Project 511084-TEMPUS-1-2010-1-RS-TEMPUS-JPHES

LeanEA – Production and Profitability improvement in Serbia Enterprises by adopting Lean Thinking Philosophy and strengthening Enterprise – Academia connections

UNIVERZITET U BEOGRADU – FAKULTET ORGANIZACIONIH NAUKA
KATEDRA ZA INDUSTRIJSKO I MENADŽMENT INŽENJERSTVO

UNIVERSITY OF BELGRADE – FACULTY OF ORGANIZATIONAL SCIENCES
CHAIR OF INDUSTRIAL AND MANAGEMENT ENGINEERING

LeanTech ´13

2nd INTERNATIONAL SCIENTIFIC CONFERENCE ON LEAN TECHNOLOGIES

PROCEEDINGS

BELGRADE, SERBIA, SEPTEMBER 5 - 6, 2013.

Publisher
UNIVERSITY OF BELGRADE – FACULTY OF ORGANIZATIONAL SCIENCES
CHAIR OF INDUSTRIAL AND MANAGEMENT ENGINEERING
JOVE ILICA 154, 11 000 BEOGRAD, SERBIA

Editor
DRAGOSLAV SLOVIC

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Manuscript Submitted for Publication
SEPTEMBER 20, 2013

Printing
1nd

Circulation
100 Copies

CIP Classification

CIP – Каталогизација у пибликацији
Народна библиотека Србије, Београд

005.591.1(082)
658.51(082)
005.6(082)

INTERNATIONAL Scientific Conference on Lean Techologies (2; 2013; Beograd) Proceedings / 2nd International Scientific Conference on Lean Technologies, LeanTech '13, Belgrade, September 5-6, 2013; [organizer] Faculty of Organizational Sciences Chair of Industrial and Management Engineering; [editor Dragoslav Slovic]. – 1st printing. - Beograd: Faculty of ORganizational Sciences Chair of Industrial and Management Engineering, 2013 (Smederevo: Newpress). – 227 str.:ilustr.; 30cm

„Project
511084-TEMPUS-1-2010-1-RS-TEMPUS-JPHES,
LeanEA-Production and Profitablity improvement in Serbia Enterprises by adopting Lean Thinking Philosophy and strengthening Enterprise – Academia connections“ --> nasl. str. – Tiraž 100. – Bibliografija uz svaki rad.

ISBN 978-86-7680-283-8

a) Менаџмент – Зборници b) Управљање
квалитетом – Зборници c) Управљање
процесима – Зборници
COBISS.SR-ID 201354508

“This project has been funded with support from the European Commision. This publication reflects the views only of the author, and the Commision cannot be held responsible for any use which may be made of the information contained therein.”

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Financing and publishing of this Proceedings was aided by ***Project 511084-TEMPUS-1-2010-RS-TEMPUS-JPHES,*** *titled: “****LeanEA – Production and Profitability improvement in Serbia Enterprises by adopting Lean Thinking Philosophy and strengthening Enterprise – Academia connections”.***

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LeanTech'13
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State of the implementation of the lean in Serbia

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ABSTRACT

This paper presents results of the survey originally carried out in organizations from developed European countries. Purpose of this research is to compare results brought by European and Serbian populations. A very low response rate in Serbia unfortunately did not enable making valid comparisons, but, even so, some indicators are obvious. They are described in detail in this paper.

KEYWORDS: Lean, Implementation, Serbia

INTRODUCTION

It is reasonable that present situation has a crucial impact on the direction and way of our thinking. If we look at the present situation in Serbia, we can conclude that it is indeed far from excellent: unemployment rate of about 25%, average salary of about 380 €, negative industrial production growth rate of 0.5% during the last year (according to Serbia's Republic Statistical Office, Web-1), foreign trade deficit during the last year was 2.1 billion € and Serbia's external debt is 26,3 billion € (according to Ministry of Regional Development and Local Self-Government, Web-2). In the light of recent events (Serbia became candidate for membership in EU), it is looks likely that Serbia will become member of EU somewhere in 2020. At that moment, barriers between Serbian economy and EU will disappear. There will be no privileged positions in trade and tax protection of Serbian economy will not exist any more. Having in mind the current state of the Serbian economy, it has no chance to survive competition with EU economy. What, then, should we do?

Recalling some historical data (old Romans used to say that history is life's teacher - "Historia est magistra vitae"), reveals countries in much worse situation, e.g. Japan. After the Second World War, Japan was a completely destroyed country, with no industry and natural resources, which is not the case with Serbia today. One of the things that helped Japan to become what it is today is lean. Thus, for the Serbian economy, starting a lean journey could also be a first step on a road to improvement.

During the 2008, Allied Consultants Europe (ACE) conducted Operational and lean management survey (Web-3). The main goal of the survey was to explore "how companies applying the lean management principles are being used to outperform their competitors". This survey is very informative, for two reasons: (i) it provides referent point considering lean implementation in developed European countries and (ii) it enables us to reasonable compare between Serbian and European organizations – our direct competitors in the future.

Survey was conducted in Serbia by e-mail, and was sent to about 6500 organizations in Serbia. The survey was created to be filled on-line.

Unfortunately, we received only 24 responses (0.3%). On one side, this is extremely disappointing, because it suggests that our organizations are not interested in this topic (either they have no knowledge about current management practices and motivation to learn about new business philosophies to change old habits or they are unaware of seriousness of the situation). On the other side, it illustrates our present situation – due to economic crisis, lack of concern and interest are predominant in most of our organizations, and no one thinks about how to reach future, but only how to survive today. Low response rate may put the validity of our conclusions under question, but this is all we have at the moment. Besides, some number of respondents in original European research (34 from Sweden and 35 from Czech Republic) are nearly the

same (speaking of the number of respondents) and could suggest that our results might be comparable and conclusions valid.

COMBINED SURVEY

Original survey was conducted in organizations from 8 European countries: Italy (number of organizations participating in the survey n=69), France (n=81), Switzerland (n=192), Holland (n=64), Czech Republic (n=35), Germany (n=118), Denmark (n=178) and Sweden (n=34). Survey had 4 parts: Process Improvement Activities, Achieved Results, Change Management and Future Ambitions.

Questionnaire had a series of questions to be answered using 5 point Likert scale, ranging from 0 to 4, where 0 was the worst obtainable result and 4 was the best. This enabled calculation of each organisation's score for the following categories: "Improvement activities", "Results achieved", "Change in results over the last 2 years", "Change of management culture", "Future ambitions for improvements" and finally "Total score for all categories", which definitely enabled answering the ultimate goal-questions:

- What do top performing organisations do to improve more than the others?
- Is there a relationship between the use of lean management and achieved results?
- What can be learned from the Top performers?

The following text presents the results of original European survey, as well as corresponding results from our survey.

RESULTS OF THE SURVEY

In the original study, all responses are classified according to the following performance categories:

- Top performers. All organisations with a score between 75-100% of maximum score. 5% of the European and 29% of Serbian respondents ended up in this category.
- Good performers. All organisations with a score between 50-74% of maximum score. 45% of the European and 42% of Serbian respondents ended up in this category.
- Poor performers. All organisations with a score between 25-49% of maximum score. 40% of the European and 25% of Serbian respondents ended up in this category.
- Worst performers. All organisations with a score between 0-24% of maximum score. 10% of the European and 4% of Serbian respondents ended up in this category.

At the first sight of these data, one can assume that Serbian economy is much healthier than European. This (obviously) wrong conclusion can be explained by two different types of errors. One error type is that respondents in Serbia did not understand questions for they are not in a possession of sufficient knowledge about lean. Another, most likely error type, is that we received response from only the better part of the population and therefore did not receive the representative sample. The later is quite possible due to the authors are involvement with some of the organizations in the sample (authors are involved with 4 of 5 organizations implementing lean, while they are somewhat acquainted with business of almost all of the other organizations that ended up in categories "Top" and "Good"). As organisation's name was not the mandatory field in the survey, we will treat Serbian response as the response of the better part of the Serbian organizations in the rest of the paper.

As presented by the figure 1, Serbian organizations are very far from European, regarding implementation of the lean. Denmark has only 4% of organizations that do not use lean and have no intentions to. In Serbia that percentage is over 60! If we accept that organizations that implement lean are mostly "top performers" (as found by the original European survey), we can conclude that most of the Serbian organizations are (or, if they are not, they are not aware of the situation and definitely should be) seriously threatened by entering European Union.

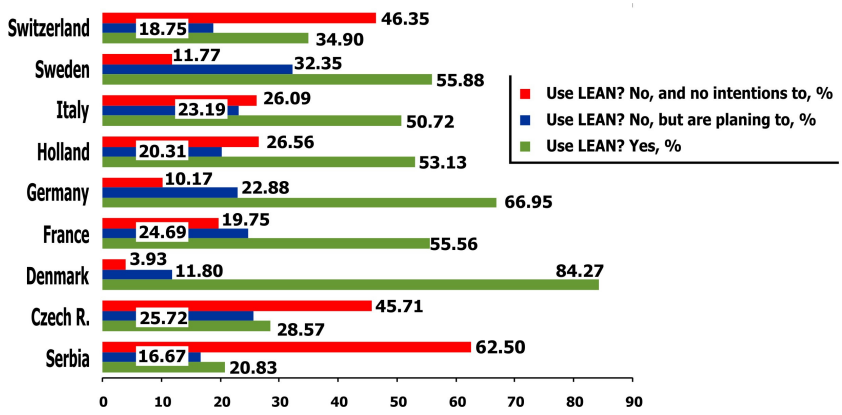

Figure 1: Percentage of organizations implementing or planning to implement lean

Figure 2 shows that top performers significantly outperformed worst performers in average. It is the case with each of the 17 categories as well (see figure 3).

Figures 2 and 3, and corresponding data show, that even anomalies can have anomalies. Anyone who is familiar with state of the Serbian economy sees at a first glance that presented data are indeed unrealistic. This is most probably caused by our old problem: we have the irresistible need to present ourselves much much better than we really are. What opinions from the observed population show is that better part of Serbian organizations is shoulder-to-shoulder with European top performers.

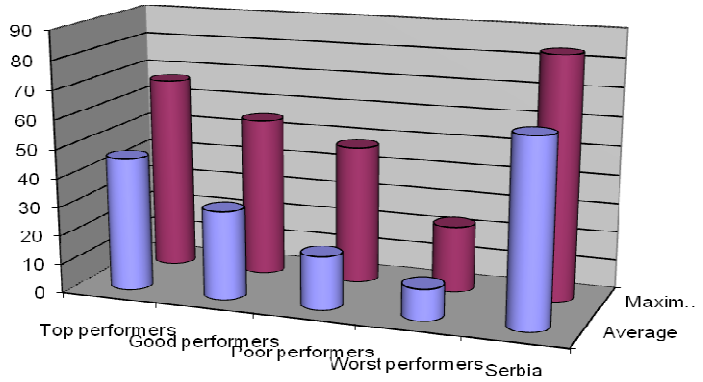

Figure 2: Maximum and average scores of the Top, Good, Poor, Worst performers and Serbian organizations

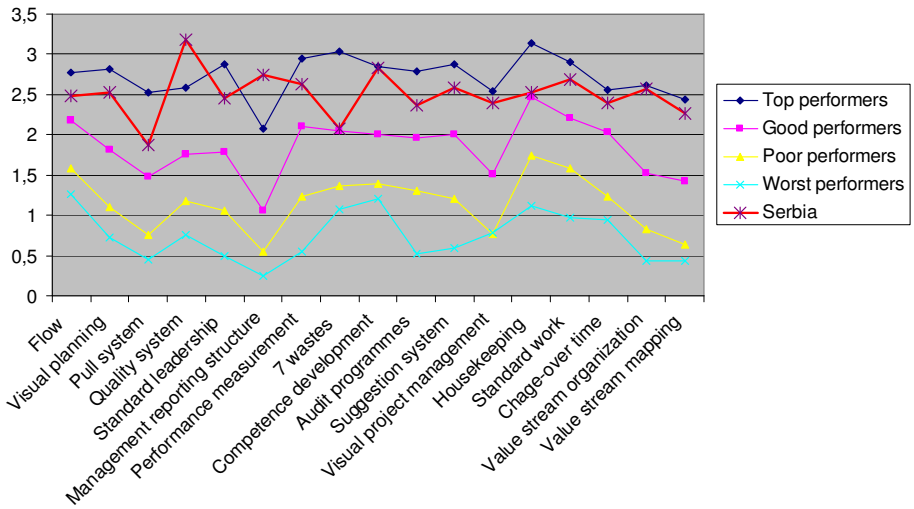

Figure 3: Average scores for 17 categories of the Top, Good, Poor, Worst performers and Serbian organizations

Figure 4 presents respondents' opinions for the level to which the work is standardized. It is a little surprising that Serbian average is higher than the European top performers', but we have a long tradition of documenting and standardizing work (that was something unquestionable during period of socialism), so the high Serbian average seems quite possible. Of course, expressed levels of work standardization and documenting today are rather disbelieving. Finding that the equal level of standardization in Serbian organizations is the same as lean philosophy is expecting / requiring is also distrustful.

Widely accepted system of measuring performance (in lean organizations) is well known KPI system (Key Performance Indicators). During the past years, 8 typical areas are targeted with KPI's in most organizations that are implementing lean. Those areas are: Delivery performance, Reject/complaint rate (the external quality level), Earnings per year per employee, Inventory turnover/Lead time, Idea suggestions per employee per year (to measure employee involvement), Implementation rate of all incoming suggestions from staff (to measure the quality and impact of incoming ideas), Employee Absenteeism and Rate of investments in work improvements. Figure 5 presents results for all 8 areas, in Europe and in Serbia. Relations between previously defined groups remain almost the same as previously determined. Some comments follow.

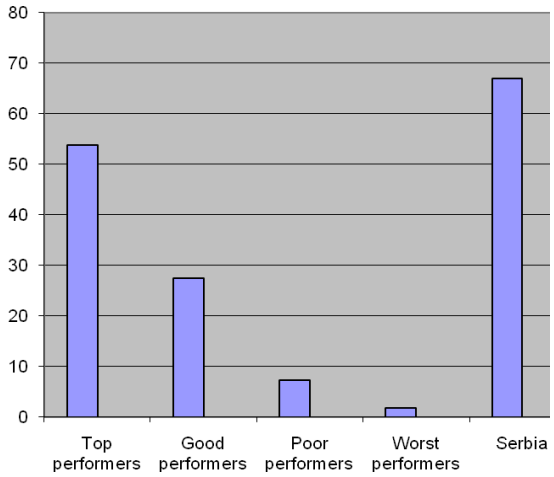

Figure 4: Standardized work at the Top, Good, Poor, Worst performers and Serbian organizations

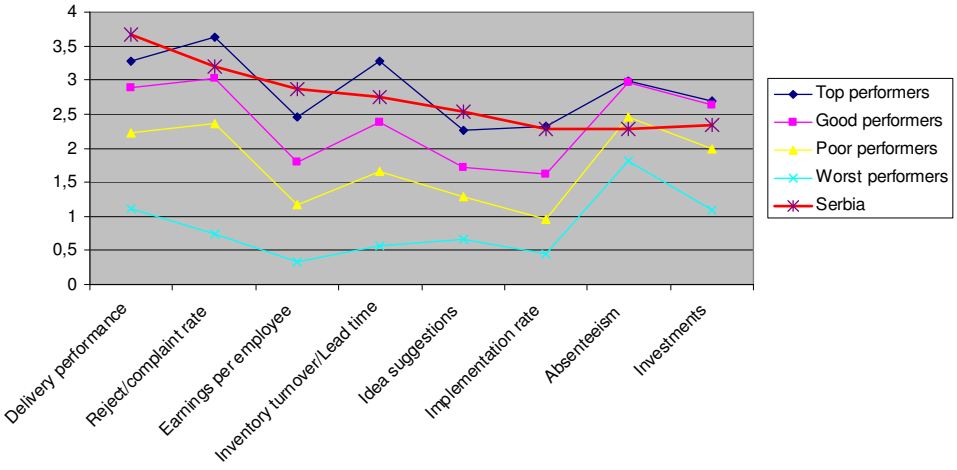

Figure 5: 8 typical areas of measuring with KPI's at the Top, Good, Poor, Worst performers and Serbian organizations

Delivery performance for Serbian organizations is higher than the average for European Top performers. This again can be treated as a pretty disbelieving result, but if we take into account that better part of Serbian organizations responded to this survey and that almost each of those organizations went through ISO 9001 certification process (it is well-known that ISO 9001 requires measuring of customer

satisfaction, satisfaction of business partners and performance of work process and product), this results may be partly treated as realistic. Again, we can say that the survey results might not be valid for the sample's doubtful representativeness. More valid facts treating the subject of this research should be determined by one much wider and more comprehensive survey.

The same conclusion can be drawn for the reject/complaint rate. Successful Serbian organization realized that unsatisfied customer cost more than one product. Thus, in many cases, organizations accept complaints even if they don't have to.

Earnings per year per employee is generally considered as data of high confidentiality in Serbia, so we didn't ask for the exact amount (or span) of those earnings - the item remained in the survey only whether organizations are measuring that KPI. This answer would anyway not be comparable to the European average earnings. It is worth emphasising that Top European performers "earn on average 10 times more than Worst performers".

Inventory turnover is also value measured in most organizations from the better part of the Serbian organizations. However, situation with this KPI is the same as with earnings per employee, so we did not ask for the exact value, just if it is measured or not. This means that this value is also not comparable with the corresponding value in Europe.

The following parameters: Number of Idea suggestions per employee per year (to measure employee involvement), Implementation rate of all incoming suggestions from staff (to measure the quality and impact of incoming ideas), Employee Absenteeism and Rate of investments to gain improvements are the KPIs that are not so widely accepted among Serbian organizations and maybe those questions are least understood among surveyed organizations (that is propbably why among Serbian organizations, lean organizations had lower values than non-lean organizations!).

A special part of the questionnaire was devoted to change management, for good change management system prevents organization from sliding back into old habits.

There are the 12 most common problems organization face when implementing lean: (1) difficult to change the old behaviour, (2) difficult to sustain changes, (3) difficult to integrate with current IT systems, (4) difficult to determine the duration of operations, (5) difficult to reserve time for lean activities due to other duties, (6) difficult to measure the effects, (7) difficult to create the sense of urgency, (8) difficult to manage projects, (9) lack of internal knowledge/resources, (10) difficult to communicate, (11) insufficient support by middle management, (12) insufficient support by employees and (13) insufficient support by senior management.

One of these problems, difficult integration with current IT systems is, to some level, treated in the study Radlovacki et al. (1) 2011 where only a weak relation is found between information systems and measuring organisational performance in Serbia (this relation is indeed stronger in the developed capitalism). Almost the same group of authors in the study Radlovacki et al. (2) 2011 determined that organisations employing IT administrator(s) are applying quality management principles (8 management principles described in ISO 9004 standard, a part of ISO 9000 family) at a higher level than others in Serbia. In this study, some attention is also attracted by the finding that the application of work improvement methods and techniques (indeed related to lean) is the worst estimated among observed elements. This is still not changed as found by some newly accomplished research done by the almost same group of authors. While carrying through the research of examining relationships between quality management and organisational performance in transitional economies (including Serbian), it is determined that in Serbia and wider region, leadership is one of the main dimensions of quality management that is not related with some key elements of quality management - customer focus and quality planning (see Delic et al. 2013). It is, then, not likely to expect it to be related with organisational performance (the existing of this relation indicates that quality management is effective and that its function enables top performance of an organisation). Leadership is determined to be the main driving force of quality management and improvement in the developed capitalism (Kaynak & Hartley 2005). That of course includes organisational performance. According to the same study, leadership is a key to success of a supply chain (this is a very important subject, but not in this study; we, unfortunately have a long way to implement effective improvements within organisations; supply chains are just the next step).

Further, there is a fair correspondence between Serbian and European organizations, as shown in figure 6. Unfortunately, these findings do not tell us which actions are to be taken by Serbian organizations to improve the situation. They just confirm old truth that human nature is the same, no matter the place or circumstances.

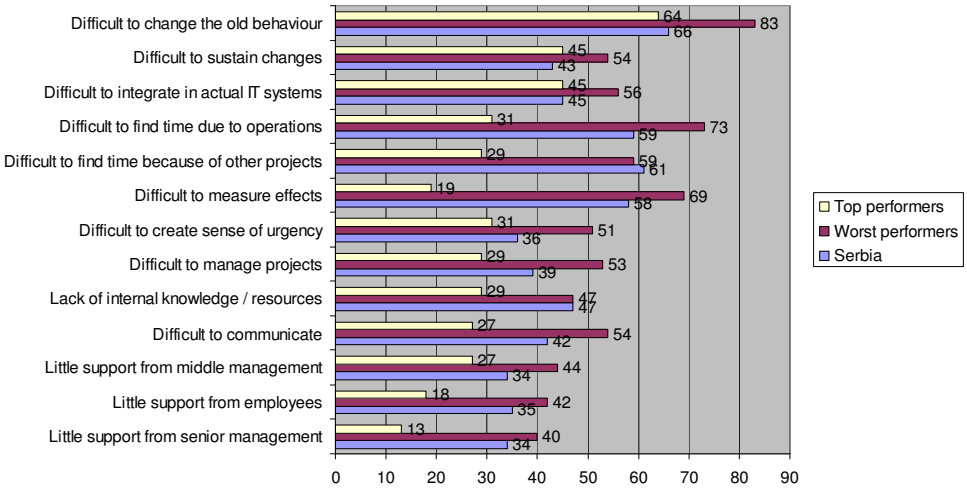

Figure 6: Change management pitfalls and differences between performance groups

It is interesting that Serbian organizations have best results at only one item: difficulties to sustain changes. This could be caused by the fact that unions are not strong in Serbia as they are in Europe, so it is much easier for management to use "pressure" to sustain changes (in which case they ruin possibilities for voluntary involvement of employees in continual improvement activities).

The results of the end part of the survey are used for discussing the plans and aspirations related to improvement in the next 2 years. They are completely in contradiction with the previous results. As reported by figures 7 and 8, employees in Serbian organizations are feeling that they have to work really hard to manage improvements, because, deep in their mind, they know that the situation is not as good as their opinions show (see previous parts of the survey).

Now becomes visible another unfavourable characteristic of how Serbia generally interpret the work process improvements. If asked about improvements, Serbia says efforts must be directed to all imaginable improvement actions. All at once! Figure 8 shows that respondents in Europe, no matter the group they belong, have different opinions about areas that should be covered by improvements (they even almost agree on what should be considered as a priority). It is more likely that respondents in Europe considered in detail every item unlike respondents from Serbia. It is obvious that Serbian respondents did not have much experience in improving their jobs. Otherwise, their answers would have somewhat higher dispersion among improvement activities offered in the survey. In other words, they would have known that a large number of parallel improvement activities at the same time may disable regular business activities to be performed as planned.

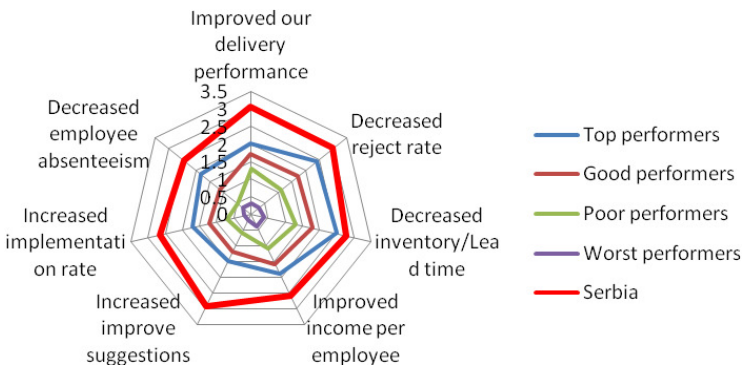

Figure 7: Ambitions to improve current results over the next 2 years

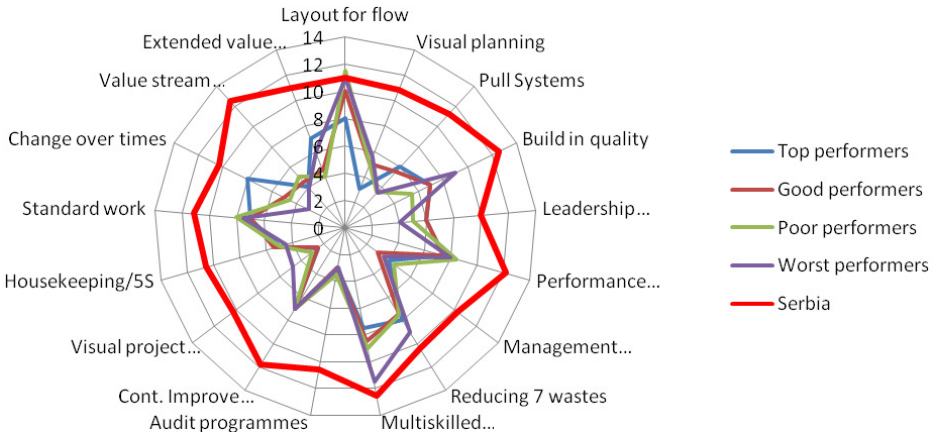

Figure 8: Improvement activities for focus over the next 2 years

CONCLUSION

Surveys are excellent way of making overviews of the situation in particular area. To draw out valid conclusions, it is necessary to have significant number of responses, which is not the case with this survey. Unfortunately, only 24 responses do not form a valid sample. So, these conclusions should be taken with reserve.

Original survey in European countries was conducted by Allied Consultants Europe, during 2008. We repeated that survey on the sample of Serbian organizations to compare Serbian and European organizations.

Estimates collected from Serbian organizations are much more favourable than is the situation in Serbian economy (according to our knowledge). Thus, we concluded that only better part of Serbian organizations responded to the survey and, even then, it seems that collected opinions are too subjective.

European survey had an intention to answer on three crucial questions and we will here present their answers and try to provide adequate answers for Serbian organizations.

(1) What do top performing organisations do to improve more than the others?

Results from European survey suggested that top performing organisations have focused on a wide variety of improvement activities, have a clear roadmap of their improvement programme, a clear vision and a long-term plan. We received only 5 answers from Serbian organizations that implement lean, and we cannot make any distinction among organizations. This answer may serve as a guideline for our organizations what to do on a way to improve their work process.

(2) Is there a relationship between the use of lean management and achieved results? Findings are that "there is a clear relationship between those that apply lean and achieved results".

Serbian results are so blurred with subjectivity (and possibly by misunderstanding the lean terminology), that it is not possible to distinguish between lean and non-lean organizations. But, here lies a useful lesson for some future survey in Serbia: avoid subjectivity by any means!

