жаңа жабдықты немесе қолданыстағы түрлендіруді қажет ететіндігін көре алмады. Орнату уақыты коммутаторлар санымен бірге жоғары болды. Нәтижесінде, оның өндірістік орталықтары жүктеме деңгейі 20% -дан төмен, қосалқы бөлшектермен және адамдарға функционалды біліммен жүйелер мен техникалық қызмет көрсету тәжірибелеріне қарағанда анағұрлым жақын жабдықтармен толықты. Осындай күрделі ұсыныстың өмірлік циклін басқаруды қолдайтын жаппай және баяу ұйым құрылды. Екінші жағынан, сатып алушыға әсер күткеннен төмен болды, ал жалпы сатылым аздап төмендеді.

Түйін сөздер: жетілдіру тобы, Lean Six Sigma, DMAIC, Жобаны басқару, стандартты жұмыс тәртібі.

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КОНЦЕПЦИЯ ПРОГРАММЫ УЛУЧШЕНИЯ LEAN SIX SIGMA И СТАНДАРТНАЯ РАБОЧАЯ ПРОЦЕДУРА

Аннотация. Скорость изменений в производственном и сервисном бизнесе увеличивается из года в год. Клиент становится все более изощренным, резко расширяются возможности продукта / услуги. Улучшение –

это вопрос жизни и смерти компании. В такой среде компании решают инвестировать в команды по улучшению и программы, чтобы достичь практического результата. В большинстве случаев эти компании используют инструментарий и инфраструктуру Lean Six Sigma как проверенный на данный момент лучший подход.

Метод реализации Lean Six Sigma хорошо описан в литературе, но с общим акцентом на уровне CEO и исполнительного совета. Организационные уровни ниже, менеджеры процессов и руководители проектов в большинстве случаев были оставлены наедине с созданием и выполнением программ улучшения в соответствующих областях. Целью данного тезиса является расширение структуры улучшения процессов на этом переднем уровне организации.

В этом тезисе мы сначала рассмотрим основные концепции Lean Six Sigma, а также инструменты снижения сложности, чтобы установить основу и контекст для деятельности группы по улучшению. Во второй главе мы объединим инфраструктуру Lean Six Sigma с методологией управления проектами, чтобы разработать стандартную рабочую процедуру в качестве рабочей структуры для команд по улучшению, действующих в средних и малых организационных единицах (менее 350 человек). Таким образом, эта стандартная рабочая процедура представлена блок-схемой, которая служит единой дорожной картой для всех групп по улучшению в организации.

Было установлено, что одна известная международная компания следовала этой политике в течение десятилетий. Он потратил миллионы на запуск продуктов в новой упаковке, предлагая всевозможные размеры и функции на любой вкус. Что их маркетинг и разработка продукта не смогли увидеть, так это то, что каждое их изобретение требовало нового оборудования или модификации существующего. Время установки было выше, вместе с количеством переключений. В конце концов, его производственные центры были заполнены оборудованием с уровнем загрузки ниже 20%, с медленным запасом запасных частей и функциональными знаниями, скорее связанными с человеком, чем с системами и практикой технического обслуживания. Была создана массивная и медленная организация, которая поддерживала управление жизненным циклом такого сложного предложения. С другой стороны, влияние на покупателя оказалось ниже ожиданий, а общий объем продаж немного снизился.

Ключевые слова: команда по улучшению, Lean Six Sigma, DMAIC, управление проектами, стандартная рабочая процедура.

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