(3) What can be learned from the Top performers? Authors of the original survey gave us the most significant characteristics of top performers:

- they have a clear, long-term roadmap to improvements related to their vision,
- they have a vision which secures a strong platform for the improvement programme related to a project management system,
- they set clear targets: what to achieve and measure, with what frequency and what indicators,
- they create leaders that take ownership of the programme and become role models for the cultural change needed (the importance of developing organisational culture in transition is also a finding of Delic et al. 2013),

- they focus on a few activities at a time (over a 1-2 year period),
- they become excellent at applying changes to avoid sliding back to old practice, before progressing to the next few activities and
- they continuously exercise the organisation's ability to accept change.

These characteristics can be used to determine the course of action for a Serbian organization. According to figures 7 and 8, it is obvious that our organizations are planning significant improvements in the next 2 years in every possible area. This indicates the lack of focus on few important elements, which is one of the characteristics of top performers.

Also, it is possible to make some conclusions related to Serbian organizations only. There were five respondents from lean organizations. Four of them are in private-foreign ownership and one in private-domestic (according to our knowledge, owner of that organization worked for a long time abroad – in the Europe). This means that our lean organizations started lean journey initiated by the knowledge coming from abroad, not from Serbia. This is extremely serious warning for our education system. Another conclusion is that we have to get rid of our bad habit to present us and our situation much better that we really are. Ignoring problems will not solve them nor will they just disappear for no reason. Instead of that, we should prepare a program for wider education about lean, Quality management and other proved improvement frameworks, and promote the advantages of applying thereof, because there is no more time to waste.

At last, here comes the final conclusion regarding the core question of this survey: can we compete with European organizations? The answer is yes, followed with a huge "but". We found that only better part of Serbian organizations responded. That means that our best / better organizations can compete with European organizations. But, our better organizations are foreign-owned and that means that European organizations from Serbia are competing with European organizations! What can we tell about domestic-owned organizations? Due to the small sample and subjectivity in answering, we can't tell. It is sure we have our organizations to compete with European, but those organizations are just a few. Can Serbian economy compete with European? We are afraid the present answer is "no", unless we are ready to become serious in accordance with the situation and start with a hard work on wide education/training programs and projects of applying lean and other improvement frameworks in our organizations.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Trajectories for successful lean transformations: Case studies of four Swedish SMEs

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ABSTRACT

This paper describes four lean transformation journeys in Swedish small and medium sized companies (SME). All the companies have had successful lean transformation processes. Three of the four companies has been a part of a national program, "The Production Leap" and one of the companies has mainly been working internally with the lean transformation process. The paper shows that the point of departure is important, meaning if the company has implemented parts of the lean concept prior to the lean transformation process, e.g. tools like 5s. Furthermore, the context of each company is important when designing the lean transformation process, e.g. the market situation, the maturity of the branch (suppliers and customers), readiness for change in the own company, the support from the board in the company, etc. The conclusions of this paper are that it is not possible to copy an optimal given journey to lean transformation success, instead, it is necessary to develop the company and the lean transformation process depending on companies own situation, both internally and externally. However, characteristic for all companies, are strong focus on the lean transformation with large involvement of management and employees.

KEYWORDS: Lean, transformation, SME, case study

INTRODUCTION

During the past decades, the conditions for the manufacturing industry have changed considerably and it has become important to manage a globalized market. This globalization has resulted in specialization and international groups of companies. A company belonging to a large group of companies has often the advantage to more easily develop operations and access to centralised supporting competence centres in their development of performance. Possibilities for organisational learning between production units, different companies in industry groups and between markets and countries are frequently exploited by those companies (Hines et al., 2004). However, this situation is not the case for many small and medium sized companies (SME). From studies in Sweden it has been recognised that there are large productivity potentials in most SMEs (Almström et al., 2012). In their present situation, improvement it is both a question of surviving and of expansion.

Lean as operations strategy has proved to be fruitful in order to develop companies. Many companies, especially large ones, have developed their own lean applications, used to facilitate the implementation of a common strategy through the whole company. SMEs have got behind, not having the possibility to evolve and utilise new knowledge and practice. But, many SMEs being suppliers to large companies are expected to improve their operations and implement lean as applied by their customers (Ballé and Ballé, 2009). Moreover, SMEs experiences of lean are often limited.

In Japanese culture and lean, it is essential to focus on the process and the method (Lafayette De Mente, 2003). It is thus important how the strategy is operationalized into operations and actions. In western

culture, the results and effects are in focus and operations strategies are looked on as of less importance and this have lead to difficulties in the lean transformations. Many issues are discussed as important in lean transformation processes: the role of management, need of competence, use of external consultants, large changes in relation to step by step changes and assessment tools are all controversy topics. Often, management is pointed out as important for lean transformation failures. Emiliani and Stec (2005) state in their study 11 reasons for failures, where the four in top concern management: the system, behaviours, participation and continuity.

In Sweden a national program, the "Production Leap", to strengthen the production capabilities and support lean transformation of SMEs has been proceeding since 2007 (Medbo et al., 2012). This program includes coaching of individual companies according to a formalized methodology. Based on experiences from the program, the aim of this paper is to increase the understanding of successful lean transformation in SMEs.

The paper is based on a multiple case study where four companies having successful lean transformation trajectories are included. In descriptions and analysis, a framework with the meaning that the (1) context (experiences and current situation) influence (2) the design of the transformation process and both in turn influence the effect (result), is applied. Three of the four companies has been a part of the "Production Leap". Company representatives deeply involved in the lean transformation were interviewed, i.e. managing directors, production managers or change managers. Also lean coaches and teachers from the "Production Leap" contributed with information.

This paper is organised as follows. First, the four case company transformations are described, followed by an analysis of each case, Thereafter the cases analysis is discussed. The paper ends with conclusions.

CASE COMPANY DESCRIPTIONS

Company A has about 2000 employees and has a turnover of 2 billion SEK and is since 2011 part of a multinational corporate group. The company develops, manufactures and sells products for the healthcare sector.

The company started their lean implementation in 2005. At that time the company had increasing sales volumes and generated a large profit but the delivery reliability was poor due to the high sales volume and a large proportion of scrap and rework. Another problem was the functional organization resulting in lack of clear ownership of the production flows. The knowledge about lean was poor when the implementation was initiated. The initiative for the lean implementation was taken by the new production manager realising that if the company should continue to grow they had to deal with the poor delivery situation. Prior to the start of the lean implementation some key persons were sent to a ten days university course in lean.

The first step in the implementation was an education program to broaden the competence of the employees in the daily work tasks and competence matrices were created. Since the company operates in the healthcare sector, standardized work was already developed. A new suggestion system was early introduced in order to involve the employees. Over 3000 improvement suggestions per year have been handed in. In order to raise the level of knowledge of lean in the company, 60 employees including first line managers, representing all departments, participated in a four days university course in 2006. At the end of the same year 5S was introduced in the production. In 2006 they also started to level out the workload in order to facilitate efficient production flows. Cross functional coordination teams were formed, each responsible for a certain product family and the introduction of the coordination teams has resulted in a clear focus on the production flow. Daily control meetings and lean production boards were also introduced. In the years that followed operator maintenance, visual management and team concept has been implemented.

The company has not had any external help in their lean work. In the beginning, the lean activities was initiated and managed by a lean team. Today the lean team is more a support team who supports the organization with planning and expertise whereas lean initiatives originate from the top management and the lean activities are owned and managed by the lines. The top management conducts weekly rounds in the different team areas where the progress of the lean work is assessed.

Regarding lessons learned the company state that a major problem in the beginning was the lack of priority and follow up by the top management even though they were highly committed. Another lesson learned is the focus on lean tools, e.g. 5S, consequently they missed to market lean as an integrated system. The major benefits of the lean implementation are higher productivity, higher delivery reliability and increased level of employee involvement.

Company B develops, manufactures products for the medical device industry with a high degree of customization, has 700 employees and a turnover above 1.5 billion SEK. The production unit studied in this paper is located in the middle of Sweden, has 60 employees and a turnover of 190 MSEK.

The company decided to start their lean journey in autumn 2010 and had limited previous experience in lean. A new production line had recently been implemented with help from external consultants. The main reason for the change in layout was poor delivery reliability (75%) and too long lead-time (31days). The changes were mainly technical with limited involvement of employees and the expected results were not realized. The company recruited a new production manager and decided to focus on implementing an improvement process, driven from the line managers, with a high commitment from all employees.

The company was part of the "Production Leap" (2011-2012). They decided not to appoint internal lean coordinators as they were hoping for a line driven improvement program, guided by the line managers. They realized a need to strengthen the competence in lean and sent nine key persons in a ten days university course in lean. A steering group for the transformation process was appointed and a pilot area chosen. In the pilot area the operative work included development of a team for continuous improvement, 5S, standardized work, daily control and problem solving. The process to implement the new working methods outside the pilot area did not start in a systematic way during this timeframe. The company has also developed a handbook describing the company philosophy and guiding principles.

At the same time (2011) the company decided to implement a companywide program for continuous improvement with help from external consultants. This program has a process for policy deployment, were all employees meet one day every half year. The improvement teams describe achievements accomplished every half a year; the management team presents the company vision, overall goals and strategy; the teams has the possibility to ask questions, give ideas to clarify the overall goals and strategy, ending up in the teams formulating and agreeing on targets and activities for the coming six months for the improvement team to accomplish. Every second week one hour per team is devoted to improvement work. The company invested in education for the team-leaders in group dynamics and the role as a coach. An internal support structure for coaches was implemented.

Initially the management team and steering group were highly committed and involved, but faded when the pilot area work started. This is one major shortcoming, the management team should have been more active. The employees in the pilot area were very enthusiastic and accomplished a lot of improvements, in time the management team realized this and started to engage in the pilot area.

Regarding lessons learned the company state that the most important factor for success is management commitment and ability to engage all employees in continuous improvement. Today the managers are committed and the investment in capability has started to give results, in both lead time reduction (from 31 to 7 days) and in delivery reliability (from 75% to 99%).

Company C is part of a multinational corporate group. The unit described in this paper develops and manufactures products for the building industry. The unit is located in west Sweden and has about 175 employees in production and has a turnover of 400 million SEK.

The company decided to start their lean journey in 2011 and had limited previous experience in lean. On the other hand they had recently (2009-2010) restructured their production, a new layout with focused production flows and production cells. This implementation was mainly technical and driven top-down including a limited number of employees in the work. The aim was to be able to meet the expected increase in sales. The company had poor delivery reliability and productivity due to frequent disturbances and a lot of fire-fighting.

The production manager initiated the lean implementation in order to engage all employees in the improvement process. The company was part of the "Production Leap" (2011-2012), including education of

key persons in a ten days university course, forming of a steering group of 22 employees and operative work in a pilot area. This was probably the most important factor for success. The steering group had meetings every second week. In between the meetings the lean implementation was driven by the managers in the line organisation. Recruitment of a lean coordinator was also important, supporting the managers in the different activities.

Early in the process they decided to stop the production for one day to start up 5S. The reason was mainly to demonstrate the commitment from management and to get a head-start for the whole company, engaging all employees. 5S became a platform and after that the company formed local improvement teams. Daily control meetings and lean production boards were introduced during 2011. At the end of 2011 the management team launched the company Production System, a written handbook covering fundamental values and guiding principles. In 2012 the focus was on introducing operator maintenance and standardised work.

The company had external help in their lean work, mainly for training and coaching of the steering group. The roadmap and activities were initially decided by the steering group but after the first year the company decided to create an operative lean team. The lean coordinator is responsible for this cross-functional team were all production managers and support functions are included.

Regarding results the company state higher productivity (10%), higher delivery reliability (75% to 93%), but emphasise that the most important result is a change in culture, mind-set and behaviour. Today the root-cause is solved and the production teams implement improvements to a much higher ratio than before. The involvement and commitment on all levels in the organisation is higher.

Regarding lessons learned the company state that the most important factors to success was training of a large number of managers, to be able to support and train the production teams. Also the early engagement of all employees in 5S enabled a platform for the transformation.

Company D has about 100 employees and a turnover just above 300 MSEK. It is a family owned company situated in the northern part of Sweden. The company develops, manufactures and sells products for construction machines, mainly excavators. The company has recently (in 2012) been divided in two separate companies. The company described in the case is an own company since 2012. However it was managed rather independently and situated in a separate building. The products are common in Scandinavia, but relatively new on other markets and therefore the company is growing.

When the company started the lean implementation in 2008, they had recently gone through a project in gender equality. The experiences from that project were used in the lean implementation, especially when developing the booklet containing the company's lean philosophy.

The main reason for starting the lean transformation was to strengthen the competitiveness of the company. The company describes their competition situation as follows; the competition is global and the customers will choose the supplier, which can offer the best quality at the best price.

The company was part of the program production leap (2008-2010) and followed the implementation concept. There was a pilot group appointed for implementation, which is now a part of the case company. The implementation started with introducing lean to all employees. VSM was performed and also 5S was introduced in production and offices. The main goals during the production leap period were to implement improvement groups and daily production control meetings.

One person was sent to a university course in lean and formed a lean management group. This group was slightly larger than the normal management group. One person was appointed lean coordinator, whose role was to be the internal lean expert providing assistance to managers and group leaders.

The result after the production leap was that all employees in production are involved in improvement groups and also the production is controlled via daily meetings.

During 2012 a special project was run in the company which aimed at training pull controlled production. Since there are many variants of the products, normal kanban was not possible to implement. Instead a project group consisting of engineers, planners, managers and operators was formed to work with

the case. The result after approximately six months is that the WIP for these products have been reduced in the range of 80 %.

Table 1 Summary of case descriptions

	Company A	**Company B**	**Company C**	**Company D**
Context, point-of-departure	-High profitability -Low delivery reliability -High scrap and rework -Low lean knowledge	-Low delivery reliability and long lead-time - Recent change in production layout, but limited effect -Low commitment in improvement work	- Poor delivery reliability and productivity - Recently implemented production flows and production cells - Limited knowledge in lean	-Need cost reduction -Aim for involve-ment of all personnel
Transfor mation process design	1. Competence 2. Suggestion system 3. 5S 4. Leveling workload 5. Flow orientation 6. Daily meetings 7. Weekly rounds by managemen t	1. Production leap 2. Education of managers and key persons 3. Companywid e program for continuous improvement	1. Production leap 2. Large and cross-functional steering group 3. Implementa tion of 5S in all areas 4. recruitment of a lean coordinator	1. Production leap 2. Formulated own lean philosophy 3. Pilot group tested all new ideas 4. All personnel introduced via "the lean game"
Effects	-Higher productivity and delivery reliability -Increased level of employee involvement.	- Shorter lead-time and higher delivery reliability - management commitment and ability to engage all employees in continuous improvement	- Higher productivity and delivery reliability - change in mind-set and behaviour - management commitment	-Daily production control meetings -Improvement groups -Lean knowledge in VSM and 5S

CASE COMPANY ANALYSIS

In **Company A**, the successful lean implementation can be explained by the early focus on employee involvement (lean education and 5S), employee knowledge, early assign of resources (lean team), management commitment (enthusiastic production manager, priority and follow up, weekly rounds) and focus on visualisation and consensus building (cross functional coordination teams and daily control meetings).

Company B has been mainly successful in their lean implementation. The implementation of a companywide program for continuous improvement has had effect on both management and employee commitment. The education of managers and key persons has resulted in better understanding and a high commitment. However, the implementation of working methods from the pilot area to the rest of production has so far been limited.

The successful lean implementation in **Company C** can be explained by the large commitment from a cross-functional steering group, education of all first line managers and the early decision to start up 5S in the whole company to demonstrate the commitment from management and to engage all employees.

The lean implementation in **Company D** has been successful. The company's lean philosophy was developed and presented in a handbook, which facilitated the development and lean implementation. Despite the lean coordinator leaving the company, the lean implementation continued. The introduction of daily control and improvement groups further improved the strength of change. Crucial in the ability to implement pull control was lean knowledge, especially value stream mapping. Most important in the process of implementation was the top management full support and the employees' engagement.

CROSS CASE ANALYSIS

There were both similarities and differences in the point of departure for the four companies. All the companies were profitable and a common strategy for growing the market shares. Furthermore, all the companies prior to the lean transformation experienced problem with the delivery reliability and long lead times. The differences naturally comprised many areas, the basic organisation and layout was traditional functional for company A and D while flow oriented for company B and C. Other topics related to lean that differed were working environment and commitment from employees, insufficient process stability and quality difficulties, experience of lean and different types of change programs, external support as consultants.

In the lean transformation processes, the companies designed or ended up in different trajectories, but there were also similarities. In all the companies the initiation of the lean transformation was a question of timing as there was a strong interest for lean from operations management and manufacturing engineering departments. One important similarity, highlighted in all the companies, was the commitment from the management. Especially, the operation managers were real enthusiasts and really committed to drive the lean transformation. In one of the companies, D, the managing director had also a prominent part. Furthermore, all the companies focused on getting the employees deeply involved in the lean transformation process. This was done in different ways, but all companies pointed out the importance to get commitment for the employees.

All the companies got good results of their lean transformation efforts, both regarding traditional quantitative measures as well as qualitative measures. The delivery reliability, which was a driving force for all the companies, had greatly been improved. Furthermore, productivity, work in process and quality had also been improved. There had also been improved commitment from the employees resulted in many continuous improvements initiatives.

DISCUSSION AND CONCLUSIONS

In order to create a successful lean transformation in a company, leadership and management involvement are essential, which is described and highlighted in all the cases. Here, it is important that the management not just support the lean initiatives, but are deeply involved in the process, which is the situation in all the cases. This supports earlier research describing the importance of leadership and management involvement (e.g. Emiliani and Stec 2005). Furthermore, it is important for the managers to spread their vision and strategies regarding the lean transformation to the whole organisation. This is often been done by, a team of key persons in the organisation, developing a "production system" to describe the company's values, principle and methods. All the companies involved in this study developed their own production systems. Thus, the successful lean transformations focused on processes and methods rather than on result measures.

In all the companies, there has been one enthusiastic person, who has been the glue in the lean transformation process and without him/her the lean transformation would not have been such as success. This is of course a dangerous situation for the companies, if this person for some reason leaves the company. Therefore, it is important for a company in a lean transformation process to work with the organisational learning, in order to keep the knowledge within the company.

In all the cases, the employee involvement has been highlighted as a success factor. How this is realised differ between the companies. The 5S method could be a useful tool to involve the employees and to create enthusiasm for the lean transformation process. Working with continuous improvement groups and education are other methods for creating employee involvement in a company.

It is essential to assign resources to the lean transformation process, in order to make successful lean transformations. This was especially highlighted by company A, but all the other companies committed themselves to the "Production Leap" program which makes them committed to spend resources in their lean transformation process.

The conclusions of this paper are that it is not possible to copy an optimal given journey to lean transformation success, instead, it is necessary to develop the company and the lean transformation process depending on companies own situation, both internally and externally. However, characteristic for all companies, are strong focus on the lean transformation with large involvement of management and employees.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Application of Value Stream Mapping in a Real Process

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ABSTRACT

In today's market conditions, organizations may ensure survival only through adequate and timely reactions to market changes and elimination of all activities that do not add value to goods/services, hinder and slow down systems' processes. The goal of the LEAN approach to process organization is cost minimization, profit maximization and increase in competitiveness. Application of this approach encompasses an appropriate level of systems' flexibility, processes' automatization, use of latest hardware and software solutions in planning activities and managing processes and a maximal employee dedication to constant improvement. Alongside these preconditions, it is necessary to apply LEAN tools and techniques, to facilitate process effectiveness and efficiency, resulting in the mentioned cost reduction and a competitive advantage. Through application of LEAN tools, as Value Stream Mapping, it is possible to, visually and in an efficient manner, present activities that (don't) generate added value to a goods or a services, and which processes should be remodeled in order to meet user demands. Value Stream Mapping illustrates the relationship of information streams and material flow. It is used for documenting the current state and proposing a design for the future state of the system, which is practically illustrated on an example of a real production system. The goal of this paper is to illustrate the current state of the aforementioned production process, to identify space for improvement and to design the future state of the system.

KEYWORDS: lean, Value Stream Mapping, production process

INTRODUCTION

Products and services market development, i.e. increasing competitiveness, results in a need for fast development and application of new, contemporary knowledge from the field of the process designing and process management. Need for new, more functional products and services that suits growing client demands, simultaneously causes problems in relation to their realization, hindering effectiveness and efficiency of the production process and provision of services. It is possible to apply the LEAN concept in order to obtain an efficient management of the production process, with the aim of eliminating loss i.e. activities that don't generate added value to a goods or services. The goal of this paper is to propose a functional enhancement of a particular production system, through illustrating the current state of this system and proposing application of specific LEAN tools.

The LEAN Concept

The beginning of the LEAN concept (the LEAN Philosophy) originates from the end of the 19th century Japan; it gained wider application after the WWII. Japan, being a country with scarce natural resources, located on a seismically unstable region, was additionally severely damaged during the WWII. In order to recover the economy and market competitiveness, Japan had to create competitive advantage through high quality of the products and shorter delivery times, bearing in mind its extremely small quantities of essential resources (natural, financial, human). For this reason it was necessary to perform high level of technological, practical research, the results of which would later be implemented in industrial processes. LEAN concept is, in fact, Toyota Production System (TPS), or production method. Taiichi Ohno, chief of Toyota's production plant in the years following the WWII, is considered to be the father of this

concept. Today's term (LEAN), was coined by John Krafcik in 1988, in his work "**Triumph of the Lean Production System**". The term became popular after the publication of the book "**The machine that changed the world**", written by professors James P. Womack, Daniel T. Jones and Daniel Roos. Generally speaking, LEAN represents a specific approach to planning with a set of principles, defined with the aim of securing an effective and efficient organization of the production process (or provision of services) and supply, eliminating all activities that don't generate added value to a product or service, as well as a tendency for constant systems' improvement.

Activities that were identified as loss, have been classified in 8 groups, according to (Liker, 2004), as follows:

1. overproduction,
2. inventory / stock,
3. overprocessing,
4. transportation,
5. waiting,
6. defects / errors,
7. motion and
8. underuse staff creativity and innovativeness.

For the purpose of proposing a solution to a problem, defined in the following chapter, and for improvement of a specific production process, we used particular LEAN tools; they have been briefly referred to in the following text, with a couple of characteristic terms for the issue, essential for understanding the entire process of application of LEAN tools and the aforementioned approach to improving the production process.

Takt Time is the required work dynamics, in which the work items must be processed in order to meet market demands. It is calculated by dividing the available working time with demand for a production/service over a particular time period. It is the basis for establishing LEAN production. (Lee & Snyder, 2006)

"5S" represents workplace organization principles. The goal of this approach is to render each workplace organized in a manner that will accelerate and simplify the work of an employee. 5S is an acronym made out of five Japanese words: **Seiri** - sorting, **Seiton** – straightening or setting in order to flow, **Seiso** – systematic cleaning, **Seiketsu** – process standardization, **Shitsuke** – service (sustain). It offers crucial support to implementation of the remaining measures of processes' improvement, "such as shorter equipment changeovers, just-in-time inventory systems, total quality management, and total productive maintenance". (Hirano, 1996)

Continuous Production Flow - One Piece Flow is a production management system, organized in such a way that one employee addresses only one work item at a time and only one work item is guided between operations within a process, without generating stock. Application of such an approach to production process organization has the biggest impact on reduction of duration of material flow and on enhancing activities that generate added value to a product/service in general. It requires previous analysis of all process operations, client demands, existing equipment, number and skills' level of the work force and the work environment. (Dolcemascolo, 2006)

The "pull" system of work orders' distribution was generated according to LEAN principles, as a particular approach to production planning. It might be said that the beginning of production, in this approach, is initiated by the user and his specific demands. Such an approach is a connection between user demands, internal organizational processes and suppliers. (Zylstra, 2006) The essence of this approach to system organization is in maintaining stock levels on the necessary minimum, reduced quantities of engaged financial capital and high user satisfaction.

Contrary to the "pull" system is the "push" production organization and work orders' distribution system. Basic characteristics of this approach, often referred to as traditional, are marketing-forecast based and sales-function-forecast based production planning; accordingly, issuing of work orders, delays of intermediate products on interoperation depots and, as a consequence, large amounts of capital in resources' stock, intermediate and finished products. The difference between these two approaches is clear. In the "pull" system, parts are not delivered until the destination plant or the production line does not give the "ready" signal. In the "push" system, parts are delivered as soon as they are finalized, regardless of the conditions (state) in the destination plant or the production line." (Baudin, 2004)

Value Stream Mapping (VSM) is practically a visualization of all stages of the process (those that do/do not generate added value), the ones that should be remodeled in order to ensure optimal user satisfaction. A Value Stream Map identifies information streams and material flow and major obstacles in them. It is used in documenting the current state of the system and well as the improved (future) state of the process. One of key goals of this LEAN tool is to identify processes that don't generate added value to a product/service, in order to eliminate them. Most frequently used description of this tool is one from the book "**Lean Thinking**", where it was portrayed as "the set of all the specific actions required to bring a specific product through the three critical management tasks of any business: …the problem solving, … the information management, …the physical transformation." (Womack & Jones, 2010) There are eight steps of the VSM process:

1. securing employee dedication to the LEAN concept (all participants in the process),
2. choice of a value stream (for a particular good/service),
3. understanding of the LEAN concept,
4. mapping of the current process state,
5. choice of (LEAN) measurable process indicators,
6. mapping of the future process state – demand, stream and leveling,
7. production of Kaizen plans (continuous improvement plans),
8. implementation of Kaizen plans (Luyster & Tapping, 2006)

Problem Statement

The case study was carried out in an organization specializing in machine processing on CNC machines, production of parts and sheet metal subassemblies, installation and testing of a range of appliances. Special attention has been given to the installation process of the most demanded product of this organization-units intended for managing fluid flow (positioners). They are used for remote indication in a range of electric applications and as junction boxes for direct installation of electromagnetic valves. Final users of these appliances are organizations from oil, chemical, food, pharmaceutical and other industrial branches.

There are 6 workers employed in the production (assembly) process of the aforementioned product. Upon conducting an analysis of the current state, we have reached several conclusions: there is a disorganization of the production space and inadequate distribution of work space within the plant – the first work post- preparation of the housing and lid for final assembly, as well as the indicator assembly to the lid, is about 15m away from the next work post in the process; this causes time loss when transporting products. In addition, there are a number of containers (80x80cm) and palettes in the vicinity of each work post, occupying significant space in the production plant.

The following relevant characteristic, significantly affecting the product installation process, is displacement of the work material (parts) and tools, which in turn results in significant time loss in locating them on work posts and shelves. These parts are mostly stored in cardboard boxes, without visible labeling, which makes the process of selecting the appropriate material/part more complicated for employees. In addition, there is disorder in all work spaces, with a lack of usable work space, occupied by materials and especially tools not needed for an operation at hand. However, the most alarming problem that is, to a

significant extent the consequence of all previously mentioned, is the prominent inefficiency of the production process as a whole, where the organization engages employees 5,5 days a week (two shifts on working days and one on Saturdays), in order to meet market quantity and quality demands; that is 2 shift of 12 hours, resulting in staggering 79200 seconds/day of the production – available time.

The production process is conducted in 6 work posts, defined as operational units. Operations contain a specific number of actions (Table 1), whose number and duration are not uniform. The process is initiated by preparing the housing and appliance lid for final installation, and is then carried out in a manner of a classic "push" system. Following finished actions, products are transferred to an interoperation stock (palette) and transferred to the following work post (operation) when full capacity is reached. In addition, lots' size has been determined in respect to the size of palettes, which may host up to 36 units of product.

Generated through use of VSM tools, Figure 1 illustrates the current production process. The figure indicates a disharmony in times required for specific operations. There are a number of reasons for this, some of which are: inadequate specification of the operations (number and distribution of actions within them) as well as number of workers allocated to them. Such a system results in creation of interoperation stock in the production process and a unbalanced employee workload. The user has a current demand for 800 units of product, every 2 weeks (1600 units/month). According to the presently available production time, in order to meet this demand, the organization must produce 73 units on a daily basis, which is roughly the size of 2 lots. Calculation of the production process takt has determined that the takt for the current process organization method is 1085 seconds, i.e. one product unit must be generated every 1085 seconds in order to meet user demands. By measuring time needed for each activity, it has been determined that, under the current state, the production process time is 2505 seconds for a single unit of product (in Table 1, all activities and workplaces are listed).

Due to high costs of overtime work, the management requested a remodeling of the entire process, in such a manner to maintain the current production level (1600 units per month, which is the current demand), under following conditions: to reduce working hours to 5 days a week, two shifts per day, and institute effective duration of shifts of 8 hours (with additional 30 break minutes, a single shift lasts 8,5 hours). In addition, with predictions showing an increase of monthly market demands to 2000 units, a feasibility study should be conducted as well as remodeling of the current production process.

Table 1 – List of activities in respect to operations (Current State)

No	Activity	Work place
1.	Paint quality control	WP 1: Preparation of housing and lid for installation
2.	Excess paint removal	
3.	Paint protection sticker removal	
4.	Attaching of external lid stickers	
5.	Tracing of the cabling scheme	
6.	Screw driving	
7.	Attaching of the "OPEN-CLOSE" sticker to the indicator	
8.	Fastening of the adapter inside the indicator	
9.	Fastening of the "O-ring" to the indicator lid	
10.	Cutting cable to measure	WP 2: Circuit switch assembly
11.	Cable insulation removal	
12.	Assembly of cable pedals on cables	
13.	Connecting cables with terminal	
14.	Connecting cables with switches	
15.	Assembly of insulation tiles, switches, spacers and screws	
16.	Installation of circuit switch in unit housing	
17.	Electric breakdown test	WP 3: Electric breakdown testing
18.	Twisting the blue plug	
19.	Certification of the tested piece by stamp	

No	Activity	Work place
20.	Assembly of the axle set	WP 4: Installation of axle set in housing
21.	Installation of the axle set in housing	
22.	Attaching of the "O-ring" to the lid	WP 5: Installation and appliance testing
23.	Assembly of grounding pads and screwdriving	
24.	Adjusting of switch guides and functional test	
25.	Lid installation, screwdriving and Shim test	
26.	Installation of indicator and indicator lid	
27.	Installation of metal lid with warning sticker	
28.	Preparation of the cardboard box	WP 6: Packaging
29.	Packaging of the appliance and accompanying product documentation	

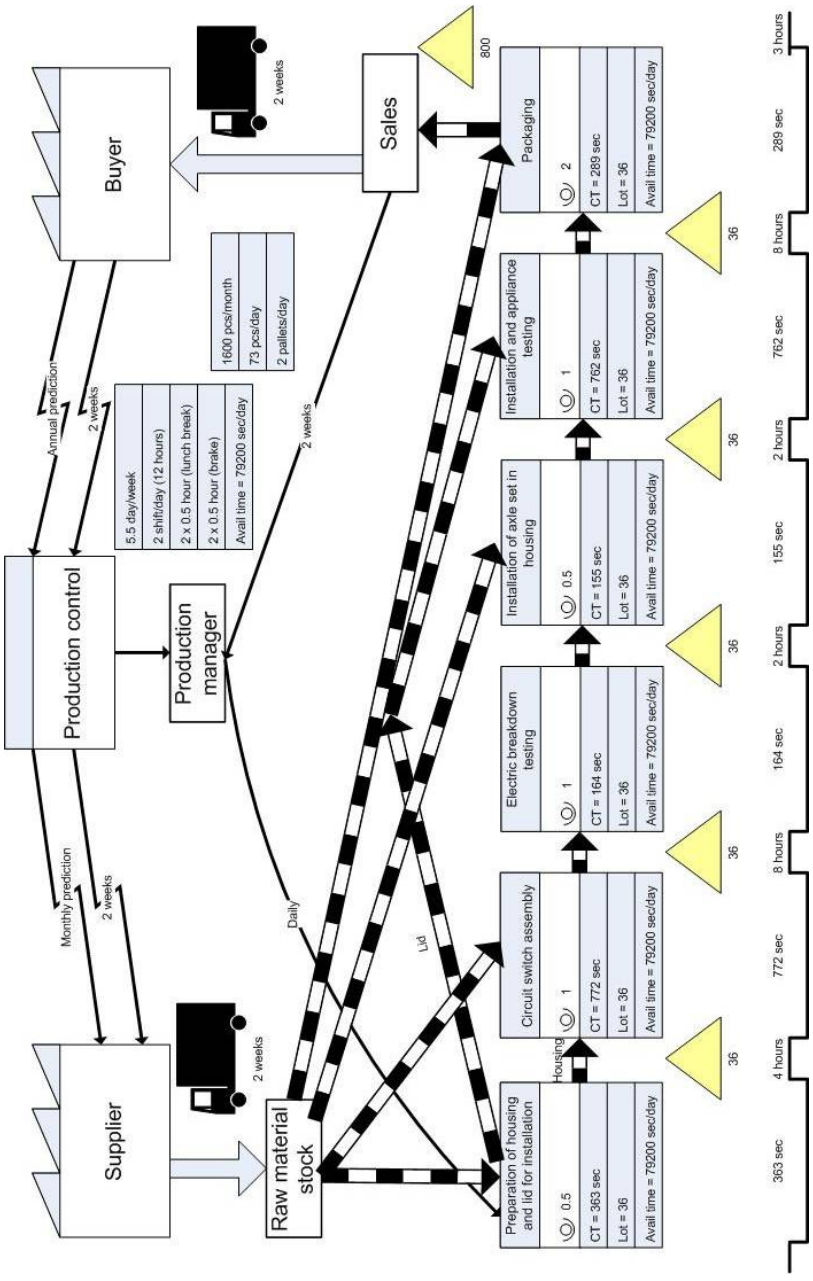

Figure 1: Value Stream Map – Current State

After remodeling of the production process, changing locations for specific operations (work posts) and re-allocation of the activities per operation / WP (Table 2), the new VSM presents proposed future state of the process (Image 2). The remodeled process is carried out in a continuous production flow, rather than the previous push system. According to this approach, each employee completes his / her set of actions before forwarding it to another work post to continue with the following operation. We have accomplished a 1271 seconds time reduction in the process – now 1234 seconds, by applying production leveling, balancing the number of actions and their duration throughout operations (guided by technical-technological feasibility principles), introducing parallel operations and appointing two additional employees to the process (improvement is made without assuming the improvement of employees' productivity).

In-process stock has been reduced by 80%, which primarily resulted in less occupied space in the shop floor. It is, however, necessary to emphasize that these are exclusively resources (parts) in quantities necessary to produce one lot of appliances (units). Prior to the remodeling, the process also contained stock of intermediate products. Palettes containing intermediate products have been removed from 4 different locations; they occupied considerably more space in comparison to ones storing materials and parts that are located by each work post and formed cardboard boxes in the packaging operation. A single palette is still present in preparation of housing and lid for final installation, bearing in mind the dimensions of these parts. Also, application of 5S tools has enabled sorting of installation parts, their classification along shelves and labeling of boxes with clearly visible stickers that simplify and shorten the process of finding the right ones. Further, it is performed a cleaning and straightening of each work post and removal of all excess tools and leftover parts. This, in turn, facilitated a friendlier, more usable and ergonomic work post for each employee.

We have calculated takt production time with several sets of preconditions, and have acquired several values that imply different conclusions.

Conditions 1 – demand is 1600 units/month, duration of the process is 2505 seconds, 6 employees, 11 shifts per week with duration of 12 hours each (available production process time is 79200 seconds). Resulting takt time is 1085 seconds (current state).

Conditions 2 – demand is 1600 units/month, duration of the process is 1234 seconds, 8 employees, 10 shifts per week with duration of 8 hours each (available production process time is 57600 seconds). Resulting takt time is 720 seconds (enhanced state).

Conditions 3 – predictions show that market demand will soon rise to 2000 units/month, duration of the process is 1234 seconds, 8 employees, 10 shifts per week with duration of 8 hours each (available daily production process time is 57600 seconds). Resulting takt time is 576 seconds (condition for the projected increase in demand).

Table 2 – List of actions in respect to operations (Improved, Future State)

No	Activity	Work place
1.	Cutting cable to measure	WP 1: Circuit switch assembly
2.	Cable insulation removal	
3.	Assembly of cable pedals on cables	
4.	Connecting cables with terminal	
5.	Connecting cables with switches	
6.	Assembly of insulation tiles, switches, spacers and screws	
7.	Assembly of the axle set	WP 2: Circuit switch installation, assembly and installation of the axle set in housing
8.	Installation of the axle set in housing	
9.	Installation of circuit switch in unit housing	
10.	Paint quality control	WP 3: Preparation of housing and lid for installation
11.	Excess paint removal	
12.	Paint protection sticker removal	
13.	Attaching of external lid stickers	
14.	Tracing of the cabling scheme	

No	Activity	Work place
15.	Attaching of the "O-ring" to the lid	
16.	Screwdriving	
17.	Fastening of adapter inside the indicator	WP 4: Installation and appliance testing
18.	Fastening of the "O-ring" to the indicator lid	
19.	Attaching of "OPEN-CLOSE" sticker to indicator	
20.	Assembly of grounding pads and screwdriving	
21.	Electric breakdown test	
22.	Twisting the blue plug	
23.	Certification of tested piece by stamp	
24.	Adjusting of switch guides and functional test	
25.	Lid installation, screwdriving and Shim test	
26.	Installation of indicator and indicator lid	
27.	Installation of metal lid with warning sticker	
28.	Preparation of the cardboard box	WP 5: Packaging
29.	Packaging of the appliance and accompanying product documentation	

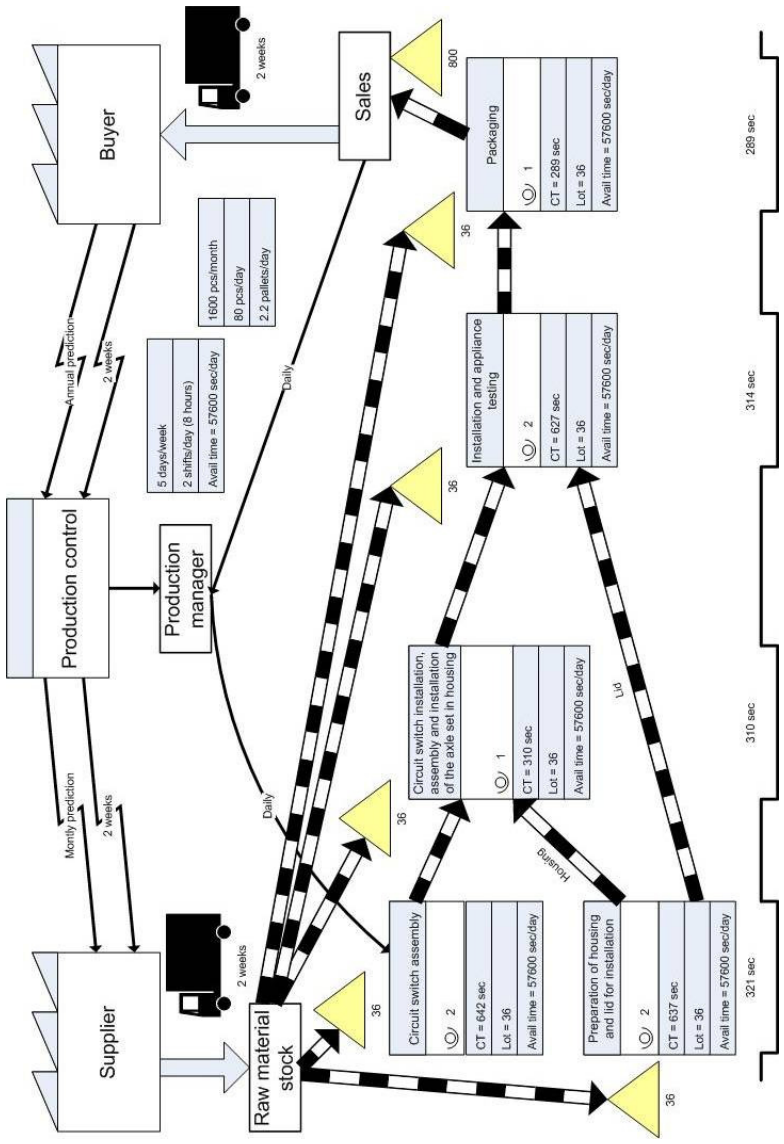

Figure 2: Value Stream Map – Improved (Future) State

When duration of all operations is divided with takt time, the results shows that 2.5≈3 workers are necessary to meet user (market) demands, in the current state and set of preconditions; second set of preconditions (enhanced state) requires 3.5≈4 workers for the same task, whereas increased demand and production augmentation requires 4.35≈5.

Validity of engaging 8 employees in the production process, as prescribed in preconditions of the enhanced system state (Image 2), is expressed in a reduction of the total number of paid working hours per week by 152 (792 hours in the current state, 640 hours in the enhanced), and increased system flexibility in the sense of possible further demand growth (possibility to meet the demand for even 3600 units/month under set preconditions), because the organization strives towards a daily increase in sales and market share.

In order to avoid overproduction (predicted 2000 units/month would require about 9 of 16 available working hours in total), special attention will be given to continuous improvement activities, increased control of performed operations by each worker (in order to reduce the share of rejects and post-processing in overall production) and engaging workers in other processes in the organization, which has several other production lines for a range of products.

CONCLUSION

The goal of the LEAN approach to product/services process organization is to maximize profit and give organizations a competitive advantage, with the lowest possible cost. It is necessary to secure unobstructed flow of items between steps in the production process and not to allow excess intermediate stock of unfinished products; this also applies to materials and finished items that are waiting their order. This paper illustrated a way in which a LEAN approach to process organization can realize significant savings in resources and, logically, increase in profits, through a case study of a production process of a specific product and application of LEAN tools, primarily Value Stream Mapping.

The paper analyzed the state of the current production process of a particular product, it indicated improvement options and offered an enhancement proposal, by using LEAN tools (VSM, 5S, Continuous Production Flow). We proposed a reorganization of work posts (operations) in respect to distribution of actions within operations. These measures resulted in reduction of process duration from initial 2505 to 1234 seconds, balanced employee workload, better organization of work posts, reduction in in-process supplies by more than 80% and an increase in process flexibility, in respect to increase in market demand. It also enabled a reduction in employee shifts – total number of shifts reduced from 11 to 10 per week (2 shifts a day, on working days), with working hours reduced from 12 to 8 hours, elimination overtime cost.

Proposed solutions are certainly not final for the aforementioned production process. They are merely a representation of an approach to enhancing and optimizing the current state and create a possibility for further analysis and new improvement suggestions. Possibilities for further enhancement are primarily in better utilization of employee working hours, and may concentrate on analysis of each action at hand, specific moves and by different sequence of actions within operations. In addition, certain operation may be carried out simultaneously, through remodeling of work posts in the production plant.

Application of the LEAN concept in all processes and employees' understanding of the approach is an important precondition for ensuring strong dedication of employees to the organization and their identification with organizational goals and its progress.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Research of Possibility to Implement Lean Principles in Product Disassembly Systems

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ABSTRACT

Acceptance and application of LEAN philosophy, its tools and principles is in constant increase. There are numerous examples of different systems in which they are implemented. Thus, their implementation has spread in health care facilities, educational institutions, various service systems and even government institutions of some countries adopt this philosophy - LEAN government. Systems for product disassembly at end of product's life, which are increasingly gaining on importance, by their nature, are very specific. While getting familiar with the nature of the problems that exist in the disassembly systems, it is important to find a way to overcome them. LEAN philosophy, with its application results seems to be a good way to do it. The aim of this paper is to explore the possibilities of applying the tools and principles of LEAN philosophy, to identify characteristics and problems in the implementation and suggest ways to solve them. The research given in this paper presents the main conclusions of the LEAN philosophy implementation in disassembly systems, the difficulties encountered along the way and gives directions for further research in this area.

KEYWORDS: disassembly, product's end of life, LEAN, end of life strategies

INTRODUCTION

The processing of products at the end of life cycle through disassembly and recycling is becoming the standard in product's life management. However, in a system for disassembly as a preparatory process for recycling, there are numerous problems which may greatly reduce efficiency of the overall system performance. The efficiency of labor is reflected in the quantity of products treated and disassembled, as well as in the quality of selected materials suitable for recycling processes after disassembly operations. One of the main reasons for reduced system efficiency is the lack of information about products that arrive to system for disassembly and due to improper work organization.

Disassembly is defined as the process of dismantling of the product into its constituent parts or subassemblies [2]. It also includes the analysis of product's state and selection of separate parts. It is always a set of operations that are performed on technological systems for disassembly with the help of specific tools. Generally, the goal of the products disassembly is [2] [3]:

- Extraction of valuable parts/components that are common in other products that are still in production,
- Extracting of valuable parts/components that are common in other products that are still in use,
- Removal of hazardous parts,
- Increase of purity of the product remains,
- Separation of usable parts from the product remains and storing them for later re-use,
- Reduction of the amount of cutting residues and waste that will be sent to the landfill disposal and

- Achieving production standards that is environmentally safe.

Disassembly of products includes disassembly of certain elements of the product, and then analysis of the situation, condition diagnosis and selection of disassembled components in to the appropriate material flows [3]. When preparing for the process of the appropriate product disassembly, there is no information about the necessary tools and ways of implementing operations of disassembly process. The particular problem is the lack of recommendations for strategies according to which products disassembly should be carried, quality of parts to be checked and their selection in the appropriate material flows to be performed, thus insuring that the quality of disassembly and recycling systems outputs.

Products in disassembly systems come in different quantities, types and quality. In any particular case, the quantity, quality, and product's time-of-life products can vary unpredictably. The difference between manufacturing and disassembly system is the in the flow of incoming parts and materials. In conventional manufacturing systems, they arrive correctly at regular intervals, while in the disassembly systems they arrive in unpredictable quantity, quality and type of product. Therefore, the first step for planning the organization of disassembly system is identification of groups of products which will be coming into the system [4].

It is in the interest of manufacturers to achieve a balance between efficient use of labor, tools, machinery and space. In disassembly processes it is difficult to control the main supply chain, thus making an improper inventory in stock. Another complex problem of disassembly system is variability of the products that arrive to the warehouse. There are two issues that comprise this problem. First, the problem of product amount variability creates confusion in the termination, resulting in a stock in the processing on both ends of the system - the intake and exit. Second, some preparation is necessary - final time, the labor process, tools, equipment, etc… These characteristics make the whole process unpredictable.

Systems for disassembly can have various configurations, complexity and size. Major contribution to the success when designing large and complex disassembly system is achievement of economic goals and efficient use of resources [4].

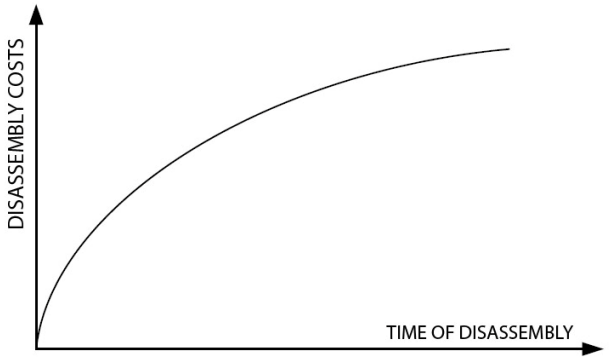

Figure 1: Dependence of disassembly cost from disassembly time [4]

Disassembly can be applied on most of the products. However, long time for disassembly operations make the process uneconomic, so the profit made by recycling parts and materials is often less than or equal to the cost of performing disassembly procedures (Figure 1). Also, costs are dependent on the number of performed disassembly operation (Figure 2).

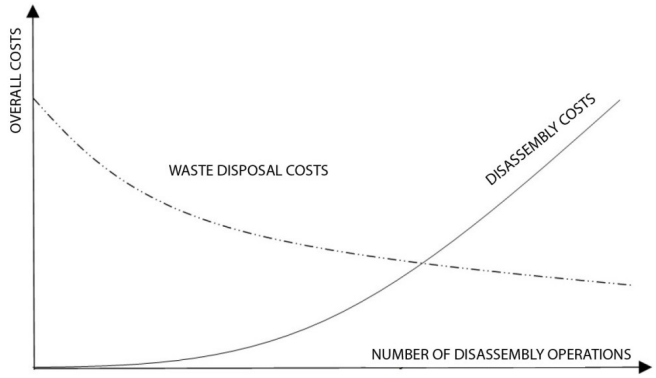

Figure 2: Disassembly complexity impact on costs [4]

Lean concept deals with doing right things at the right time, at the right place and in the enough quantity to achieve minimum waste and to increase the effectiveness of the system. Standardized work is one of the LEAN's tools which is the baseline for continuous improvement (KAIZEN). According to LEAN, standardized work has several major elements [7]:

1. The order of standard operations – is the exact order of operations which the employee must adhere. Standardized movements provide the same job duties for employees as a part of the operation execution process, thus reducing variation of the working process. Ideally, the procedure should be in accordance with the hand movement (MTM).
2. Standardized time – tact time, is a frequency of work completed at work station (work place). Its purpose is to accurately determine and oversee the production rate of the work station. In LEAN manufacturing, tact time of each production process is actively guided and controlled in order to ensure a steady flow.
3. Standardized supplies – are the required minimum of inventory that can make up a possible discontinuity in production and provide a constant production flow.

In an effort to increase the efficiency of the disassembly system (i.e. waste management), which has been the subject of research, by applying LEAN philosophy, the basic principles of LEAN concept are taken as a starting point [1]:

1) Recognition of losses (WASTE) - The first step is to recognize what is the value for the customer (from customer's perspective). Any material, process or product characteristic that does not lead to the creation of value from the customer's perspective, is the unnecessary cost and should be eliminated.
2) Standardization of processes - LEAN concept requires extremely accurate and detailed manufacturing procedures which at any time define the condition of materials, time needed, continued operation and result of activities which the employee has carried on. In this manner, the number of job variation is reduced thus minimizing potential error made by employees.
3) Continuous flow - Lean aims to implement a steady stream, freeing the manufacturing process of bottlenecks, waiting, interruptions and overriding.
4) Pull System - The objective of this system is to produce only what is needed and when it is needed. Production is initiated by a signal from a workstation that is located further downstream. Thus, each workstation produces only what is needed for next workstation in the series.
5) Quality at the source - The goal of LEAN concept is to detected manufacturing defects in the making. To make this feasible the workers have to question the quality of parts as part of the treatment process.
6) Constant improvement - the constant quest for perfection by removing losses from production. In this way, all employees of the company are involved in this ongoing process.

In later developed research, application of LEAN philosophy will be considered in a wider and more detailed context, taking into account a greater number of principles and tools of LEAN philosophy.

THE SYSTEM FOR DISASSEMBLY OF PRODUCTS - STATE ANALYSIS

The starting point of the analysis

Under the current conditions, the waste management system in which the research was conducted essentially consists of the following activities:

a) Collection - process of bringing, separation, sorting, packing in proper working packages and properly labeling of waste materials.

b) Transport – transport of discarded electrical and electronic equipment, chemical and other waste by vehicle registered for ADR transport and transport of dangerous materials. All drivers hold ADR certificates for the transport of dangerous goods. Preparation for transport, loading, unloading and reloading is performed by persons who are qualified by the Ministry of Interior. All workers are properly trained and have ADR certificates.

c) Storage - Storage includes classification, depending on the state of waste, dispose of it for temporary storage of waste materials in a proper and environmentally safe way to their final dispatch to end buyers or authorized processors in the country and abroad.

d) Treatment - a process that involves disassembly (disassembly of component parts) and then, after disassembly making the selection of disassembled components in to the corresponding flows of materials. Once prepared, materials are sent to appropriate centers for processing and recycling. Treatment of materials includes specific approach related to the extraction of raw materials and separations of the components that have the characteristics of hazardous substances.

Further research will be focused to the application of the basic LEAN principles and tools in the part of the system that relates to the production itself and to the part where disassembly of product and preparation of disassembled components, parts and materials for transport to recycling centers is done.

Disassembly of products - the treatment and analysis of losses

The observed disassembly system has three processing lines (lines for disassembly):

1) Line for processing of electronic and electrical waste,

2) Processing line of chemicals used in graphic industry,

3) Line for processing of cables.

Line for processing of electronic and electrical equipment is the focus of the research. In this part of the disassembly system there are numerous problems that result in reduced effectiveness of the system.

Line for processing of chemicals used in graphic industry is for storage and disposal. Waste gathered this way is redirected to appropriate centers for further processing.

Cable processing line includes just a technological system (machine) that performs milling of gathered cables and separation of copper and plastic. The impact of man is reflected primarily in the activities of providing materials (wire for recycling) and preparation of materials for processing on a machine.

Analysis of the line for processing of electronic and electrical waste

During this analysis starting point was the analysis of the main seven losses that exist in various production systems: transportation, waiting, overproduction, errors, unnecessary movement, excess treatment and idleness of people. Most of the losses exists in every disassembly system and are frequently very salient. To be able to inspect losses in disassembly system, the process of disassembly must be monitored.

The process of disassembly of products consists of the following activities:

- Forklift delivers a pallet with electrical, electronic and other equipment to the gathering site,

- An employee select devices from pallet and performs disassembly of certain products (components),
- Parts that are detached by disassembly are disposed in containers,
- When the container is full, pieces in it are put into jumbo bags provided for storage,
- Some jumbo bags are located next to the disassembly work stations, but some are disposed quite far away in the storage area,
- When the process of separation of parts is done, the forklift caries jumbo bags to the warehouse.

Transport

Lack of marked transportation routes in the system is a major problem (Figure 3). Transport analysis shows that routes of transportation are often blocked by pallets that are stored in places where they should not be, and thus block the passage of workers, who have to wriggle between pallets. Forklift often cannot pass until the pallets are moved (Figure 3. and Figure 4.).

The consequences of such organized material transport are too much manipulation in transport, long transport times, increased transportation costs, etc…

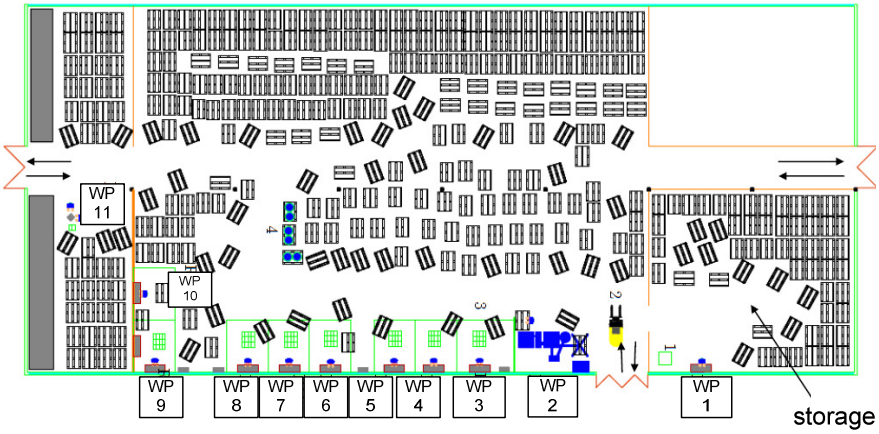

Figure 3: System layout

Figure 4: Pallets on the transport route

There is no exact plan how to dispose incoming products for disassembly, nor disassembled products ready to ship (Figure 3 and Figure 5). Products that need to be disassembled are scattered across the hall without a plan of disposal.

Figure 5: Scattered product waiting to be processed

Forklift is used to manipulate with pallets. Intensive use of diesel fuel run forklift is exposing employees to gases which are highly carcinogenic.

Causes of losses in disassembly system

Workplace losses vary and are numerous. Every type of losses on the work places could be recognized trough 7 basic wastes: Overproduction, Wait Time, Transportation, Over processing, Inventory, Motion, Defects/Rejects [7], [8], [10], [11]. Each of losses affects the inefficiency of whole system and contributes to lack of productivity and employee safety.

Some of the observed causes of losses are [4]:

- Lack of information about the product,
- Lack of knowledge about the structure of the material,
- Lack of knowledge about special procedures,
- Wrong selection of materials,
- Process slowing down due to variable product selection and
- Losses due to movements during the operation.

The current method of disassembled parts disposal requires a lot of employee movement during the selection of materials. It consists of 12 small plastic containers (Figure 6), stacked next to each other (in 4x3 formations). This method takes up a lot of space in the hall. Employees are losing time while disposing of the disassembled product, and they generally choose to "throw" parts in the container, which is very dangerous to the safety of other employees and can cause damage to the product. It is also difficult for them to dispose these disassembled parts, as they have to circle the container.

Figure 6: The arrangement of elements for collection of materials after the disassembly is completed

5S analysis

After completing an overview of the company's resources, according to the technological process and the recorded conditions, the following was determined:

- Workplaces where disassembly is performed are usually crowded with unnecessary things, such as tools not fitted for current job, which are creating a mess in the workplace (Figure 7).

Figure 7: Workplace and tools in the workplace

- Containers for the disposal of certain disassembled products components are often poorly spaced, situated to one another, and are far from the workplaces which are used for products disassembly (Figure 6 and Figure 8).

Figure 8 The position of the container for the disposal of disassembled parts

Visual management analysis

There are no visual signs in the production area. Under the direction of visual management there should be a set of the following signs: boards, announcements, signs on the floor, marks for the movement for forklift and pedestrians, marks for the disposal of the products received for disassembly and disassembled product, label for hazards materials, andon boards, table for storage tools, boards for measuring and monitoring of the employees performance [10].

Situation analysis in terms of standardization

Based on performed analysis and taking into account the specificities of the disassembly process, it is not difficult to notice that the current state of the observed system is that there are no signs of standardization or efforts to standardize the disassembly process. The reason for this is primarily because there is no awareness of the importance of standardization. On the other hand, the disassembly process is quite specific and in this fact lays another reason for the current state of affairs for the issue. The absence of standardization activities in different processes within the system can be considered one of the major factors of influencing to decrease the efficiency of the system.

CONCLUSIONS OF THE ANALYSIS AND SUGGESTIONS FOR THE IMPLEMENTATION OF LEAN TOOLS

First step of 5S and visual management

After recording of conditions and deficiencies, issues resolving is the next step. One possible way of improving the situation is by eliminating the unnecessary items in the workplace, these items are not required for disassembly operations. The red tag is used to identify unnecessary items. Red tag contains information

about the name of the item, the category in which given item belongs, the reason for flagging, the required intervention and the action taken and the date of identification and signature of the employee who hung the tag. Red tag should be completed and attached to any object that is not needed in a particular area. All labeled items must be stored. Their later use will be questioned. Next is sorting the remaining items in the workplace and achieving better workplace environment. Now, employee will be able to find necessary tools a lot faster than before. As part of this phase of the work and the implementation of LEAN, it is necessary to develop appropriate plans and procedures for the storage of products for disassembly. Then it is necessary to proceed with the implementation of 5S towards developed and well-known elements of 5S (Sort, Shine, Set, Standardize, Sustain).

PROPOSAL OF INTRODUCING VISUAL MANAGEMENT

Tables for the disposal off tools and containers for disposal off parts

Each board should be placed next to particular job position, close to the workers. On the board, there are places provided for each tool that is often used. When an employee takes a particular tool, dashboard view will immediately show which tools are missing, and the worker after using the tool will return it in the designated place (Figure 9).

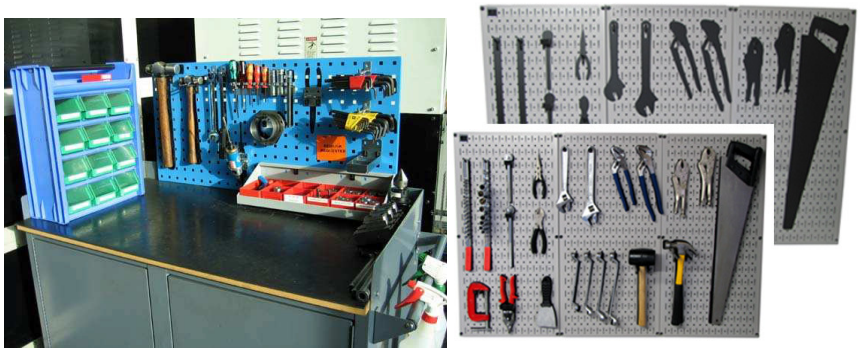

Figure 9: Visual management and 5S tools

Problems with the disposal of parts (Figure 6) can be solved in a manner that containers line up in three rows of three or four containers in the row, as shown in Figure 10. In this way, the disposal of parts will be simplified and within reach of workers. Cost savings will be realized in the additional space in the hall. When the container is full, it is easy to exclude it from the rear, and to set a new one in its place.

Figure 10: Proposal for warehouse storage of parts

Safety marks

Mark the space for the placement of containers with yellow lines, where the workers will dispose the parts after some disassembly operation is finished (Figure 11).

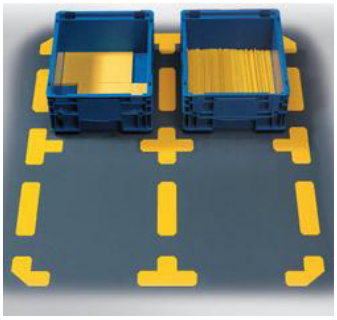

Figure 11: Lines for container setting

Mark the places for the disposal of jumbo bags which contain disassembled parts ready for further transport (Figure 13). Therefore access of forklift to the bags will be easier. In Figure No. 12 shows the current way of placing jumbo bags. They are left next to each other, so that one cannot be easily accessed if necessary.

Figure 12: Current way of delaying jumbo bags

Figure 13: Proposal for jumbo bags disposal

It is necessary to mark the space for movement of workers and forklifts, to determine ways of transport, in order to avoid possible injuries (Figure 14).

Figure 14: Transport routs

Info board and performance tables

It is necessary to set the table for measuring and monitoring of the employees performance. In this way, all employees will have access to current state, as production takes place, and will be notified if something is not going according to plan. Important is to set info board panels for hanging of various documents e.g. productivity diagrams, effectiveness sheets, defects, maintenance check lists and various other analysis and images (Figure 15).

Figure 15: Info board and performance tables

Ergonomics issues

Ergonomics of job positions for employees in disassembly processes is not on a high level. Before disassembly process can start, an employee must carry the product from the palette to table to get it disassembled. This operation is not a problem when it comes to small and simple products. The problem is when for example, an old TV that is robust and heavy has to be lifted. An employee who repeatedly lifts heavy objects at the work place is endangering his health.

To minimize the burden of the worker one of the possible solutions is the introduction of cranes to work places where heavy objects appear. Problems that occur as a result of poor ergonomics issues are loss in time and in performance, resulting in other losses addressed by LEAN approach.

The proposal for changes in the project layout

In line with the aim to achieve increased productivity and worker safety, to reduce transport routes and costs and to reduce losses in the system, it is possible to provide more options for changing of the spatial structure. The paper will present a proposal (Figure 16).

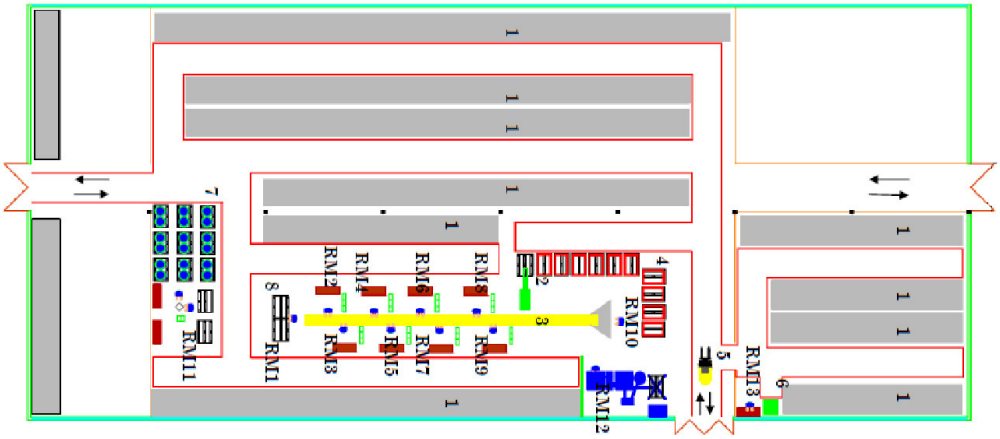

Figure 16 Proposal of spatial structure

CONCLUSION

Application of LEAN approach to the systems for disassembly is a completely new area for research. As already noted above, systems for disassembly have numerous problems ahead. For this reason, the application of LEAN in that kind of a production system is very challenging. Many problems and

specificities in the work of disassembly system have resulted in opening new areas of research in the field of LEAN application.

Work standardization can be considered for one of the main causes of reduced efficiency and effectiveness of the disassembly system. Knowledge of the technological process for disassembly is generally not available for most products. Their development by the system for disassembly is expensive and requires additional efforts and a great amount of work that needs to be invested in order to make production processes for a large number of classes and variants of products. A great job was transferred to the last link in the chain of managing products throughout the life cycle. In this sense, systematic approach is required to solve this problem. Mutual exchange of information between product manufacturers and disassembly systems will contribute to that cause. For this reason, the first step in an effort to improve the situation is to create opportunities and possibilities for standardization of work processes in the system for products disassembly.

Implementation of 5S, visual management and Kaizen are the first steps in this direction that should "fix" working conditions and to create basis for further research.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Application of Lean Tools in the Optimization Layout and the Flow of Material in the Production Process

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ABSTRACT

This paper presents a practical implementation of some of the Lean tools in the manufacturing process in order to optimize the layout and flow of material in case of one work station. The final objective of the optimization is to reduce losses, which is the main role of the LEAN methodology. Procedures that systematically find out useless activities in the production process will be studied in this paper, as well as the source of errors in order to influence the quality, cost and time of production. The focus of optimizing the layout and flow of material is to eliminate all losses and all activities that do not add value. Optimization will be implemented in three aspects: scattering i.e. losses, mapping (draft of flow of material on layout with accompanying marks and ratings) and indicators (10 specific indicators that assess the production line or plant).

KEYWORDS: Lean, manufacturing process, optimization, layout, flow of material

INTRODUCTION

Nowadays the most important thing in the industrial sector is to produce the product of good quality, in required quantity and deliver it to the customer on time. That activity is carried out by the use of diverse resources, people, machines and other forms of equipment. As it is mentioned in the introduction, the subject of the analysis of this paper will also be the joining of all these resources into one functional system, i.e. its improvement.

The improvement of Layout in one factory can be one of the key factors for improvement of productivity (Watanapa et al., 2011).

The projecting of Layout of one section is complicated, due to existence of several factors, such as: people, the position of machines, the flow of production materials and auxiliary material through the work station, connections between the machine and the work station, connections among several work stations.

The analysis of the existing layout can be chosen as the first step with the aim of identifying the problem, and with the aim of increasing the productivity with minimal investments.

LAYOUT PLANNING

As we have already mentioned, Layout of one factory represents the place where all machines, work stations, warehouses (raw materials, final product – FG, production materials, components, WIP (Work In Progress) parts, empty containers, etc.), all premises, maintenance, premises for employees, TPA (truck preparation area) as well as the employees themselves (figure 1) are located.

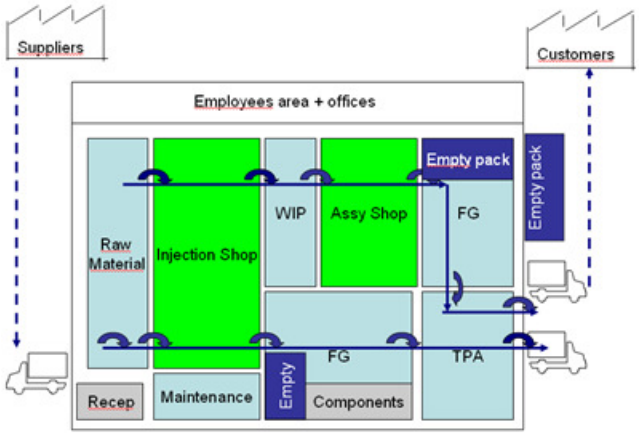


Figure 1 . Figure of well organized Layout

On the occasion of projecting of layout, one should take care of the following:

- that the disposition of machines and equipment do not endanger the safety and health of people,
- that the work surface is adequately used (rotation / m2),
- that the handling of material is as little as possible (short transport paths),
- that the productivity of equipment is as high as possible,
- that the equipment is as available as possible for maintenance,
- that the equipment is visually available for control,
- that the equipment is flexible for possible changes, and in accordance with the shape of the building.

THE ANALYSIS OF THE EXISTING LAYOUT AND FLOW OF MATERIAL

The first step in the analysis of the existing state is the analysis of space occupancy, check of validity of the equipment disposition (in flow, out flow), as well as the manipulation line of raw materials, components, waste and final product.

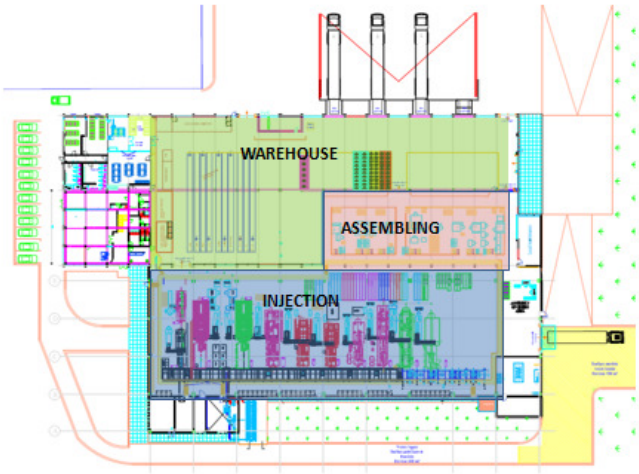


Figure 2 : Picture of the existing layout

As it can be seen (figure 2), the factory space that is analysed is divided into 3 large entities: Injection, Assembling and Warehouse. Total surface of these three entities is 4,180 sqm. In this paper the focus will be on the analysis of the production entities of the sections of Injection and Assembling.

The current ratio of occupied and free space in the production premises, as well as the surface that these two spaces occupy, is shown in table 1.

Table 1: Representation of space occupancy

	Space occupied	***Surface (sqm)***
Injection	59%	2,210
Assembling	70%	619

Table 1 shows that space occupancy in the injection section is 59%. If the space that is free, due to the lack of equipment whose arrival is yet to come, is excluded from that percentage, but only the part of the space where the machines are located is analysed, one comes to the number of 70% space utilization (figure 3).

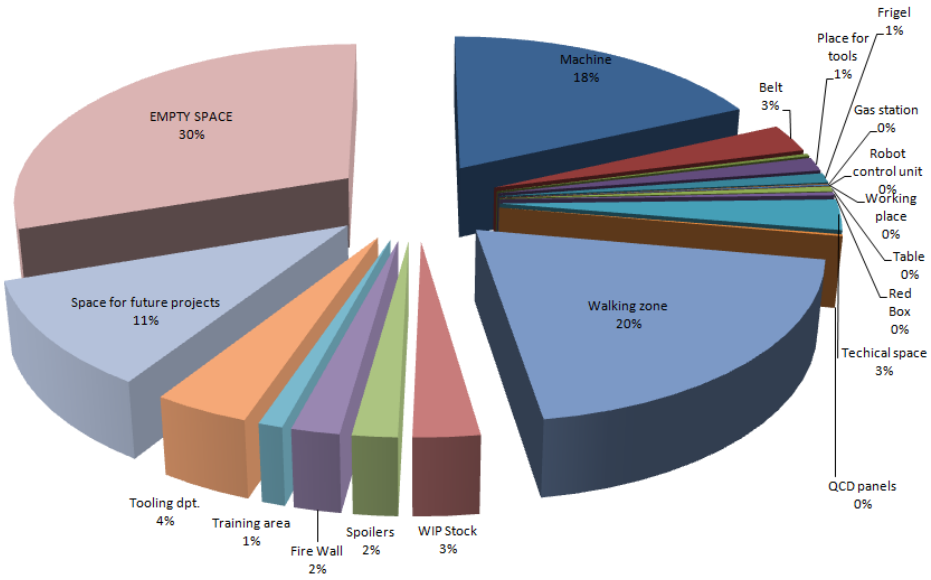


Figure 3: Injection occupation

Table 2: Representation of space occupancy by the elements in the injection section

INJECTION		
Description	***Surface (sqm)***	***Number of pieces***
Machine	400.45	11
Belt	62.83	11
Electrical cabinets	5.95	9
Place for tools	30.55	9
Frigel	21.32	10
Gas station	1.33	1
Robot control unit	2.87	9
Working Table	10.95	8
Red Box	7.12	7
Techical space	67.26	/
QCD panels	3.96	11

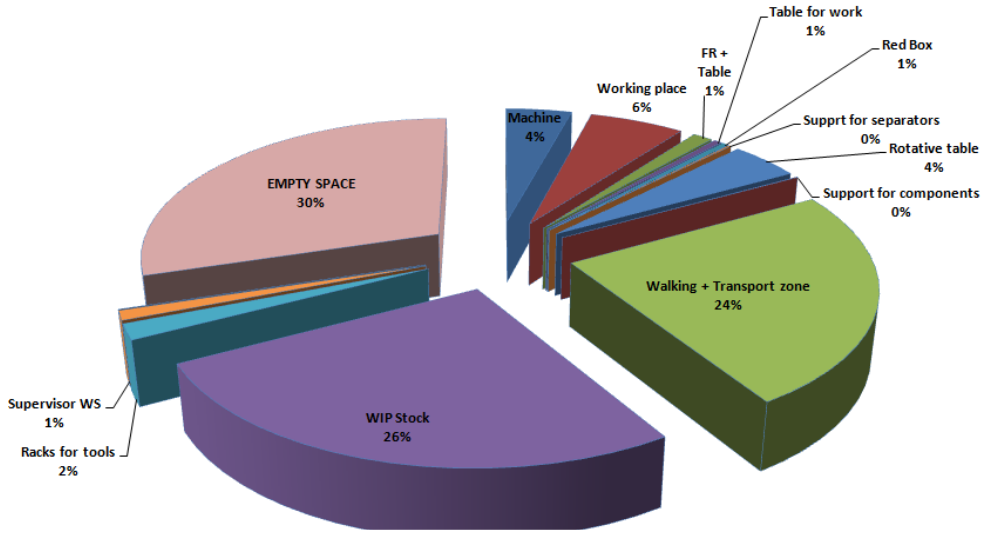


Figure 4: Assembling occupation

The walking zones, transport paths and the space between machines have the largest share (table 2) in space occupancy with 20%, and then followed by machines with 18%, conveyor belts and WIP stock with 3% each, work station of assembling of spoilers with 2% etc.

Table 3. Representation of space occupancy by the elements in the assembling section

ASSEMBLING		
Description	***Surface (sqm)***	***Number of pieces***
Machine	26	9
Working place	37.35	9
FR + Table	7.73	4
Work table	3.07	3
Red Box	2.52	9
Support for separators	0.92	4
Rotative table	27.17	7
Support for components	0.35	1

In the assembling section (table 3, figure 4), the most of the space is occupied by WIP stock (26 %), the walking zones and transport paths (24%).

THE APPLICATION OF LEAN TOOLS IN LAYOUT OPTIMIZATION

As it is seen from the analysis from the previous section, the space in the production sections is not used to the maximum. In order to optimize i.e. to use the space to the maximum as well as the layout itself and flow of material, it is necessary also to use some of the tools of Lean, such as:

- Spaghetti diagram - for optimization of flow of material and identification and elimination of losses (waste) in the process.
- Kanban – for optimization of amount of stock of semi-product (WIP stock) as well as the organization of flow of material between two production entities
- 5S and Standardize Work – for optimization of workplace itself.

Spaghetti diagram

Spaghetti diagram is a very useful tool by means of which, in a very visual way, flow of material, information and people can be presented, and later also be analysed through some process. Also, this diagram can be used in the analysis of movement of the operator on one work station, and also for the identification and elimination of all losses in the process. Every activity that does not add value to the customer is called 'waste', (Alukal G. and Manos A., 2006; Melton, 2005). There are 7 (according to some authors 8) main types of losses: defects, over-production, waiting, transport, inventory, over-processing and motion.

The analysis of the movement of material between the work stations (WIP - Work In Progress parts) is presented with the help of spaghetti diagram (figure 5). Based on that analysis, the following can be concluded: for production of which parts is the distance between the work stations largest (marked in red colour). As it is mentioned, one of the losses is transport, so that it is of key importance to optimize this part of process.

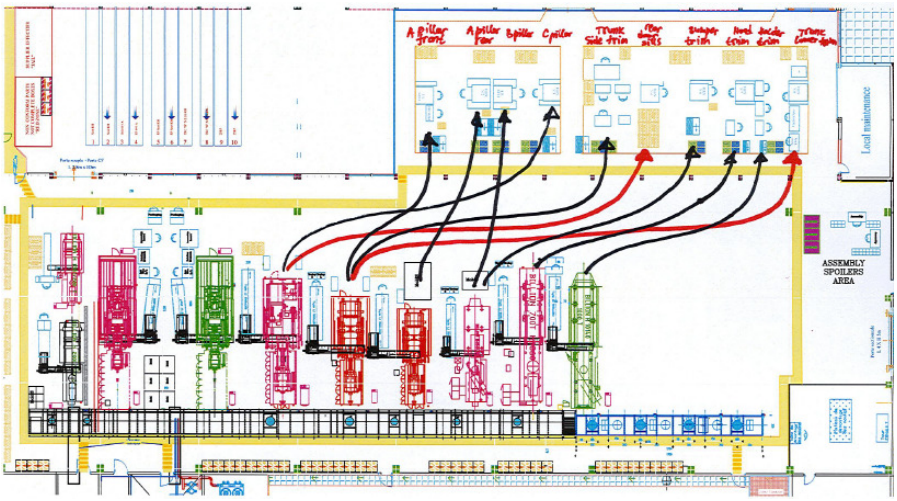


Figure 5: Spaghetti diagram

Kanban

KANBAN is a manual informational system that enables signalling "to the supplier" to send exactly specified quantity of goods, at fixed time and in the specified quantity to the ordering party, and also ordering of the same quantity for production. "Supplier" is every workplace or even the manufacturer, which preceeds the schedule of material processing. Kanban is Japanese word that means "card" or "sign". Apart from the cards, the empty space or trolley, or any other form of signalling for the buyer to say "I want more" can be used for communication. The basic idea of Kanban system is the imitation of supermarket. The buyers take the goods from the shelves, and the staff fills the difference that has appeared of the stock in the warehouse.

One of the most important concepts of the Lean production is the division of production batch into as little as possible, and the introduction of Kanban system has an important role in it.

Kanban system should ensure:

- automation of production process,
- mastering of stock size,
- reducing of interruption of supply,
- improvement of production effectiveness,
- that the problems become more noticeable.

In observed case Kanban system has been introduced between two production entities, injection and assembling, and with the aim to prevent excessive production, which represents one of the losses, and also that every irregularity in realization of production plan is easily noticed.

After the system implementation, a special attention is paid to the fulfillment of the following 5 conditions:

1. Number of parts in every packing unit must be exclusively the same as the number marked on Kanban card – in the case of excess or deficit of parts the control is lost of the production time per packing unit and lead time in that case can stay out of control,
2. The next step of production must get exactly specified quantity of production materials and at an exact time,
3. Number of parts at the end of the production line must coincide with the sum of all Kanban cards that have passed through the work station – the production without Kanban card is strictly forbidden, the production of parts beyond the number marked on the card is also strictly forbidden.
4. By improving the very process of production (by increasing the number of tool change and by reducing the time of its duration, by reducing the total time of delay etc.) one should also aim at reducing the number of Kanban cards i.e. reducing the production batch.
5. Observation of the standard work (it will be explained in the next chapter) – detailed description of work, step by step, with Kanban cards.

On the occasion of calculation of the batch size, influential factors that are taken into consideration are:

Available time of the machine for production during the day, cycle time of the part, number of tool changes that is possible to be done on the machine on which the product that is the subject of the analysis is produced, the duration of tool change.

The batch size (LE) is one of the factors in the calculation of required number of Kanban cards besides the maximum time required for replenishing of the stock (TA), the minimal stock that can endure the fluctuation (SM), the value of Kanban card (Vk, 1Vk = 1 transport trolley = 36 parts), the demand of the buyer per day.

$$Nk= (((TA +SM)xCMJ)+LE / Vk) \quad (1)$$

Table 4. Number of packaging units by the products and required surface

Description	*No. of PU*	*Packaging dimensions (mm)*	*Max batch size (set)*	*Packaging/ m2*	**Surface WIP stock (m2)**
A PILLAR FRONT	22	800x600	880	0.48	10.6
A PILLAR REAR	56	800x600	1,008	0.48	26.9
RDS	42	1,200x600	504	0.72	30.2
TST	36	800x600	720	0.48	17.3
HOOD TRIM	18	1,200x600	540	0.72	13.0
C PILLAR SHORT	36	800x600	324	0.48	17.3
BUMPER TRIM	5	1,200x600	800	0.72	3.6
TLT	56	1,200x600	448	0.72	40.3
B PILLAR UPPER	24	800x600	864	0.48	11.5
B PILLAR LOWER	24	800x600	960	0.48	11.5
BSM REAR	16	800x600	800	0.48	7.7
BSM FRONT	16	1,200x600	800	0.72	11.5
HOLDER TRIM	36	1,200x600	1,080	0.72	25.9
				TOTAL	**227.3**
			AVAILABLE SPACE FOR WIP		162.74
					-64.56

If we compare the data (table 4) for required number of packaging units and the surface that is necessary for their placing (227.3 sqm) with available surface for placing of WIP parts (162.74 sqm), one comes to the conclusion that all PU units cannot be placed on this surface. As can be seen from the table, semi-products of 2 items (TLT with 40.3 sqm and RDS with 30.2 sqm) occupy the most space.

The next step that is imposed is to check which of the products can be produced ON FLOW, so as to eliminate the transport means. The production ON FLOW in this case means that the process of assembling is done immediately after the outflow of the part, without the transport on the other work station.

Decision-making matrix

Help with decision-making whether something is more payable to produce IN FLOW or OUT FLOW will be offered by the matrix (figure 6) that consists of the set of logical, empirical questions. As it is explained before in the text, to produce IN FLOW means to perform the operation of assembling immediately after injection of parts, without additional manipulation, i.e. without the transport of parts from one station to the other. The production OUT FLOW also carries with itself WIP stock where the parts are put away between 2 operations, injection and assmebling.

The matrix that is composed to be the help at faster and better decision-making consists of **42 questions** divided into two entities (assembling in flow and assembling out of flow) with 21 questions each. Each of 2 entities is divided into three fields with 7 questions each, with different influential factors. Influential factors are 5, 3 and 1 or -5, -3 and -1 depending on which entity we talk about. Questions by columns are also classified according to the influence of their answer to the final decision. For example, some of the questions from the first column with the biggest influential factor of that entity (-5), assembling out of flow, are: is assembling mandatory only on the cold part?, or the size of the part is small? It is anticipated that, if the answers to these questions are positive (mark 1), i.e. that assembling is mandatory on the cold part, as well as that the dimension of the part is large, the additional points will be attributed to the decision that the part is more payable to be produced OUT FLOW. As it can be seen from the matrix (figure 6), assembling out of flow has negative coefficients, while assembling in flow has positive. For each of the questions the mark 1 is given if the answer is positive or 0 if the answer is negative. The final result of every column is obtained by multiplication of every column with its influential factor.

The final result that can be positive or negative is obtained by the sum of all columns. In case it is positive, assembling in flow is the solution that is more payable.

We have chosen to analyse two products for whose placing in WIP stock we need the most space (table 4).

The matrix (figure 6) shows the result of the analysis for one of the elements on the basis of which it is concluded that the part that has been the part of the analysis is payable to be produced in flow. Also, by the same analysis it is presented that the same case is with the second element.

ASSEMBLING OUT OF FLOW						ASSEMBLING IN FLOW					
-5		-3		-1		1		3		5	
1	THERE IS ASSEMBLING PROCESS	0	THE MOD FOR OTHER PARTS IS DIFFERENT	1	PRESSE VERY LOADED	1	THE LAYOUT ALLOWS THE IMPLEMENTATION OF INJECTION FLOW	1	PRESSE NORMALY LOADED	1	NOT SURFACE STORAGE AVAILABLE
0	THE LAYOUT OF INJECTION DO NOT ALLOW THE FLOW	0	SURFACE FOR STOCK IS AVAILABLE	1	MULTY PRODUCTS PRESS	1	ASSEMBLING OF HOT PART IS POSSIBLE	1	PRESS IS GROS TONNAGE	1	MOD NEEDED FOR OTHER MOLDS IS IDENTICAL
0	MOLD MULTY CAVITIES >2	0	MACHINE SPE IS NOT NECESSARY TO BE ALWAYS CLOSE TO PRESS	0	PRESS IS SMALL TONNAGE	1	STAFF IS POLYVALENT	1	ASSY MAHINE CAN STAY CLOSE TO THE PRESS	0	THE MOD IS EXPENSIVE
1	FEW HOURS PER DAY INJECTION	1	MACHINE SPECIALE DON'T HAVE A LOT TPM	0	THERE IS LESS PPL DURING THE NIGHT SHIFT	1	ALL THREE TEAMS HAVE A SAME POLYVALENCE STAFF	0	MACHINE SPECIAL IS RELIABLE , TPM	1	MOLD 1 OR 2 CAVITIES
0	ASSEMBLING OF COLD PART IS MANDATORY	0	FOR THE PROCESS WE NEED MORE THAN 4 MOD	0	BREAKES ARE NOT ORGANIZED	1	BREAKS ARE HELD	1	THE PROCESS DOES NOT REQUIRE MORE THAN 4 MOD	1	MANY HOURS A DAY INJECTION
0	ASSEMBLING MACHINE IS FIXED	1	COST OF MOD IS CHEAP	1	LACK OF COMPETENCES FOR PLANIFICATION	0	COMPETENCES N PLANIFICATION	0	THERE IS NO ASSEMBLY WORKSHOP	1	THE PART IS BIG
0	THE SIZE OF PART IS SMALL	0	THE MOD CHANGING THE PACKAGING	0	STAFF IS NOT POLYVALENTE	1	LINE FEEDER SUPPLY THE EMPTY CONTAINERS	0	ASSY MACHINE WITH WHEELS	0	THE PRESS IS DEDICATED TO A PRODUCT
-10		-6		-3		6		12		25	
								TOTAL		24	

Figure 6 . Matrix

On the basis of the analysis that has been done (spaghetti diagram, Batch size, Kanban calculation and decision-making matrix), it is established that two "critical" products, from the viewpoint of required space for placing of semi-products and the distance between the work stations, should be produced IN FLOW. By this application we have got enough space for placing of all semi-products, we have eliminated the transport path that is too long between the work stations, and by the integration of spoilers into assembling zone, we have got new 170 sqm under the crane for placing of new machines. You can see the picture of the Layout before and after the analysis in figure 7.

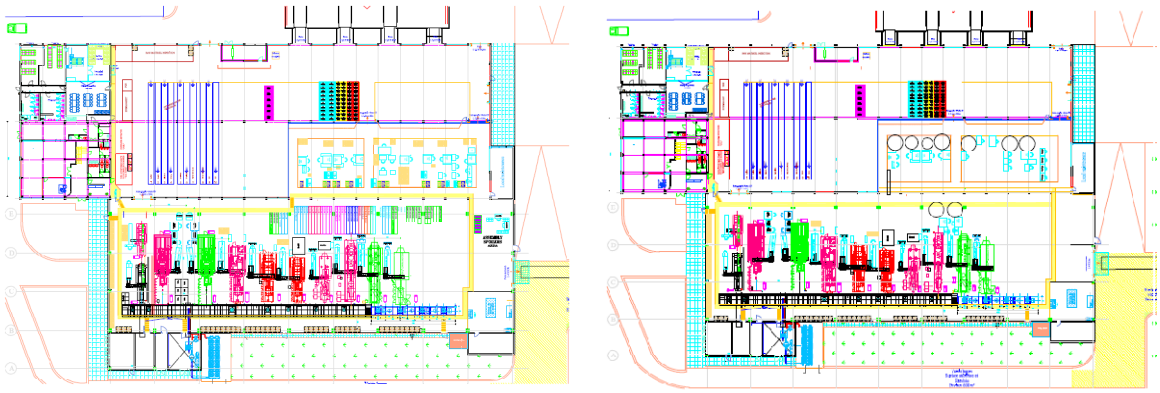


Figure 7: Picture of the Layout before and after the optimization

5S and the standardization of the workplace

Some people mistakenly think that 5S initiative is for cleaning, the most probably because one of the final results of the application of 5S is clean workplace. As a matter of fact, the basic function of the first S (sort) is the elimination of losses (waste), such as unnecessary moving of things, as well as searching for tools and material. Also, the other steps 2S – set in order, 3S – shine, 4S – standardize and 5S sustain serve for developing and disciplining of working habits on work station, which should enable easier implementation of the lean methodology.

After the implementation of 5S, it is necessary to standardize the work station. One part of standardization is done within the implementation of 5S standards (4S), but it is also necessary to standardize the work of the operator. The standardization of work is done so that it is ensured that every operation at forming of the final product is always done in the same way as well as that the final product is always of the same quality no matter who produces it (the main operator or its substitution).

Also, by the standardization of work operations the variance in the process is reduced, which represents one of the main sources of losses (Jeffrey K. Liker and David Meier, 2006).

To repeat, by 5S standard we have defined what is necessary of tools and other means of labour to be located on the work station, as well as their location on the work station (figure 8), while by Standardize work document we have defined the sequence of performance of the operations, the way of their performance (figure 9), sequence and their duration (figure 10). Standardize work consists of three parts:

- Vivid representation of performance of the operations and their sequence,
- Layout of work station and the way of movement of the operator while performing the operations (figure 10),
- Work combination table (figure 10).

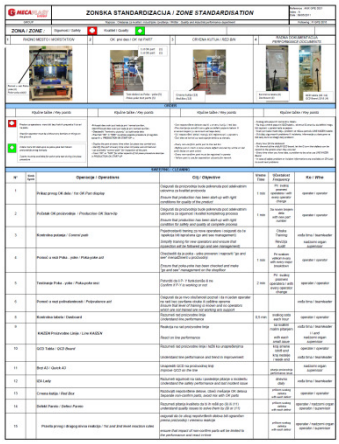
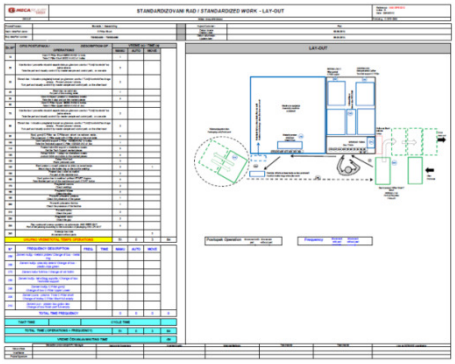


Figure 8: 5S standard document

Figure 9: Standardize work sheet 1



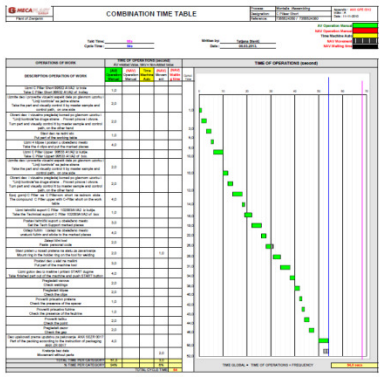


Figure 10: Standardize work sheet 2 & 3

CONCLUSION

As it is stated in the introduction of this paper, the lean methodology and the lean tools are used for the purpose of the elimination of all losses in the process, and which is imposed by modern business where the buyer and his/her satisfaction is in the first place. So as to achieve maximum quality of some production process, it is necessary to direct the energy only to the processes that add value, i.e. to the processes that the buyer is willing to pay.

This paper has shown that the application of the lean tools in forming the layout and in creating the path of the flow of material is one of the basic elements in forming high-grade production process. By the use of spaghetti diagram, the analysis of flow of material through the production process is firstly done, then the possibility of overproduction is eliminated by the introduction of kanban system, and the production of only the necessary semi-products is ensured, in specified quantity and in right time. When the basis of the new process is established, the elimination of the excess of material from work stations is done by the application of 5S, and the standardization of work by introduction of standardize work.

Besides the application of the lean tools, the focus in this paper is put also on the decision-making matrix that should make the decision easier whether it is something more payable to produce IN FLOW or OUT FLOW. The advantage of the use of this matrix is in the fact that the process of decision-making is brought down from the expert level to the level of engineer decision-making. It means that while making such decisions in the future there will not be necessary to include the expert team in making of final decision, but it will be sufficient to do the analysis on the level of engineer group.

After all changes that have been done in the production process, the losses in the form of transport of the parts from one station to the other are eliminated, and that is for the parts where these distances have

been the largest, there have been made enough space for placing of complete WIP stock, and also additional 170sqm are formed for placing of additional machines in the area where the manipulation is possible with the crane.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Lean supply chain management framework and practical implications

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ABSTRACT

In today's global market an effective supply chain management (SCM) is crucial for business success. The current challenge is to make SCM more competitive, capable of responding to customer's demands, and ready to eliminate all processes that add no value. That is why some different approaches and solutions are required, and one of them is the lean concept. A Lean-SCM approach is a relatively new concept which has emerged from the implementation of lean philosophy into SCM. A lean-SCM concept has been proved to be an effective SCM model primarily by eliminating all forms of wastes in the entire supply chain making it transparent and efficient. The main purpose of this paper is to obtain a better understanding of a lean-SCM concept. A lean-SCM framework, opportunities and practical implications are presented and discussed. The research scope indicates that multiple benefits can be achieved for all participants in the SCM system. The value of this paper is in its systematic attempt to present the framework of lean-SCM integration and application.

KEYWORDS: lean, SCM, lean-SCM concept, framework

INTRODUCTION

Lean philosophy has been defined as a new business strategy whose primary goal is to reshape manufacturing processes making them more efficient and transparent by continuously adding new values to the products or processes in the focus of observation as previously shown (Ilin and Simic, 2012). For a long time, lean has been developed and utilized in the manufacturing setting. Supply chain management (SCM) presents the movement and storage of raw materials, parts, various inventories, finished goods and the related information flows from the point of origin to the point of consumption. A Lean-SCM approach is a relatively new concept which has emerged from the implementation of lean philosophy into SCM. Decision making in a lean-SCM context is challenging because of the complexity, dynamics, and uncertainty inherent to both supply networks and the types of waste (defined as any processes, including use of resources, which do not add value to customers) as previously shown (Liu et al., 2013.).

The purpose of this paper is to provide an overview of lean-SCM framework, opportunities and practical implications. At first, SCM concept, lean concept and a lean-SCM concept are explained. Furthermore, the main focus is on four different phases in the SCM system and the following integration with lean concept: lean supply, lean transportation, lean manufacturing, and lean distribution. In addition, two examples from practice are presented and discussed. The structure and the content of this paper have the purpose to decrease dilemma regarding some basic questions about lean-SCM concept: "what is the right definition of a lean-SCM concept?", "at which areas of SCM lean has the strongest impact?", and "what are the measurable results from the practical lean-SCM implication?".

RESEARCH FRAMEWORK

SCM concept

The Council of Supply Chain Management Professionals (CSCMP) is the most well-known organization regarding SCM. CSCMP define SCM as:

"*…planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies*." (Web-1)

Originally, supply chains have been designed to manage forward logistics as previously shown (Ilin et al., 2013). Within the organization, the supply chain refers to a wide range of functional areas. These include SCM related activities such as inbound and outbound transportation, warehousing and inventory control, sourcing, procurement, push and pull strategy, cross-docking, and supply management. Inbound transportation refers to the movement of raw materials, parts, various inventories and the related information flows from suppliers to manufacturers, warehouses or retail stores. Outbound transportation refers to the movement of final products and the related information flows from the end of the production line to the end user. Warehousing refers to the storage of raw materials, packing materials, spare parts, components, final products, etc. Inventory control refers to the supervision of supply, storage and availability of goods in order to ensure transparent supply. Sourcing refers to different logistics strategies in the supply chain design. Procurement includes market research, make-buy decisions, requirements planning, ordering and control, etc. A push strategy refers to the forecasting of demanded customer's products, while a pull strategy refers to the transfer of final products or information flows demanded by customers. Cross-docking refers to the removing of goods from an inbound trailer to an outbound trailer, without ever stocking the goods in the warehouse. In addition, evolution of SCM is presented (Figure 1).

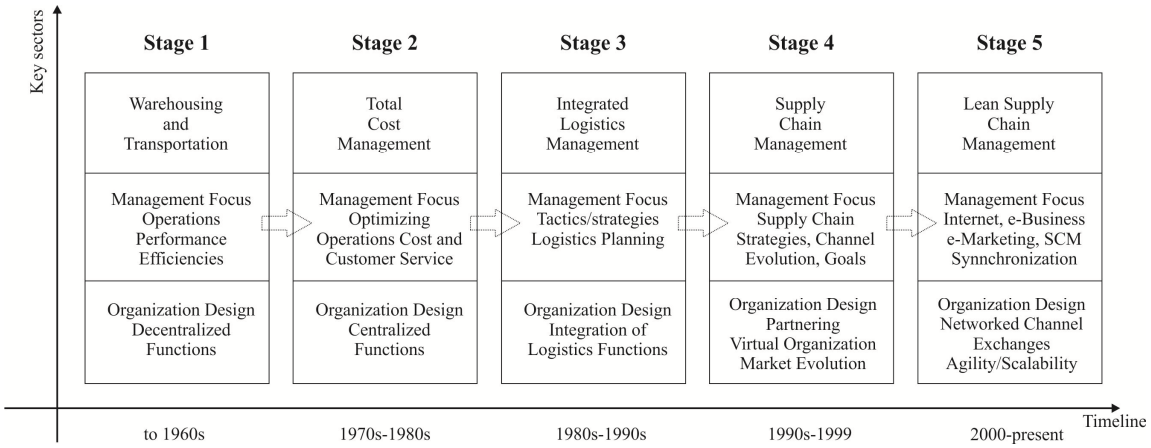

Figure 1: Evolution of SCM (Web-3, edited by authors)

Three different types of supply chains are defined as shown by Vonderembse et al. (2006):

1. A lean supply chain, which employs continuous improvement efforts which focuses on eliminating waste or non-value steps along the chain.
2. An agile supply chain, which responds to rapidly changing, continually fragmenting global markets by being dynamic, context-specific, growth-oriented, and customer focused.
3. A hybrid supply chain, which combines the capabilities of lean and agile supply chains to create a supply network that, meets the needs of complex products.

LEAN concept

As shown by Kilpatrick (2003) and Liker (2004) basic principles of lean concept are:

- Identification of losses (waste);
- Standardization of processes;
- Continuous flow;
- Pull system;

- Quality at the source;
- Continuous improvement.

Enterprises that practice lean concept systematized seven types of waste as shown by Gross et al. (2003):

- Overproduction;
- Defects;
- Inventory;
- Transportation;
- Waiting;
- Correction;
- Motion.

As previously shown (Leach, 2005) the benefits of lean for company are significant with managing the flow of products and information: increased operational readiness, increased product quality, increased workers' efficiency, increased utilization of machines and space, reduced of machine failures, compressed cycle times, reduced logistics costs, increased inventory levels, increased supply chain visibility, improved supplier and logistics performance.

A LEAN-SCM concept

Lean thinking in supply chain management is the use of lean principles to align activities across corporate functions within the firm and to manage business relationships with customers and suppliers as previously shown (Web-2). At a very high level lean is the relentless pursuit of eliminating waste across an extended supply chain as shown by Trent (2008). Also, a lean-SCM concept is a supply chain operational and strategic management philosophy that utilizes Internet-enabling technologies to effect the continuous regeneration of supplier and service partner networks as previously shown (Web-3). Basic characteristics of a lean-SCM concept are orientation towards pull rather than push systems and making material and information flows transparent as much as possible. The main streamlines of this concept are to reduce any form of waste, increase time reduction and optimize the main process.

In recent years, a lean-SCM concept has become interesting for many researchers. In Table 1 review of lean terms search "hits" is presented for years 2008. and 2013. Significant difference can be noticed for all terms, which only additionally highlights the interest for this topic.

Table 1 List of the most important lean-supply chain management terms

Search term	Google results (2008.)	Google results (2013.)
Lean manufacturing	2.500.000	12.800.000
Lean production	728.000	23.700.000
Lean operations	56.400	62.200.000
Lean procurement	28.300	13.900.000
Lean supply management	16.800	5.410.000
Lean purchasing	1.400	12.200.000
Lean logistics	31.800	12.700.000
Lean transportation	2.140	47.700.000
Lean distribution	9.340	44.500.000
Lean supply chain	74.800	41.600.000

The following areas of SCM can benefit when introducing lean concept: product development, warehouse and logistics centres location, supplier selection, transportation fleet, demand estimation, customer order fulfilment, type of information systems, etc.

LEAN-SCM INTEGRATION AND APLLICATION

Comprehensive overview of a lean-SCM integration and application framework is shown on Figure 2. In general, lean impacts SCM comprehensively, but in order to understand a clear picture it is necessary to understand the impacts on specific parts of SCM. Four different segments have been identified: lean supply, lean transportation, lean manufacturing and lean distribution.

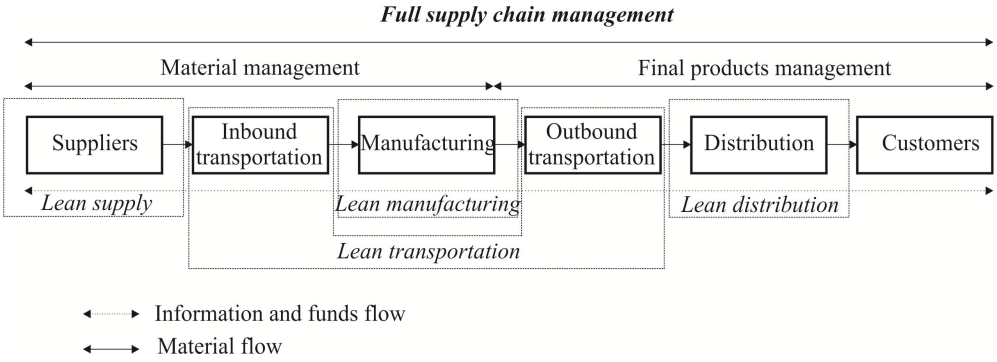

Figure 2: A Lean-SCM integration and application framework

Lean supply refers to the optimization of inputs of each production oriented organization. Also, lean supply is one of the least recognized and pursued parts of a supply chain as previously shown (Trent, 2008). It includes just-in-time (JIT) concept, selection of adequate suppliers that support lean principles and establishment of supply flows which remove waste from supply processes. JIT concept refers to smaller quantities of goods which are delivered frequently to buyers exactly when they needed. Pull principle is favoured in lean supply section. Selection of adequate supply domain includes evaluation, selection and development of lean oriented suppliers. Suppliers that apply lean principle are particularly suitable for selection. The main questions regarding lean supply section are how to ensure strong commitment to continuous improvement, how to remain cost competitive, and how to secure enough capacity to satisfy demand requirements. Lean supply section supports long-term supply strategies and multiple criteria process regarding supplier's selection.

Lean transportation refers to the inbound and outbound transportation in SCM with emphasized lean principles. A lean transportation section is not only about more frequent deliveries of smaller quantities, but also it provides predictable and more frequent deliveries to a specific point-of-use as previously shown (Trent, 2008). Mostly, lean transportation strives to minimize total distances travelled within a transportation system. Many companies support new rising solutions, such as third-party logistics (3PL) companies, which facilitate organization of transportation sector. Very important viewpoint of lean transportation is the introduction of the term trade-off. Trade-off means giving up one thing in return for another. As previously shown (Simcki-Levi et al., 2003) five of the most important trade-offs are (1) lot size-inventory trade-off, (2) inventory-transportation cost trade-off, (3) lead time-transportation trade-off, (4) product variety-inventory trade-off, and (5) cost-customer service trade-off. In order to achieve optimal lean transportation system trade-offs are necessary. The implementation of specific trade-off depends on the real situation.

Lean manufacturing refers to processes between inbound and outbound transportation phases. The basic five principles regarding lean manufacturing are (1) setup time reduction, (2) facility layout changes, (3) pull systems, (4) uniform loading, and (5) level scheduling as previously shown (Trent, 2008). Setup time reduction can be achieved by improving setup methods, tracking setup improvements, planning and staging, enabling new equipment, etc. Facility layout changes have an important place on the lean manufacturing map. Physical layout is very important in order to ensure transparent material flows within the facilities. Consequently, improved performances of this sector are more likely. Pull approach is associated with lean because it depends on direct request rather than rely on forecast that may never occur. The main reason for emphasizing pull system is because of transparency of each step which initiate alert to react. Uniform loading refers to the connectivity of each process within manufacturing phase, while level scheduling aims to create a smooth production flow over some periods.

Lean distribution refers to improved demand estimation, form and time postponement, delivery optimization technology, cross docking technic, make-to-order production strategies, optimized channel design, and the creative use of information and communication technologies (ICT) as previously shown (Trent, 2008). In order to provide benefits from the lean distribution system several actions need to be performed (1) inventory control system should be established or checked, (2) demand estimation capabilities should be improved, (3) material flows should be optimized (labelling, packaging, assembling and manufacturing), (4) various ICT solutions need to be implemented (e.g. Global Positioning System (GPS), Radio Frequency IDentification (RFID), Geographic Information System (GIS), etc.), (5) an ICT-logistics management system need to be established (e.g. Transportation Management System (TMS), Warehouse Management System (WMS), etc.), (6) supporting software need to be installed, (7) make-to-order production strategies must be adopted (pull concept), (8) distribution resource planning need to be scheduled (e.g. optimal inventories, vehicle load scheduling, vehicle routing), (9) cross-docking technic should be favoured as much as possible (time reduction in waiting is utilized).

LEAN-SCM PRACTICAL IMPLICATIONS

As an example, two case studies are presented in order to provide an answer to the pragmatic question: what is the practical implication of lean-SCM integration and application? Although the explicit answer cannot be clarified based on only two case studies, better understanding of lean-SCM integration and application can be obtained. The both case studies are analysed in accordance with the following questions: what is the main objective of the study and where it is conducted, why it is conducted, how it is conducted (research method), and what are the main findings and practical implications.

The first example of lean-SCM integration and application is the case study of non-food manufacturing companies in Malaysia as shown by Agus et al. (2012). This case aggregates results from already applied lean principles in SCM in Malaysia. The research method applied in this study was a structured survey questionnaire consisting of two major parts. To enable respondents to indicate their answers, a seven-point interval scale was used in the questionnaire. This approach enabled easier statistical analysis. From the 300 companies sampled, 200 responses were completed, representing a 67% response rate. Product quality performance (PQP) was in the main focus. The main goal was to identify the determinants of lean production that can enhance PQP and the bottom line results such as profitability, return on sale, and return on asset. Three main hypotheses were determined: (H1) lean production has a positive structural effect on PQP, (H2) lean production has a positive structural effect on business performance, and (H3) PQP has a positive structural effect on business performance. The obtained results demonstrated strong association between lean production, product quality performance, and business performance. Hypothesis H1 and H3 have shown strong statistical matching, while H2 has shown moderately statistical support of positive structural effect. The final result indicates that manufacturing companies should emphasize greater attention to the time reduction aspects of the lean production process and a greater degree of management support for lean production programs. According to the authors, this paper is relevant to practitioners because the findings can reveal important aspects in the implementation of lean production practices, and significant information which can be used by managers to solve implementation challenges and improve performance. Nevertheless, the paper doesn't provide explicit guidelines directions for lean-SCM managers. Also, the reliability of expertise of surveyors can be discussed as well.

The second example of Lean-SCM integration and application has set out to investigate lean practices in the Danish municipal sector through two questionnaire surveys and three case studies as shown by Arlbjørn et al. (2011). In order to avoid similarity in analysis with the first example only three case studies are taken into consideration. Nevertheless, resemblance with the first example still exists regarding the research method. Authors have tried to investigate lean practices in the municipal sector in a service SCM context. The research method applied in this study was direct approach for three municipalities. Three municipalities have been visited by authors and are referred to as Case A, B and C. Case A is about lean implementation within an administration of social security payments, case B is concerned with lean implementation in a social services department, and Case C contains lean implementation in a specialised school area. According to authors, only Case A is building on the aspect of the philosophy of lean (to reduce waste). Case A highlighted less stress in the organisation which is not quantified and throughput time reduction for 50%. Case B pointed out two benefits: user surveys every third year and none bad stories in the

public press. Case C emphasized less stress in the organisation which is also not quantified. It can be discussed whether this cases offer sufficient benefits to be considered as successful lean-SCM implementation.

CONCLUSION

A lean-SCM concept has been proved to be an effective SCM model primarily by eliminating all forms of wastes in the entire supply chain making it transparent and efficient. Major reasons for implementing lean in the SCM system encompass the expansion of the organizational strategy on a higher level and reduction of costs. It can be discussed whether the cost reduction is equals with the lean philosophy (waste elimination), but the authors support this claim. In some cases in which lean philosophy is applied, very small differences can be noticed between the common sense and the lean concept. Still, the lean concept presents a structural and methodological approach, including change of awareness of managers. Also, lean offers solutions to redesign some sectors in SCM, which was shown in this paper. Although a lean-SCM paradigm has gain increasing attention within both academic and industrial research field, it still leaves enough space for the further research and the extension of the current framework.

Future research can be directed towards introduction of ICT into a lean-SCM concept. ICT may intrigue some additional solutions and enhance proposed concept. Therefore, new integration concepts may emerge (e.g. a lean e-SCM concept). The paper titled "Lean e-logistics integration, models and applications" as shown by Simic et al. (2012) may be a starting point.

ACKNOWLEDGEMENTS

This research is supported by the Ministry of Science and Technological Development of the Republic of Serbia, Project No. TR 36030.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Energy Control Program in Maintenance Sector in Zelezara Smederevo (SteelWorks)

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ABSTRACT

SteelWorks is a big heavy industry with heavy machines. Workers on equipment maintaining need to be very careful and to strictly respect the Energy Control Program of the company, on their jobs. The Energy Control Program is a set of rules and procedures applied to protect personnel and processes from the unexpected startup or release of hazardous energy during the servicing or maintenance of machines or equipment. Energy Control Program is a safety system that gives very good results because it is reliable, simple and logical, but requires commitment of workers, respect the procedures and good concentratration during operations.

KEYWORDS: Energy Control Program, Safety, Maintenance, SteelWorks.

INTRODUCTION

LEAN & SAFETY, if we look at their extremes, someone might conclude that these are opposing sides, because LEAN seeks to eliminate everything that does not add value to the product, and SAFETY seeks to make safer work environment, which sometimes results in steps that do not add value to the product. However, for the majority of LEAN experts, these are terms that go together and complement each other.

Some of them are supporters of theory that SAFETY is supplement of 5S (5S+SAFETY=6S), and the other support the theory that some LEAN tools are in service of SAFETY (5S, Visual Factory, Poka Yoke, Continuous flow, Standard work, Workplace organization, Autonomous activities, Problem solving (5Why, 5W+1 H), Teamwork). In any case, LEAN always strives to eliminate or reduce losses. Losses incurred as a result of work in dangerous, unsafe and disorganized work environment, very often are irrecoverable. Injuries, illness and death are biggest losses that an working organization can have, even if we could turn off the human side, these are huge losses in terms of resources, productivity and morale, which may cause a decline in production and unpleasantly work environment.

Smederevo Steel works, for the first goal of the company, set "Zero injuries!" This applies into the all factories of the company, including Tinplate production, too. It is not easy to achieve that in the steel industry, but applying the Energy Control Procedures (PKE) and Procedures for Safe Work (PBR), it is possible to avoid mistakes and work accidents. With active approach, planning, analysis of previous experiences and continuous education of employees, it is possible to predict dangerous spots and avoid potentially dangerous situations.

LEAN SOLUTIONS

Poka Yoke is one of the most important Lean tool which eliminates errors in operation. Operator errors are the most common causes of accidents. With implement of certain Poka Yoke solutions, errors can be avoided, and thus improves safety and quality of production.

Well-known solution is with two buttons that must be pressed simultaneously to start the press. It requires both hands on buttons which eliminates possibility of errors and injuries,

Figure 1: Two-hand controls

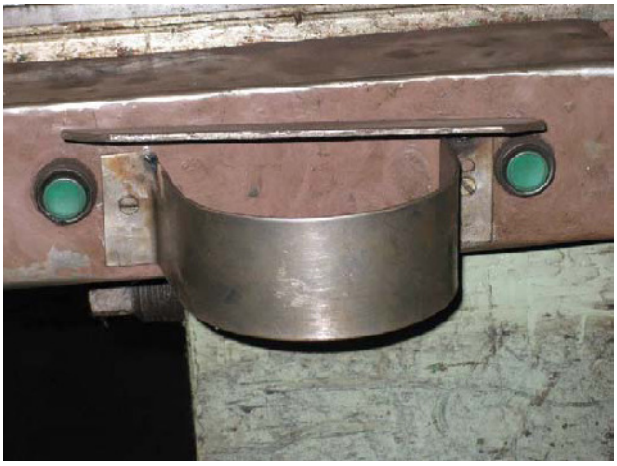

Figure 2: two-hand controls with barrier

or machining centers that can not be started until a safety barrier not set on the work position,

Figure 3. Machining center with safety barrier

or installing the fuse on the crane's hook, etc.

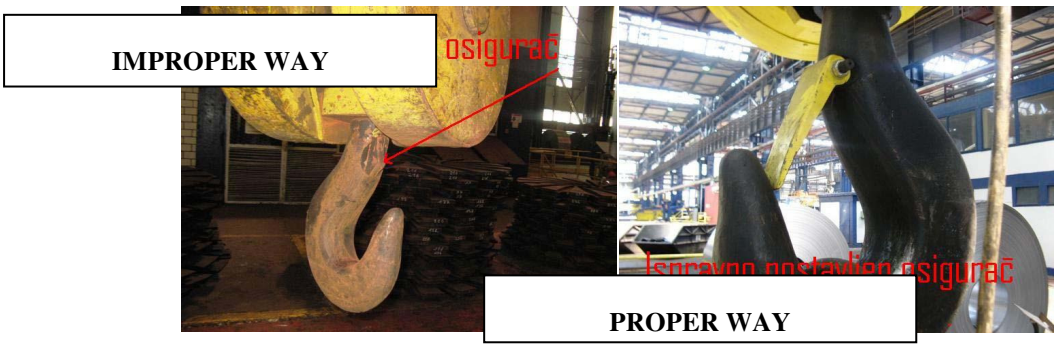

Figure 4: Crane hook without fuses and with fuses

Solutions that facilitate the operator's manual work, very often go to further improvement for better work efficiency.

Figure 5: Platform for placing sacks of chemicals for water treatment

The platform is at the stage of improvement, with the idea to expand it on the entire length of the pool. The operator will be able to put chemicals in any part of the pool, with no depending where is the pallets with bags.

Figure 6: Platform for lowering weight

To minimize security risks and the risk of damage equipment during lowering from "0" level to "-1" level, we installed a platforms for equipment lowering. This has reduced the time required to perform certain operations in maintenance of equipment and significantly improved safety and operators work.

Figure 7: Transport cart

Manual carts that are used for transport equipment, parts and tools, greatly reduce the risk of injury for workers if they transfer the burden manually.

Visual Factory besides facilitating the production process, gives excellent results in safety, too.

Figure 8: Marks for cranes parking places

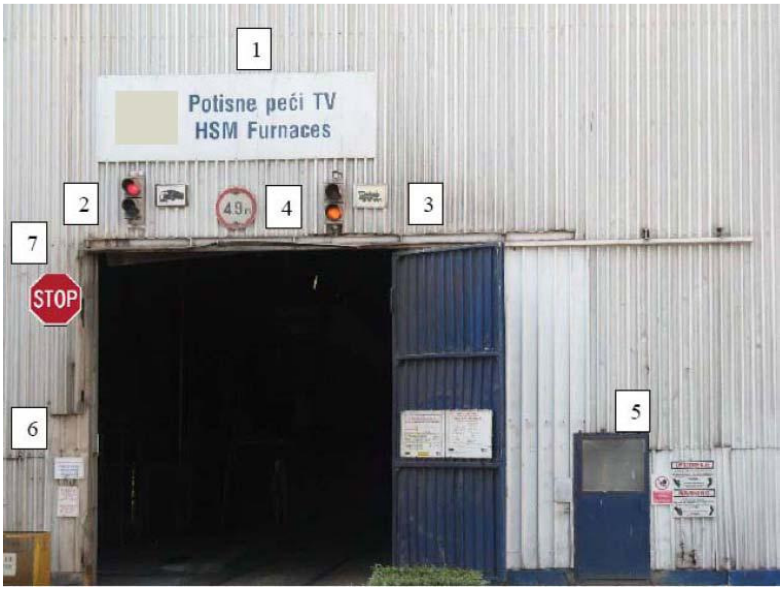

Figure 9. Marks on the hall entrance

1. Identification of the object
2. Trafic light for mobile equipment
3. Trafic light for railway equipment
4. Sign for entrance height
5. Pedestrians door
6. Sign for narrow passage
7. Stop sign

Figure 10: Pipeline color marking

Tabela br 1 UPUTSVO ZA OBELEŽAVANJE CEVOVODA SA FLUIDIMA

VRSTA FLUIDA		CEVOVOD	OSNOVNA BOJA	BOJA PRSTENA
VODA	Industrijska voda		ZELENA RAL 6018	
	PIJAĆA VODA			ZELENA SVETLA
	DEMI VODA			CRVENA RAL 3000
	TOPLIFIKACIONA VODA			BELA RAL 9010
	KONDEZAT			ŽUTA RAL 1021
VAZDUH	KOMPRIMIRANI		SIVA BOJA RAL7001	
	TURBO			BELA RAL 9010
KISEONIK			PLAVA BOJA RAL5015	
VODENA PARA			CREVENA BOJA RAL 3000	
ZAPALJIVI GASOVI	PRIRODNI GAS		ZUTA BOJA RAL 1021	
	VISOKO PEĆNI GAS			CRVENA RAL 3000
NEZAPALJIVI GAS				CRNA BOJA RAL 9005
ZAPALJIVE TEČNOSTI			BRAON BOJA RAL 8001	
NEZAPALJIVE TEČNOSTI			CRNA BOJA RAL 9005	
KISELINE			NARANDZASTA BOJA RAL 2003	
LUŽINE			LJUBIČASTA BOJA RAL 4001	

Figure 11: pipeline colors

Standard Work is LEAN tool that greatly improves work processes in the factory of Tin plate, and of course, in the whole company. That is the standard operating procedures, procedures for safe operation (PBR) concerning the Maintenance Department, and energy control procedures (PKE) concerning the Producation Department to ensure safe work of the maintainers. Almost all PKE involve the use of a some segment of LOTO Safety Program.

That is the security elements used for notifications, warnings, and the elements that will block and ensure the energy of equipment that is serviced. Energy stays turned off and under control, in order to avoid accidents during operation due to accidental or deliberate inclusion and energy release.

Energy control locks

Figure 12: Personal safety locks

Personal safety locks

-Red color

-Visible name and ID number of the Owner

-Used only by the owner for positive personal protection from the hazardous energy

-One lock can only have one key

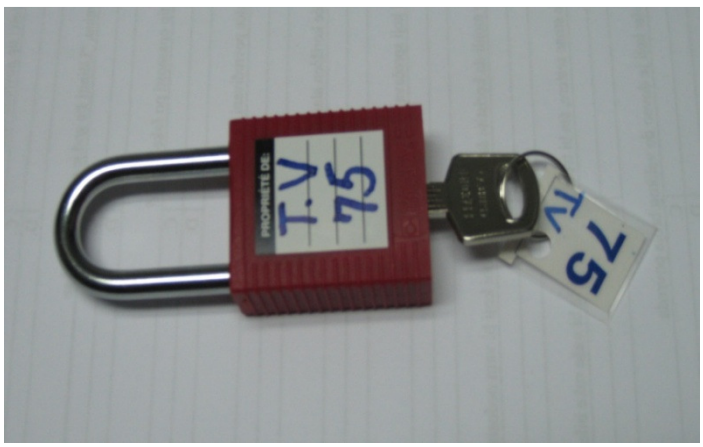

Figure 13: Department lock

Department lock:

-Red color

-Is stored inside the cabinet for locks

-Is taken out only by the authorized and primary authorized person

-Used for lock out of source of isolated energy in duration of one or multiple shifts

-It is also been used to lock the box/cabinet for the group lock out for the repair in duration of one shift.

-One lock can only have one key

Figure 14: Continuity lock

Continuity Lock

-Blue color

-Used for repairs in duration of multiple shifts

-Are taken out only by the authorized and primary authorized person

-Are positioned only on lock box/cabinet or hasp for the group lockout on which are affected employees also placing their personal safety lock

-Key of the lock is kept by the person that applied this lock or the person that is replacing him/her in the shift

Figure 15: contactors personal safety lock

Green lock (Contactors personal safety lock)

-Visible name of the Company and Owner

-One lock can only have one key

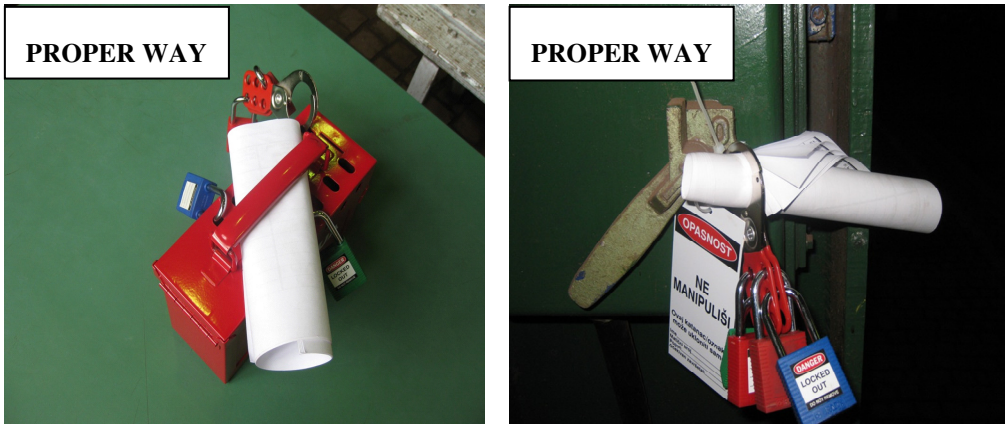

Figure 16: Proper way to lock

Properly locking the energy with PKE and PBR, group lock box, continuity lock, personal safety locks for operators who work on equipment and radnika koji obavljaju radni zadatak and a warning sign that the work is in progress.

CONCLUSION

LEAN and SAFETY goes together, and with finding the right balance you can get safe and effective work environment. In our Tinplate factory result of use all these tools and methods mentioned above, and adherence to procedures and company rules, is high level of safety, reduced the risk of unpredictable situations and accidents, and improve the work quality as well as the morale and motivation of employees.

In the numbers, that meens there was no injuries in our Tinplate factory for last 1150 days.

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Process Improvement of Clinical Biochemistry Laboratory Diagnosis Using Lean Concept

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ABSTRACT

Lean thinking can be used to identify and eliminate waste in any activity which is carried out in the clinics, laboratories, departments, or entire building. Based on the Toyota model, the Lean concept focuses on the question of how to effectively use resources, and after each step in the process is stopped and asked "which value is produced?" Concept can be used to improve the services provided to any group site, including the elimination process which does not add value to the end user of health services - the patient.

This paper presents part of the results achieved in the implementation of two Lean projects in the Clinical Center of Nis in the period since January 2012th to May 2013th year. In particular, a detailed presentation of results achieved to improve its clinical and biochemical laboratory diagnosis, using Lean concepts.

KEYWORDS: Lean, Healthcare, Kaizen, Heijunka, Pareto, SMED

INTRODUCTION

In today's changing environment in health care facilities from manager is expected to do more with fewer resources - less effort by staff, less technology, less time and less space to work - while at the same time provide patients, doctors, nurses and administrators a high level of services. To meet the growing demand, the medical staff may join their colleagues in the Lean and Six Sigma concept, a philosophy that focuses on process improvement and change management (Stoiljković, 2010).

The existing health care systems don't can solve the current demands and to solve the accumulated problems. Therefore, it is necessary to change, change that will reduce costs, shorten the duration of the process, reducing or eliminating errors and variations in the processes of health care. This will lead to a significant rising of health services and increase patient satisfaction, as well as the doctors and medical staff who provide these services.

Wastes in healthcare are high. According to data published in the literature, "For every dollar spent in health care facilities, more than 75 cents is spent on activities not related to patient care - communication, scheduling, coordinating, monitoring and documentation of care" (Debra Hadfield et al, 2010). Therefore, people need to focus on improving activities that do not add value, and not on activities that add value. To achieve this you need to "**learning to see**" 8 large wastes in the processes of health care (Mike Rotherand and John Shook, 2003). Identify when waste occurs give us opportunities to reduce or eliminate wastes by using the Lean tools. This paper deals just with identifying and reducing waste in the process of clinical biochemical diagnosis, using Lean tools.

THE PROJECT CHARTER AND IMPLEMENTATION TEAM

For the implementation of Lean process improvement project clinical biochemical laboratory diagnostics, acting director of the Clinical Center Nis, Prof. Dr. Borislav Kamenov appointed a team consisting of:

Team sponsor, Prof. Vida Djordjević,

Team leader, Dr. Sc. Vladan Cosić, and

Team members: Mr. Biol. Predrag Vlahović; Asist.dr Milan Radojković; Dr. Sc. Slavica Kundalić; dr Dragana Stanković Ferlež, Radica Milivojević, nurse, Lela Kocić; nurse, Goran Stanković: Mitic Irene, lab.teh.; Biljana Stankovic; lab.teh.; Mirjana Stamenkovic, lab.teh.; Dragan Stojanovic, lab.teh.; Jelena Djordjevic, lab.teh.; Stojanovic Dragica lab.teh. and Rajkovic Slavica, lab.teh.

Author of a paper in collaboration with Prof. Dr. Borislav Kamenov and Prof.dr Vidosava Djordjević has defined the project charter.

Short version of the charter is given in Table 1.

Table 1 Short version of the charter

<table>
<tr><th colspan="2">Charter</th></tr>
<tr><td>The mission
Evaluate and improve the process of clinical biochemistry laboratory diagnostics in the Clinical Center in Nis, including the professional staff of the Center for Medical Biochemistry and clinics that have the most requests for tests and which will use the Lean process.
Process limits: The process starts with indicating the analysis on the clinics KCN and taking biological material from patients and in the receiving ambulance, and the process end when is reported of the examination, whether laboratory test results given to patients in hospitals or in the ambulance.</td><td>Results
The team will map the process using the SIPOC model, save map process flow and value stream map to achieve the following goals:
Reducing the time to obtain the results of laboratory tests of 60 minutes in the next 6 months
Reduction of administrative activities by 20% compared to the current situation in the next 6 months
Decrease in inventories necessary materials for laboratory testing by 20% compared to the current situation in the next 6 months
Laboratory tests to reduce errors by 10% compared to the current situation in the next 6 months
Improved use of available space by 25% compared to the current situation in the next 6 months</td></tr>
<tr><td colspan="2">Current situation in the clinical biochemical laboratory diagnostics
In the process of clinical biochemistry laboratory diagnostics in the Clinical Center in Nis there are problems, which lead to 8 large wastes, which are common in health care. A particular problem arises in activities receiving samples for laboratory examination and admission of patients who make samples for testing. Currently available space for all kinds of activities in the process seems to be not sufficient to require a detailed analysis to better use of existing space, before moving on to search for additional space.
The doctors and staff who work in the clinical biochemical laboratory diagnostics, a large part of their working time is in administrative tasks that do not add value.</td></tr>
<tr><td colspan="2">Results
1. Develop a process map of the current state and future state of the process of clinical biochemistry laboratory diagnostics.
2. Develop a value stream map of the current and future state of the process of clinical biochemistry laboratory diagnostics.
3. Develop and implement a new standard work for the process of clinical biochemistry laboratory diagnostics.
4. Develop a worksheet analysis of prevention; it appears to prevent errors in any change process.
5. Train new staff for the new standard. Implement a 5S program at the Center for Medical Biochemistry.
6. Document the improved process of clinical biochemistry laboratory diagnostics.
7. Monitor the changes (and adjust if necessary) to ensure that changes are controlled and maintained over time.</td></tr>
<tr><td>Assumptions
Number of laboratory testing will increase in the future at a rate of 10% per annum.
Management of the Clinical Center of Nis and the staff at the Center for Medical Biochemistry will support change.</td><td>Risks
The staff of the Center for Medical Biochemistry will not follow the new standards.
Some stakeholders will not support change.</td></tr>
</table>

Internal problems	External problems
There is good communication between doctors with clinics and in the Center for Medical Biochemistry. Insufficient space available to the Center for Medical Biochemistry. Poor maintenance of the installation of the maintenance services at the Clinical Center of Nis. Adoption of samples for laboratory testing directly in the area of laboratory testing, and not in a separate room specifically.	Lack of understanding of the community for the necessary resources at the Center for Medical Biochemistry. Public pressure and the ugly image that creates the Center for Medical Biochemistry, in cases where there are any nonconformance.
The time frame for the project: The project is to be implemented in the period from 10.06. - 31.12.2012.	
Location / Review #	Confidentially

Since the selected process, improvement team was formed and defined charter that joined the Lean implementation of the project. The first step was to map the process using the SIPOC model. Process map allowed the team to walk through the process and to "see" and register wastes. Having identified wastes in all activities of the process, team members were able to join the search for Lean tools that allow for the reduction or elimination of wastes.

PROJECT LEAN IMPLEMENTATION

Map the process of clinical biochemistry laboratory diagnostics

Team Lean implementation project with author of this paper made a process map of clinical biochemistry laboratory diagnostics using SIPOC model and corresponding software (Figure 1).

All the activities in the process, including input and output files, and resources required for each operation, described by team members who know the process. Thus was created a manual on the process of clinical biochemistry laboratory diagnostics. This document describes the current state of how the process works. Future state process which tends to lean project team obtained after a detailed analysis of the existing processes using Lean tools.

Identify wastes in the process

Team members for the Lean project very quickly learned to "see" through waste glasses with the right metrics. This allowed them to identify the most wastes, which occur in the activities carried out, as well as in the workplace where they work. They recorded their observations in the forms prepared for it (Table 2 – only one part of form).

Workplace: CZMB KC Nis
Filled: Dr. Vladan Cosić
Date: 05.10.2012.

Table 2 Observations form

The observed wastes	Which of the 8 wastes?	Lean concepts to improve
Lists and blood samples that come for treatment are not adequately labeled; filled, missing all the relevant data, make them occasionally non-medical staff. They are often required analysis to inadequate paper, confusing and unclear written, changed order of analysis in relation to the normal order.	Errors, defects	5S Standard work Heijunka Redefine the standard form for the lab. list
Irrational indicating analyzes that do not follow the requirements of clinical protocols. Request for newly analysis for patients that have been processed, usually when moving patients from one clinic to another, since it does not follow the history of disease. In monitoring patients required repeat all the analysis done in the first act, and not just those that are indicated in suspected a disease.	Overproduction Over processing Underutilizing capabilities of people	5S Standardized work Kanban Pull system

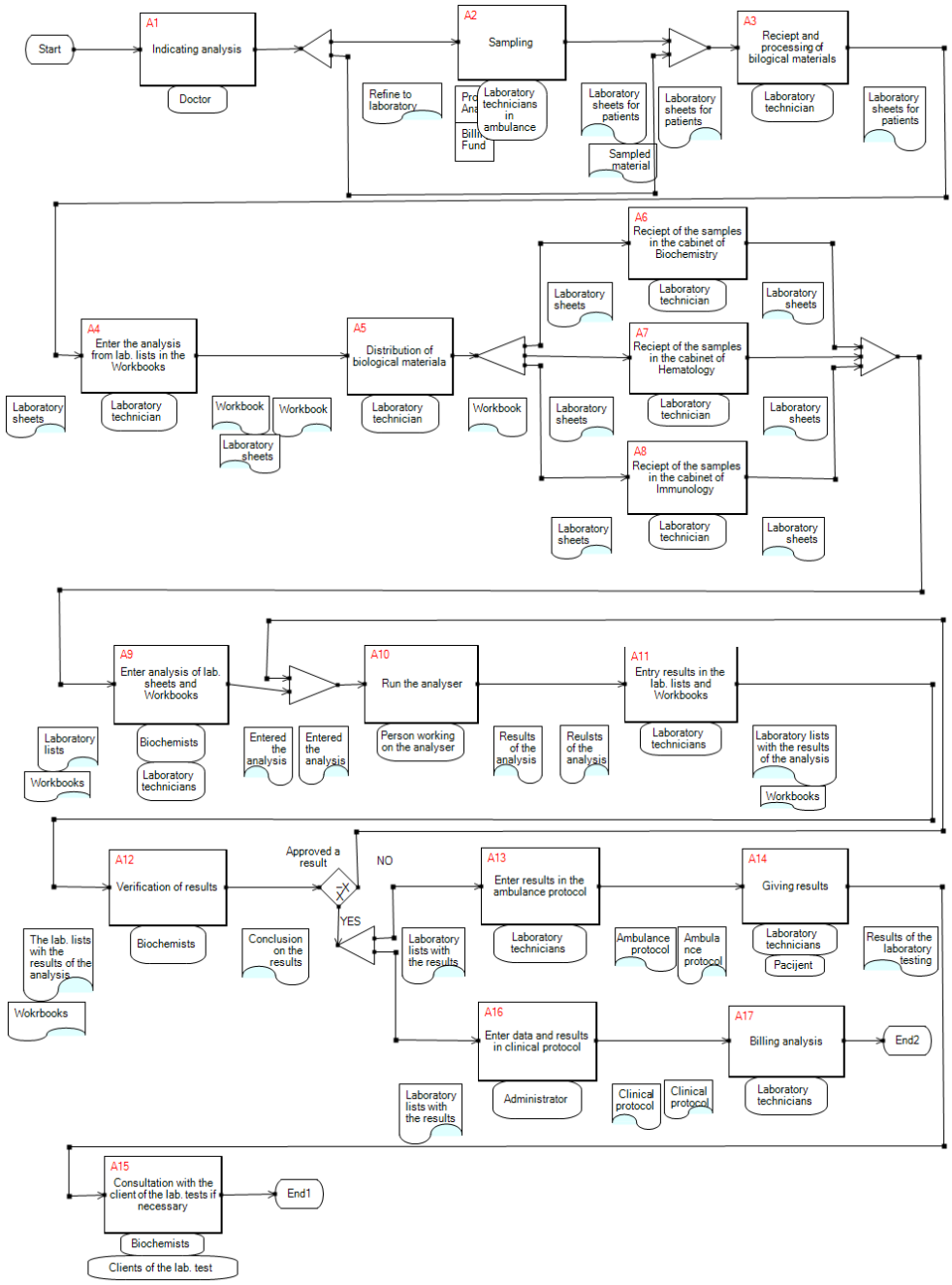

Figure 1: Process map of clinical biochemistry laboratory diagnostics

As identified wastes in the process and a Lean tools for reducing or elimination, the team passed the necessary training for 5S and Kaizen event (Masaaki Imai, 1986).

5S Kaizen event

Extended team has implemented 5S Kaizen events to improve the process of clinical biochemistry laboratory diagnostics (Thomas L. Jackson, 2009). The team had the meetings, from preparation to implementation, and concluding Kaizen events. The process of preparing the event lasted 3 weeks, 3 days in the realization of the fourth week of activities and follow-up 4 weeks after held Kaizen events.

For the implementation of 5S Kaizen events author of this work and team sponsor prepared a charter (the same is not shown by the scope of the paper).

The team members are properly trained and prepared. They accepted to engage in Kaizen event without any resistance, on the contrary, with enthusiasm. 5S Kaizen event was realized from 27-29.11.2012.

The atmosphere in the team work is best seen in the photographs in Figure 2.

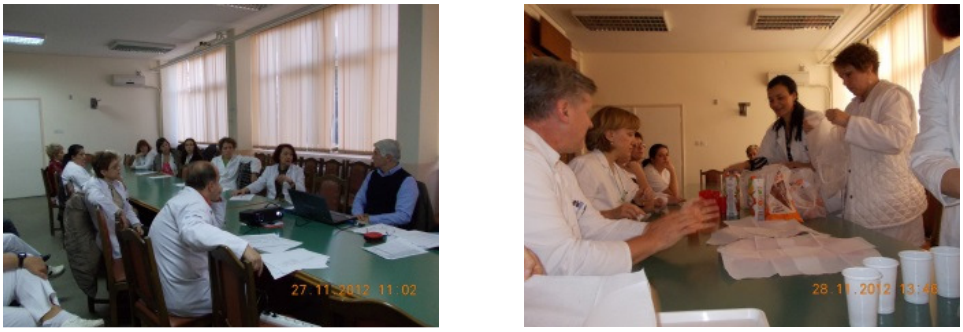

Figure 2: Team work during 5S Kaizen Event

The schedule was prepared every morning and team going training, and then realized by one of the 5S. Team first works on sort and placement of red labels on items for which the team members felt that there is no place where they are. Parts marked with red labels are shown in Figure 3.

Figure 3: Parts marked with red labels

Featured items are sorted into three groups: one group of subjects was separated in a museum of old devices; the second group of subjects, who were still usable, was intended for healthcare facilities in smaller cities such donations; the third category is sent to the store for wastes. Highlighted items filled two trucks. Some of them were more than 10 years out of use and only took up unnecessary space.

Figure 4 shows the appearance after the 5S Kaizen Event.

Figure 4: After the 5S Kaizen Event

The results achieved in the 5S Kaizen event

1. Removed all items and equipment that have been marked with red labels.
2. Exempt spaces that are occupied unnecessary items and equipment and received more than 30% of the available working space.
3. Have been made some changes to schedules to reduce unnecessary movement of laboratory technicians.
4. Designated locations for equipment located in the offices of the examination.
5. Each thing takes its place and markings.

6. Improved hygiene at the Centre for biochemical tests.
7. Increased employee satisfaction.
8. Introduced a five-minute 5S campaign that covers all laboratories at the Centre for biochemical analysis.
9. Defined the list of items for 30 days after the action 5S Kaizen Event
10. Started the process of creating a Kaizen mind

Reducing waiting times for taking biological material

To reduce the waiting time for taking biological materials form patients were used Lean tools: Heijunka and SMED - Single-Minute Exchange of Die.

Heijunka is a Japanese term to describe a "balancing - the leveling of production." The difference between "balancing demand" and "balancing production" is important because we cannot control demand (we do not know how many patients need to take biological material in a single day). What we can control the rate of loading - information, supplies, raw materials, semi-finished goods and meet the demand and actual production.

Single Minute Exchange of Dies - change tools in a minute is a philosophy where the goal is to reduce all settings - change in less than ten minutes. SMED helps to achieve lower costs, greater flexibility and higher throughput (many patients go through specialist clinics, a large number of samples go through the testing process, etc.).

Prior to the implementation Heijunka and SMED was made observations duration of each task in the process of taking biological samples from patients in the ambulance.

Worksheet to reduce the time changes in the activity of taking biological material from patients in ambulance of the Center for Medical Biochemistry KCN is given in Table 3. In this worksheet lists all the tasks and recorded during these tasks. These tasks are initially were internal tasks.

In the ambulance of CMB is sampled biological material for patients who are sent specialists from Clinical Center Niš and doctors in primary and secondary health services and Nis region. The admissions department works from 7am to 14h every day. Patients were admitted to the reception desk CZMB with health card and instruction. One of the 5 laboratory technicians, who work in the receiving outpatient CZMB, takes cards and instructions.

Laboratory technicians were arranged in the shape of cells in the table, which is one of the best schedules recommended by the Lean concept.

The problem was that the laboratory 3 working much longer their activity in relation to other laboratory technicians. After the observation time of each of the lab technician for more patients, we concluded that the laboratory 3 bottleneck (Figure 5).

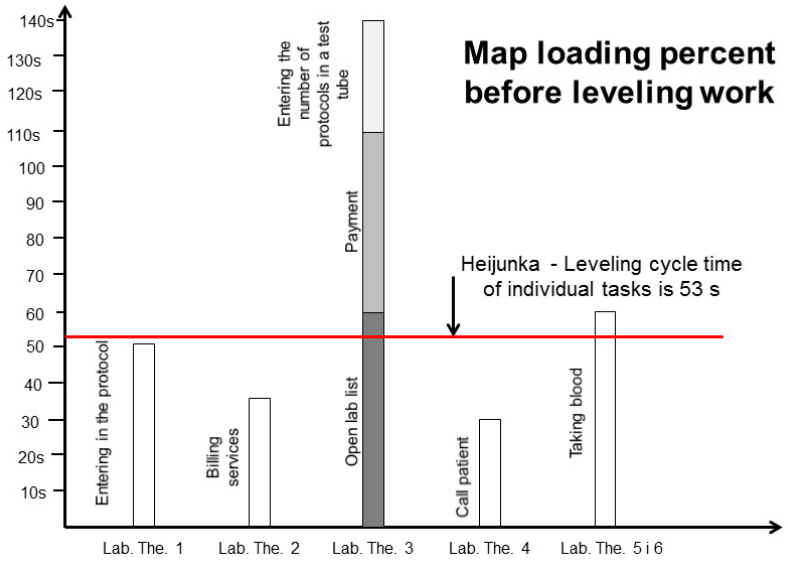

Figure 5: Map loading percent before leveling work

After removing the bottleneck in the process of working where 5 lab technicians, remained a problem in the lab for blood. After removing the bottleneck in the process of working where 5 lab technicians, remained a problem in the lab for blood. Time of blood sampling from one patient to start taking blood from another patient was greater than 6 minutes. In fact, since the complete withdrawal of blood from the patient, he needed time to preparing to go. Only when the patient left the lab was invited the next patient. This patient also needed time to prepare his or her for taking blood. Meanwhile, laboratory technicians are sitting and waiting for the patient. That was waste.

To save time to replace the patient we decided to move internal activities to external. This means that the two patients enter in the lab when two patients were on a chair to give blood. While lab technicians took blood from 2 patients, the other two patients were prepared for blood give. Thus, changing time reduced to 5 seconds.

These changes enabled the time from the patient come until he or her go out of the lab is about 4 minutes. Before the application of Lean tools that time was more than 16 minutes.

Reducing the time was 75%. After improvement of the process two patients go out of the lab every minute (two lab technicians working in Laboratory). No more waiting, no crowds in front of the ambulance.

Above example shows that it is possible has a space without building new one and shorten the cycle time. Once this is done many will understand that it is not necessary to building new premises or purchase new equipment. This required only training people to work on improving processes using Lean concepts. Investment in training is much lower than the profit.

Reducing samples testing time

Biological material taken from patients at one of the 25 clinics in the Clinical Center Nis sent to the Center for Medical Biochemistry (CMB) at testing every day, seven days a week. To send samples used classical PUSH approach, that is, with each clinic, without any order, nurses or even non-medical personnel bring samples in the CMB. This leads to a large variation in the process of sending samples for testing. In some periods of time CBM has more samples than can be tested, and in some periods has little samples, people and equipment are not used enough.

To get an idea of the variation in bringing samples in the CMB clinic during the day, 30-day data were collected. Made the form in which they were listed all 25 clinics, the date for which data is collected and the time when the samples of 07-24 hours, every hour (Stojiljković, 2013). Based on the data collected has been done control chart for bringing samples from clinics for 30 days (Figure 5).

Figure 5 shows that the control limits range from LCL = 79 to UCL = 354 samples. It is a very great variability. C_{pk} = 0.8133, which is significantly less than 1.33, which is an acceptable minimum process capability (Michael L. George and another, 2005).

Another important question was what time of day coming up samples. To answer this question, collected data, as shown in Figure 5, were entered into the program for the Pareto diagram. The processed data via Pareto diagrams are shown in Figure 6.

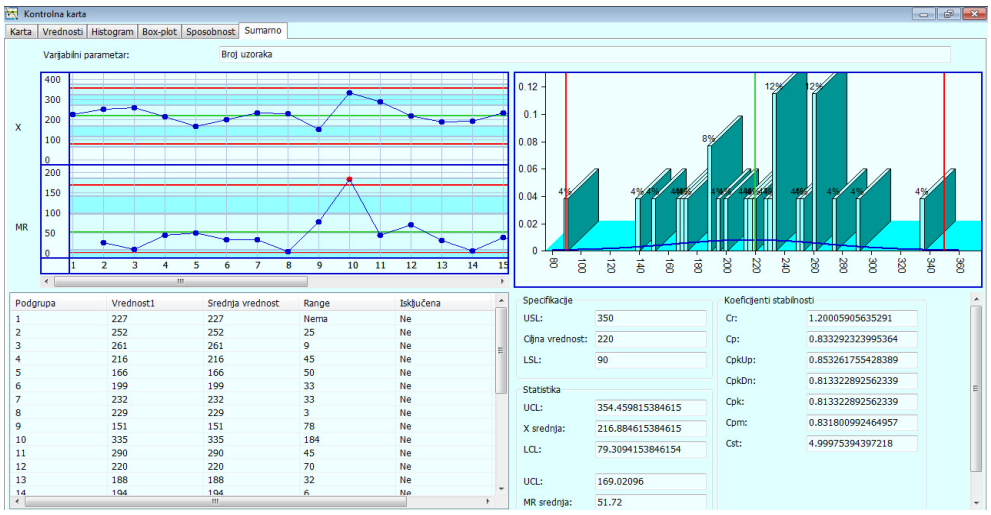

Figure 5: IMR control chart

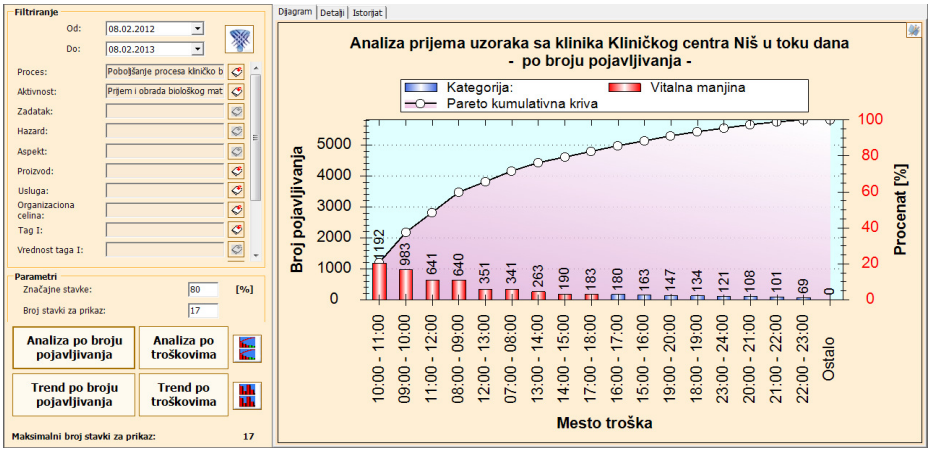

Figure 6: Pareto analyses of samples bringing to the clinic during the day

To reduce the time it took yet another analysis: from witch clinic are brought more samples. The data that were collected 30 days allowed to be processed through the Pareto diagram and give us the required analysis (Figure 7). The Figure shows that most of the samples come from KKVB, KGA, KOHR ... From 10 clinics coming 80% of all samples, and from 5 clinics as much as 54%. This shows the clinics on which we need to focus in order to reduce testing time samples. These are the top 10 or top 5 clinics.

Since we mapped the situation as-is-as, collected and analyzed data from processes using Lean tools, we were able to access the value stream mapping (Stoiljković, 2013).

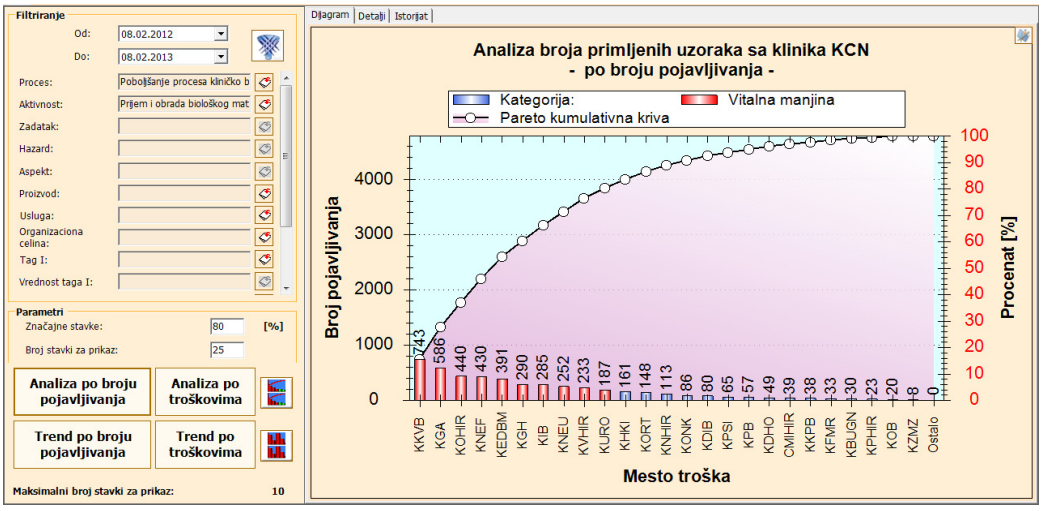

Figure 7: Pareto diagram receiving samples from the clinics KCN

We mapped first current value stream map (Figure 8). More details of the recording value stream map are given in the literature (Stojiljković, 2013).

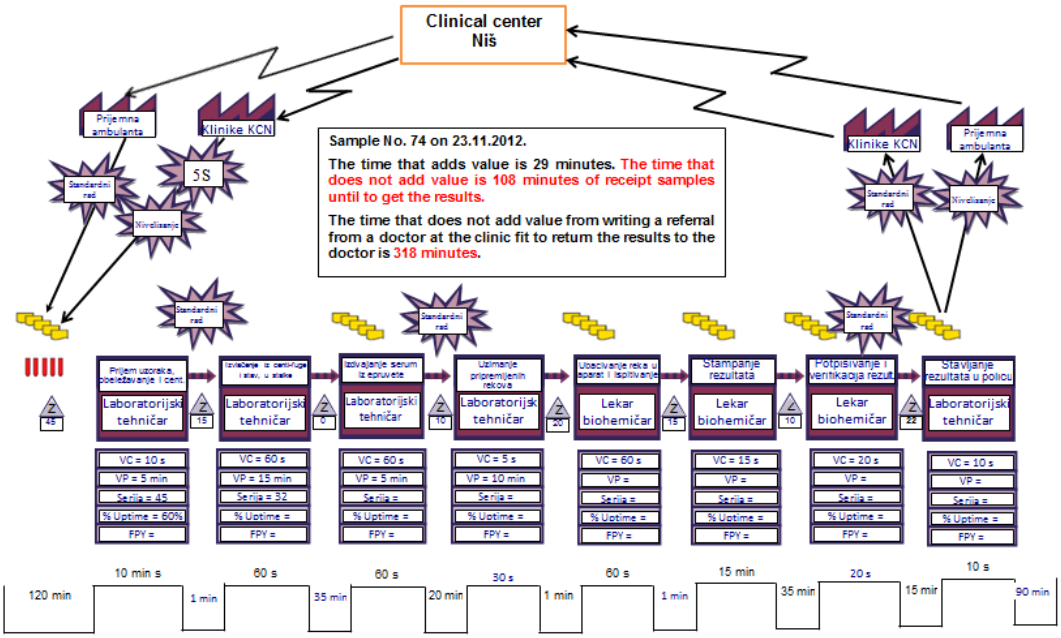

Figure 8: Current value stream maps of the process testing samples in CMB

The flow of information on the value stream map is a line with an arrow pointing to the passed information. The dashed line with an arrow between the steps is the pushing process arrow. This shows that at the end of one step of the process tubes pushed to the next step (the same would apply to the patient). This is inefficient. Change steps of pushing in a continuous stream or pulling action (this is the basic principle of Lean) can be created more efficient process.

Lead time from receipt of samples at the receiving laboratory to obtain results (Figure 8) is 108 minutes, and since that time has added value only 29 minutes. The difference between 108 minutes and 29 minutes is a waste of time and what the patient would be willing to pay to have a choice.

If you move the observation time and is counted from the moment the specialist doctor wrote a referral laboratory, by the time he got the result, we get a more unfavorable result for lead time and it is 318 minutes or more than 5 hours. The value adds time is only 29 minutes. Such a waste is a great opportunity to put forth the effort and improve the process of taking samples and pulls through the process of laboratory testing. This was done.

The analysis of the existing process of biochemical laboratory diagnostics and perceived waste in the process at all, the need arose to introduce 5S tool in the Center for Medical Biochemistry. This was done November 2012th Year, when implemented 5S Kaizen event in CMB.

The next opportunity, which noted team to process improvement, was leveling taking samples from the clinics. In addition, standardized work in the laboratories, then work on taking samples from clinics and other tasks which were taken to be standardized in order to ensure a stable testing process.

The biggest change is made when a system of pulling between the steps of the process. Specifically, in the future state value stream downstream from the upstream step entails steps samples when needed and in the quantity that can be processed.

When done all of the above, we were able to get future state value stream map (with unchanged steps, but much faster). The future value stream map in the biochemical laboratory diagnostics is shown in Figure 9.

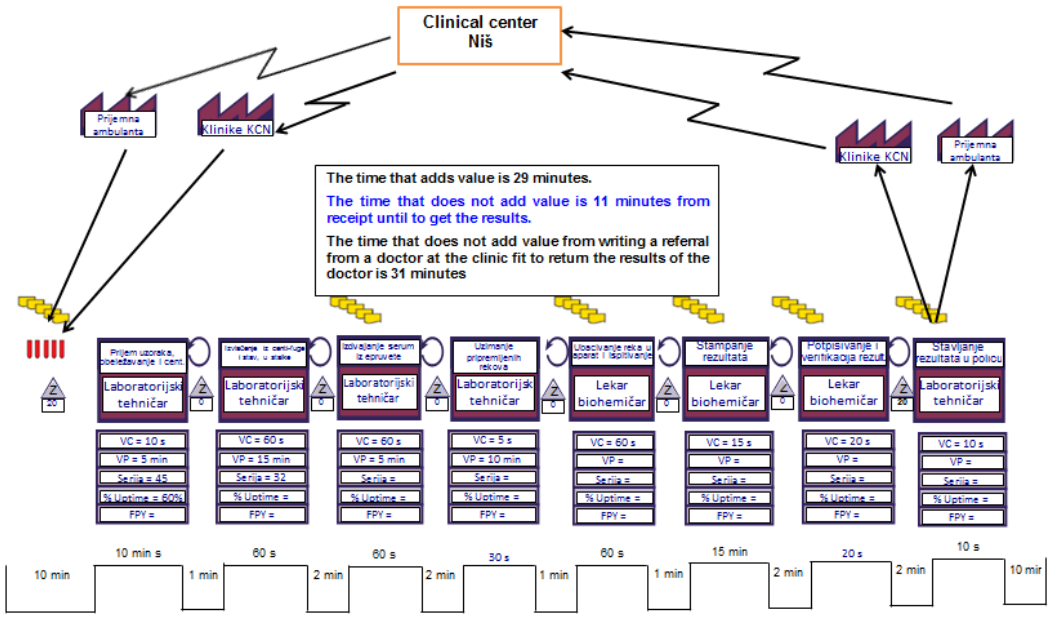

Figure 9: Future value stream maps of the process testing samples in CMB

Comparing the current value stream map (Figure 8) and future value stream map of the process of biochemical laboratory diagnostics (Figure 9) there is a huge improvement. Time, which adds value, didn't changes in the future state and is 29 minutes, but so significantly reduce the time that does not add value from 108 minutes to just 11 minutes. If the process is considered from the moment when the doctor left the referral laboratory in a box for balancing taking samples, by the time he got the result, we see that the obtained even greater improvements. Specifically, in the future value stream map specialist gets results in less than 60 minutes from the time the specimen was taken from his clinic.

CONCLUSION

Implementation of Lean projects 01/2012 and 02/2012 at the Clinical Center of Nis has shown that professors, doctors and nurses very determined efforts to improve the processes in which they now operate. All those involved in the implementation of these Lean projects were committed and engaged in identifying waste and finding ways to reduce the wastes or removed. It was a pleasure to watch all these wonderful people who selflessly engaged in this engagement he felt proud, because they contributed to the creation of better working conditions, as well as providing better care to patients in their care.

To Lean projects were successfully implemented is not enough, just the dedication and commitment of team members. The main lever that moves people are the leaders, who point to the path that needs to go in order to ensure the survival of the health institutions in the difficult times through which the health care industry is going.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Kanban System Between Warehouse and Production Lines in Automotive Industry in Lames d.o.o.

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ABSTRACT

Lean production cannot be established without smooth raw material flow between warehouse and production. Optimal stock replenishment of raw material in production shelves has to be assured in order to maintain continuous process without any stoppages and material shortages. In this paper kanban system of material flow will be presented as real system with classic kanban cards in Lames d.o.o. The company is in the area of automotive industry producing electrical and manual window lifters for cars. Two completely identical kanban systems do not exist in reality because it has to be adjusted to specific situation in specific company. In this case, specific system of kanban cards and kanban lots calculation will be presented taking into consideration production capacities and raw material packaging sizes. It will be also analyzed in which situations it is impossible to implement kanban system and how this situation is managed in order to assure continuity in production. Complete material flow from warehouse to production, warehouse keeper activities and empty packaging flow to opposite direction will be described. The structure of kanban card will be explained as well as its flow in order to assure process without any loss of cards which can be dangerous for functioning of complete system. Usage of kanban system in production process material stock levels are always on optimum level and this will be proved in this paper as well as in real system functioning in the real enterprise.

KEYWORDS: kanban, lean production, raw material flow, optimal stock

INTRODUCTION

Lean manufacturing has become leading industrial trend in the past few decades. In order to increase its competiveness and decrease costs, companies are streaming to keep their inventory levels reduced to a minimum while keeping excellent performance and quality of the production (Lavoie, et al., 2010). Pull-type production control mechanisms are widely used in automotive industry to control flow of material within the system. Kanban system is the most famous system as one of pull-type mechanisms generally used in automotive industry.

Lames d.o.o. is new green field automotive company in Serbia, part of the larger group with several factories located on three continents. The main products of the company are manual and electric window lifters for automotive industry. Lames group is supplier of many major car producers all over the world.

Demanding clients request high quality levels not only for product but also for all processes and organization of their direct suppliers. Lean approach is inevitable in order to achieve such standards.

One of the projects establishing new company was organization of the raw material flow between warehouse and production line. Like in many automotive industries, kanban concept is mostly used as the best concept for this type of lean production organization.

The main goal was to establish such system which will guarantee optimal stock replenishment of raw material in production shelves without any material shortages which could put in danger production continuity. In the same time, due to limited space in production, excessive stocks would be unacceptable.

Since warehouse software and SAP modules for finished products and production planning do not support electronic kanban, it was possible to implement classic kanban using cards. Production area consists of three production lines and three subassembly lines used for production of 24 different types of window lifters.

CALCULATION OF CONTAINERS

Before start of kanban implementation several parameters have to be defined, such as desired level of stocks in the production selves. In our case this level was supposed to be between 2 and 4 hours of production. This means that complete stock replenishment (stock turnover) will occur minimum two times during one production shift. Another important thing is capacity of the line. The higher capacity requires more material in the flow and the vice versa.

In order to define number of containers (kanban cards) which will be used in kanban cycle several other parameters have to be considered. Type of the packaging and quantity in the packaging are the last parameters needed for calculation of quantity of kanban cards needed.

The final formula for quantity of kanban cards is the following:

$$N = (T_{max} \times Q_{cap} \times Q_{bom}) / Q_{pack} \quad (1)$$

N – quantity of kanban cards needed

T_{max} – maximum production time covered with raw material in production shelves

Q_{cap} – quantity of finished product produced in one hour

Q_{bom} – quantity of specific material contained in one finished product

Q_{pack} – quantity of material in the packaging

In case that final result is decimal number, that number should be rounded up.

Taking real example for metal shaft, which is packed in carton boxes containing 250 shafts, for production capacity of 225 final products per hour, each final product contains one metal shaft, and maximum stock coverage of 4 hours calculation would be the following:

$$N = (4 \times 225 \times 1) / 250 = 3,6 \quad (2)$$

Round up 3,6 = 4

N = 4 kanban cards needed for stock replenishment of production shelves for metal shafts. Since packaging contains 250 pieces, maximum quantity on the production shelf can be 1000 metal shafts (4 x 250).

In the similar way we can calculate minimum quantity (safety stock) in the production for that material. Previously defined minimum stock for 2 hours of production would be calculated with the same formula:

$$N_{min} = (T_{min} \times Q_{cap} \times Q_{bom}) / Q_{pack} \quad (3)$$

$$N_{min} = (2 \times 225 \times 1) / 250 = 1,8 \quad (4)$$

Round up 1,8 = 2 (5)

N_{min} = 2 kanban cards as minimum stock, or 500 pieces of metal shaft (2 x 250)

The kanban calculation of the materials for one finished product can be seen in software application form as well as in the picture below (Fig. 1):

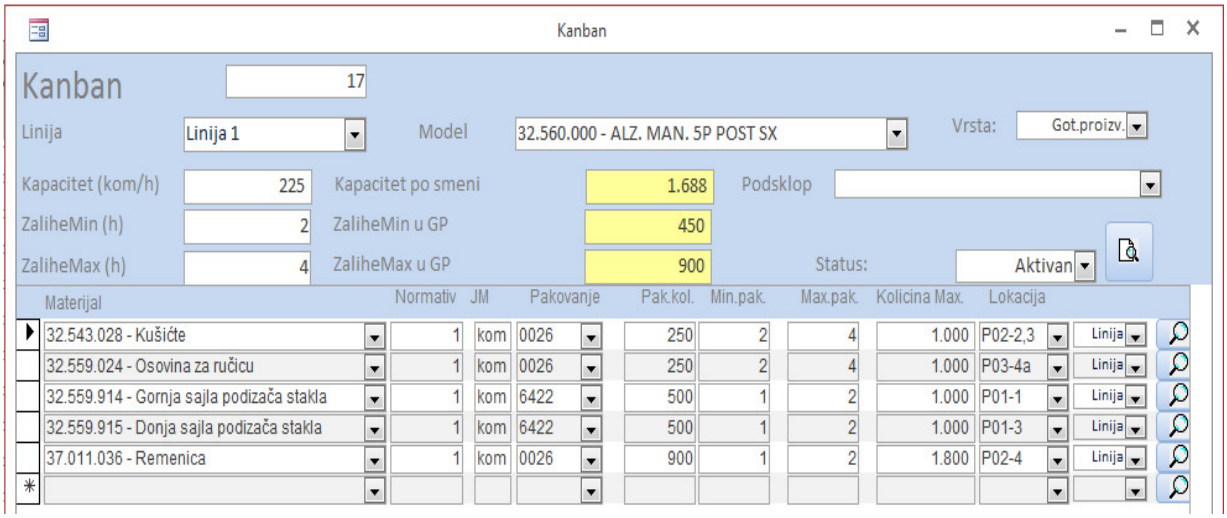

Figure 1: Kanban calculation of materials for one finished product

After calculation of quantity of kanban cards/containers, all elements for creation of kanban cards are available. These cards follow kanban containers on their way between warehouse and production until consumption of all material in them to feed the production process. The picture of one kanban card is presented below (Fig. 2).

Kanban card contains many useful information such as: material code, the name of material and location of the shelf in the production. The card contains card number and total quantity of cards for specific material. In that way it is easy to check if some cards are missing and to establish FIFO (first in first out) system for material consumed in production.

Useful information that can be found on kanban card are also supplier's name, type and dimension of packaging, total quantity in the packaging, minimum and maximum number of containers that can be placed on the shelf in the production.

Very useful information for operators on the line is information for which production models the material is used. That reduces mistake of the operator to install the material in the wrong type of product. The picture of the material on the cards reduces possibility to associate any material with the card that does not belong to it. Further to make easier for the operators, cards for different type of products are printed on the different colour paper. If material is used for more than one type of product, its card is printed on white colour paper.

Figure 2: Kanban card

Kanban cards are printed on both sides of the paper and plasticised. Printing on both sides eliminates the need for turning over the card in order to read the information on it. That saves the time for operators and warehouse keepers. Plasticisation prolongs life time of the card and reduces possibility to get dirty and reduce visibility of information printed on the card.

THE FLOW OF KANBAN CARDS

The flow of kanban cards starts in the warehouse. In accordance to FIFO system, warehouse keeper associate each card with one packaging (container) of specific material. Each card is usually placed in the box with material and together transported to production shelf.

After container is placed on specific shelf in the production, with the same shelf code as specified on kanban card, the material is ready to be used in production process.

The operator on the line uses the material from the container without removing kanban card placed inside. The card can be removed out of the container only after it is completely empty. That card is then hanged on specific place on the front of the shelf. This is automatically signal for warehouse keeper that replenishment is needed.

Warehouse keeper collects the free cards on the shelves, takes them into the warehouse in order to prepare new containers with material and place the cars inside. Such containers are transported to production and this is how stock replenishment with kanban cards works.

THE ADVANTAGE OF NEW KANBAN SYSTEM

After the implementation of kanban cards in Lames d.o.o., many benefits were recognized. Raw material stock control on production shelves was improved. As result of kanban cards implementation the stock was constantly on optimal level between 2 and 4 hours of consumption in production. Out of stock situations were practically eliminated because of improved communication between warehouse keepers and material needs presented with free kanban cards on the shelves. Excessive stock on production shelves was not possible because number of containers is limited by quantity of kanban cards.

In previous system warehouse keepers spent much more time monitoring situation on the shelves, checking each shelf, writing material codes and defining quantity that was supposed to be replenished. Such activities were time consuming and occasionally out of stock situations occurred following frequent communication between warehouse keepers and operators on production lines.

Using kanban cards communication between operators and warehouse keepers does not exist anymore. Free kanban cards are new means of communication. Production operators do not have to monitor material stock levels and can focus on production process.

Stock replenishment done by warehouse keepers now is significantly simplified. There is no need for writing any information on piece of paper about quantities needed, material code and position of the shelf on the production flour. All information needed is written on free kanban card. With that card warehouse keeper can go directly to ware house to pick up specific material and to return to the position specified on the card.

CONCLUSION

In accordance to Lames d.o.o. statistics out of stock situation occurred two times in the shift in average. Now these situations were eliminated. Manpower need was reduced as well. In previous system 3 warehouse keepers were able to provide stock replenishment for 3 lines. Using kanban cards 2 warehouse keepers are enough to perform the same activities.

There aren't two identical kanban systems. Each kanban system is tailor made for a specific company. It has to be adjusted to company specific needs and to support material flow and control in the best possible way. Some authors say that kanban is an easy concept to understand and very difficult to implement in the proper way (Louis, 2006).

In some cases only part of material can be included in kaban system. In our case there are also some materials which are out of this system due to some specific reasons. For example window lifter motors due to big packaging and lack of space on the production flour are excluded from kanban. In order to be implemented, at least two cards (containers) should exist for a material, but packaging of motors is too big and only one box can be located nearby production line.

ACKNOWLEDGEMENTS

The authors acknowledge the support for research project TR 36030, funded by the Ministry of Science and Technological Development of Serbia.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Lean Job Shop: Kanban Alternatives for Make-To-Order Environment

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ABSTRACT

This paper analyzes the applicability of Kanban in Make-To-Order (MTO) environment, and reviews production control alternatives more suitable for this type of Industry. The analysis shows that there's a number of production control systems that can cope more easily with demand variability, product and routing complexity, and lack of repetition, in an attempt to create lean shop floor. The paper also outlines key areas for future research, where empirical research into described production control systems is highlighted as the most important one.

KEYWORDS: production control, lean, make-to-order, job shop

INTRODUCTION

Differentiation by sheer quality is no longer sufficient for gaining and maintaining competitive position on the market. Delivery reliability and delivery time have established themselves as important buying criteria, alongside quality and price. High delivery reliability and short delivery times for companies demand high schedule reliability and short throughput times in production (Kim and Duffie, 2005). The logistic costs depend on low WIP levels in production and high utilisation of operational resources. Production control plays a significant role in establishing lean and effective production system.

There's a vast number of alternative approaches that claim to be universally applicable in all kinds of production environments. However, this universal applicability can also mean that some industry-specific needs are not properly met, especially in MTO environment (Stevenson et al., 2005). If a MTO company goes for a "one size fits all" solution without analyzing specificities of a business sector that it operates in, wrong choice of a production control system can be very expensive mistake, having in mind that implementation can be costly and time consuming. MTO sector is increasing in importance, since growing need for customized products on the market (Slomp et al., 2009). MTO companies face many problems with planning and controlling the flow of material on a shop floor. That's why choosing the appropriate production control system is of the outmost importance in an attempt to create lean shop floor. Kanban, Constant Work In Process (CONWIP), Paired cell Overlapping Loops of Cards with Authorization (POLCA), Workload Control (WLC), and Decentralized WIP Oriented Manufacturing Control (DEWIP) will be analyzed in this paper.

The remainder of the paper is organized as follows: Section 2 analyses the specificities of MTO sector; Section 3 criteria for evaluating production control alternatives; Section 4 reviews different production control approaches; Different approaches will be compared to each other in Section 5; after that, a short conclusion will be presented and further research areas will be outlined.

SPECIFICITIES OF MTO SECTOR

The three fundamental elements that make it difficult to control MTO realities are: (i) the dynamicity due to volume and mix fluctuations; (ii) the uncertainty related to product specifications; (iii) the complexity of products flow (Kingsman et al., 1993a; Land and Gaalman, 1996). Product specifications are usually unknown until a customer formulates a request and, even after the order has been confirmed, they can vary during the processing phase.

Stevenson et al. outline following MTO characteristics (2005):

- Customization – customization leads to non-standard product routings on the shop floor, which can lead to longer lead times than for MTS companies; lack of parts commonality and variable job routings add to the difficulties of planning and control; Regarding customization, MTO company can be classified into two types: Repeat Business Customisers (RBC) and Versatile Manufacturing Companies (VMC) (Amaro et al., 1999);
- Shop configuration – paper considers Pure Flow Shop (PFS), the General Flow Shop (GFS), the General Job Shop (GJS) and the Pure Job Shop (PJS). However, shop configuration is unlikely to lie at one of the extremes (Portioli, 2002). The key difference between the job shop and the flow shop is the direction of material flow; in reality, a dominant flow direction usually exists (Oosterman et al., 2000);
- Company size – high proportion of SMEs in customized industries means that accessibility to companies with more limited resources is an important factor in the applicability of production control approaches to many MTO companies;

These specificities will be used in developing a list of criteria for analyzing the applicability of particular production control system in a MTO company.

CRITERIA FOR EVALUATING PRODUCTION CONTROL SYSTEMS

The benefits of lean shop floor have been extensively presented in Just-In-Time (JIT) and Toyota Production System (TPS) literature. Kanban is one of the most important components of TPS. It is a pull production system that prevents allocating inventory too early to the consumers, be it downstream work stations or customers. Before defining criteria, it would be beneficial to define a pull system. Ohno (1988) identified pull system as a supermarket, emphasizing the strategic connection between the demand and production. Womack and Jones (2003) lowered pull to a tactical level, stating that pull means that no one upstream should produce a good or service until the customer downstream asks for it. Hopp and Spearman (2008) state that a pull system establishes an a priori limit on the work in process while a push system does not. This definition will be used in this paper, and will be crucial for defining criteria for evaluating production control systems.

One of the main features of Kanban is its relative simplicity. Since Kanban will be used as a reference point when analyzing the applicability of other approaches, the simplicity will be added to criteria list when evaluating Kanban alternatives. Moreover, it is argued that managers like simplicity, and that success of production control system implementation depends on its simplicity (Thürer et al., 2011).

Having in mind specificities of MTO sector, and some characteristics of Kanban (Kanban will be discussed later in more details), the list of following criteria can be used for evaluation:

- Ability to cope with non-repeat production;
- Ability to cope with routing variability;
- Ability to control and balance WIP;
- Applicability in SMEs;
- Simplicity.

KANBAN AND KANBAN ALTERNATIVES FOR MTO ENVIRONMENT

Since Kanban will be used as a reference point when analyzing the applicability of other approaches, it will be shortly described, and its applicability to MTO sector will be analyzed. After that, Kanban alternatives will be presented.

Kanban

Kanban is well established card based production control system that aims to control WIP and flow times. It is an important part of Toyota Production System (Ohno, 1988). There are several variations of Kanban, but in its pure form the cards are part specific. Kanban (Schonberger, 1983; Karmarkar, 1989) and Kanban variations (Tardif and Maaseidvaag 2001; Dallery and Liberopoulos, 2000) have been researched extensively. The basic idea of Kanban is that a workstation produces what a downstream (subsequent) workstation has consumed, thus preventing overproduction. Kanban is decentralized system, with control decisions delegated to foremen and workers. It relies heavily on visual management, by providing visual clues and information about what should be done.

Kanban requires a thorough redesign of production (even products) before implementation. Some of prerequisites for Kanban implementation are short setup times, one piece flow (if possible), controlled production process, etc. Once these prerequisites are met, Kanban implementation is very simple. Although it requires thorough planning, implementation itself is very intuitive and straight forward. The flow of information is regulated with cards, and it doesn't require a computer based information system.

This simplicity might make Kanban interesting to MTO managers, since most MTO companies prefer simple solutions not requiring more than spreadsheet support (Muda and Hendry, 2002). However, Kanban has been developed primarily for repetitive production, and cannot cope with product mix and routing variability which is predominant in MTO sector. Also, Kanban requires minimal fluctuations in the demand rate, which is a rare case in MTO industry. Still, Kanban's low applicability in MTO industry doesn't mean that other aspects of TPS couldn't be applied, especially attitude towards waste and inventory. Besides that, Kanban was used as a reference point for developing other, more general card based production control systems, which will be presented in the remainder of this paper. Some Kanban principles are used with production control systems which are not card based in its pure form, and were developed especially for MTO companies.

Constant Work in Process – CONWIP

Since its introduction more than a decade ago, the CONWIP production control system has received a great deal of attention from practitioners and researchers. It has been introduced as an attempt to present a pull system more flexible than the current pull paradigm, the Kanban system. It is a card based concept similar to Kanban, but designed to be applicable in a wider range of production environments (Spearman et al., 1989; Spearman et al., 1990). The procedural rule for CONWIP is as follows: new order for a production line is released as soon as WIP level falls below WIP limit. Unlike Kanban, which is part specific system, CONWIP is job specific system in its original form. Since CONWIP requires definition of only one parameter, which is WIP for the entire system, it is easier to model and optimize (Gaury et al., 2000; Tardif and Maaseidvaag 2001).

With CONWIP, the product mix may change and the assumptions concerning the production environment are less restrictive than for Kanban (Zäpfel and Missbauer, 1993). This makes it more appropriate for MTO sector. Generally speaking, CONWIP can be more relevant in general flow shops, while Kanban is most useful in pure flow shops.

Gaury et al. (2000) claim that a disadvantage of CONWIP is that inventory levels inside the system are not controlled individually, and that high inventories can appear in front of slow machines and when a machine breaks down. CONWIP is job specific system, which means that a number of jobs on the shop floor is determined by number of cards in the system. Single control loop connects all work stations which means that CONWIP controls the amount of WIP on the shop floor, but does not balance WIP across workstations (Germs and Riezebos, 2010). Besides that, CONWIP limits the number of jobs on the shop floor, but does not take into account the size of the job (i.e. the routing length or processing times for a certain job), which can affect throughput times.

Paired-Cell overlapping Loops of Cards with Authorization – POLCA

POLCA was developed by Suri (1998) as a part of a wider concept called Quick Response Manufacturing (QRM). Ii is a hybrid push-pull (or pure pull system, according to definition stated earlier in the paper) card based signaling system. It was envisioned as an alternative to both MRP II and Kanban. The system was mainly aimed at organizing production into manufacturing cells, but it is applicable in conventional production environment, in which case it controls the material flow between two workstations. The cards are cell specific, with cards controlling the flow of work between a pair of cells. Each pair of manufacturing cells is allocated POLCA cards, which rotate between them and authorize the production, thus controlling the amount of WIP. Card system can be implemented physically or electronically (Vandaele et al., 2008). Cards can belong to more than one fixed pairing, which allows routing flexibility. Basic POLCA principle is as follows: an originating cell is allowed to process an order when the release date of the order has been reached, and a free POLCA card is allocated to the originating cell and destination cell is available; if one of those conditions is not met, the order is blocked.

Although research efforts related to POLCA are still in its infancy, there are reports of significant results obtained in practice through POLCA implementation, especially with throughput time reduction (Suri and Krishnamurthy, 2003). In POLCAs original form, jobs travel in one direction and information returns in the other, which might not render POLCA appropriate for job shops with high routing variability (Stevenson et al., 2005). However, since authorization signals (cards) are not specific for a single product, but may be used for any product that has to visit the two production cells in the specified sequence, it can be said that POLCA can be used in production situations with a large variety in routings (Riezebos, 2013), but more research is needed on this subject.

Workload Control – WLC

WLC observes a job shop as a queuing system, with jobs arriving at queues in front of each workstation. The queue consists of all jobs that are waiting to be processed at a specific workstation. The main goal of WLC is to keep those queues short and stable, thus making the shop floor transparent and lean. Key component of this system is release decision, which allows a job to enter the shop floor, where it will stay until all its operations have been completed. Basic idea behind this system is to hold back jobs which would be routed through workstations that are already overloaded. This results in a pool of orders waiting to be released. Whilst jobs remain in the pool, unexpected changes to quantity and design specifications can be accommodated at less inconvenience.

The concept was mainly developed in three universities by groups of people working independently of one another: University of Eindhoven and Lancaster University (Bertrand and Wortmann, 1981; Tatsiopoulos and Kingsman, 1983; Hendry and Kingsman, 1991; Hendry and Kingsman, 1993), and Leibniz University of Hannover (Bechte, 1988, Wiendahl, 1995). The approaches developed at these universities differ one from another in some procedural rules, i.e. in a way new jobs attribute to direct and indirect loads of workstations over time (whether they include work queuing at a centre, work upstream, or the work downstream in the measurement of indirect load). This approach was intended to be a simple solution for production control, specially developed with job shops in mind. The concept was researched mainly through simulation of pure job shops. However, as mentioned before, practice showed that job shops rarely have completely undirected flow of material, and that real-life job shops usually have dominant flow of material, in a sense that there is a workstation where a job usually enters the shop floor, there are workstations that are typically "downstream", and that there's an exit workstation. Different approaches have shown different simulation results depending on shop configuration. Still, results of practical application of WLC are relatively scarce. Case studies report improvements in companies that have used WLC, especially in reducing WIP, shortening lead times, and improving due date adherence (Stevenson, 2006; Silva et al., 2006). However, they usually don't offer an implementation strategy that might help practitioners to apply WLC principles.

WLC researchers claim that the system is fairly simple. However, it requires an up-to-date information flow to the release decision maker if workstations have finished working at a work order. This feedback requirement might be hard to implement for a MTO SME, since it can call for sophisticated technology such

as bar-code readers or RFID. A number of software systems have been developed dedicated to computerized support of the WLC concept (Hendry et al., 2006; Stevenson, 2006; Silva et al., 2006). Some recent researches tend to simplify the system by combining it with principles of card-based systems (Land, 2009).

Decentralized WIP-oriented manufacturing control (DEWIP)

DEWIP is based on decentralized WIP control loops between the production's workstations (Lödding et al., 2003). The basic DEWIP procedure is as follows: before operators begin working on a job, they request "go-ahead" from the workstation that will process the job next; the operator of the subsequent workstation decides whether or not to give a "go-ahead" based on the WIP limit; if the WIP on a workstation and the upstream WIP exceed the workstation's WIP limit, the "go-ahead" is refused; otherwise, the "go-ahead" is authorized, and job's work content is added to the WIP account (for a detailed procedure refer to Lödding, 2013).

The concept is still relatively new, and the research regarding this subject is scarce. Simulation results show the sustainability of DEWIP for application in the industry. Lödding (2013) claims that, unlike POLCA, DEWIP can be applied in complex material flows. However, the method has not been applied on the shop floor up until now. Just like POLCA, more (action) research is needed on this subject in order to test DEWIP's applicability in practice.

COMPARISON OF PRODUCTION CONTROL METHOD'S APPLICABILITY IN MTO ENVIRONMENT

Table 1 shows the summary of comparison of different production control approaches' applicability to MTO environment. As it can be seen from the table, none of the candidates completely meets the criteria defined earlier in the paper, but two approaches, namely WLC and DEWIP, have a very high score.

Since CONWIP is more general approach than Kanban, and it doesn't require additional conditions in order for its implementations to successful (short production runs, short setup times, predictable demand, etc.), it is suitable for non-repeat production. It shows good results where there's low routing variability, but can be outperformed by other production control systems (namely drum-buffer-rope, DBR) in production systems with undirected material flow (Spearman et al., 1990). WIP control can be improved if the amount of work (in time units) is used instead of number of jobs is used for measuring WIP. It doesn't require significant material resources, and is fairly simple to implement.

Table 1 Comparison of different production control approaches' applicability to MTO sector

	Non-repeat production	Routing variability (PFS/GFS/GJS/PJS)	WIP control/ balancing	Applica. in SMEs	Simplicity
Kabnan	[-]*	[+] / [-] / [-] / [-]	[+] / [+]	[+]	[+]
CONWIP	[+]	[+] / [+] / [-] / [-]	[+] / [-]	[+]	[+]
POLCA	[+]	[+] / [+] / [-] / [-]	[+] / [+]	[+]	[+ / -]
WLC	[+]	[+] / [+] / [+] / [+]	[+] / [+]	[+]	[+ / -]
DEWIP	[+]	[+] / [+] / [+] / [+]	[+] / [+]	[+]	[+ / -]
* [+] criterion if fully met; [+ / -] criterion is partially met; [-] criterion is not met					

POLCA is suitable for non-repeat production, but more research is needed on whether it supports undirected flow of material. It can control the amount of WIP very well, and system of overlapping loops allows POLCA to balance WIP across workstations. Its card system can be controlled physically, but since cards can belong to more than one fixed pairing it can cause confusion which can increase the complexity of its application.

WLC was devised especially for MTO job shops, and its numerous variants allow for all kinds of routing variability; some are better for undirected material flow, and some are showing better results where material flow is generally or fully directed (Oosterman et al., 2000). The type of approach dictates the complexity of its implementation. Authors claim that WLC is very simple to apply, since job sequencing is done at job release stage, and dispatching on the shop floor can be done by following simple rules such as

First-Come-First-Served (Thürer et al., 2011). However, significant feedback is needed from the shop floor in order for this approach to work properly. Some recent researches are aimed at simplifying the system by combining it with principles of card-based systems, but practical applicability of this combination is yet to be proven (Land, 2009).

DEWIP has been developed solely through simulation. The simulations were done with industry data, and the results show that DEWIP is as effective as CONWIP, WLC and POLCA in controlling WIP and lead times, especially with complex material flows (Lödding, 2003). However, since method has not been applied on the shop floor up until now, DEWIP requires more action research to substantiate simulation results.

CONCLUSION

Kanban is well established production control system, but its application outside of repetitive production has proven to be difficult. There are many production control alternatives that are tailored according to special needs of MTO sector. They can cope better with situations that are characteristic of MTO sector, such as product mix variability, uncertain demand, routing variability, etc. However, it is important to note that there is no single solution that will suit every situation. Different products and different production processes can require the application of different production control concepts. The design of production control system is therefore highly individual in most cases Because of that, these alternatives were analyzed according to five criteria that were devised with needs of MTO companies in mind. New concepts that have emerged in past decades are meeting most of the evaluation criteria. Still, most of them need practical verification through action research. There are case studies that give evidence of successful production control system application, but they are usually focused solely on results that were obtained, and rarely on the implementation process itself, and issues that may arise during the implementation. Recent advancements have been aimed at simplifying production control, by combining the ability of production control system to cope with customized products and different shop configurations with simplicity of card based systems.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Type of Process Problem as Base for Selection of CPI Methodology

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ABSTRACT

This paper is focused on approaches for selection between continuous process improvement (CPI) methodologies and their mutual integration. The most popular CPI methodologies are Lean, Six Sigma and Theory of Sonstraints (TOC). Companies have a problem to recognize which of the CPI methodologies to implement in their processes. Different approaches and criteria for this selection are described. Integrated frameworks of CPI methodologies are also described in paper and they contain phases which include selection of appropriate tools for improvement. According to analysis of approaches to selection between CPI methodologies and their integration, type of problems are recognized as main criteria for selecting the appropriate methodology and tool. This paper includes guideline for selection of CPI methodologies and tools for different type of process and companies problems.

KEYWORDS: Lean, Six Sigma, TOC, business process problems

INTRODUCTION

Constant intensification of global competition and increasing of market demands force both production and service business systems to find new ways in order to preserve and improve its competence and achieve advantage on market in terms of prices, deadlines, quality goods and services (Simeunovic at al, 2012). Abbas & Hosein (2010) said that it is impossible to expand market share and gain competitive advantage, so as customer satisfaction without considering continuous quality and process improvement. The most popular methodologies for continuous process improvement are Lean, Six Sigma and Theory of Constraints. Their origin is in manufacturing environment, but they also have broad application in service environment.

Novak (2006) said that each of these methodologies is very useful, and they all sound like they would help, but no one can't do everything at once. Question is: Where to start and how to decide which methodology to use?

Different approaches and criteria for selection of CPI methodologies were analysed and type of problems is recognized as main criteria for this selection.

Many authors (George, 2002; Arnheiter & Maleyeff, 2005; Breyfogle, 2009; Sproull, 2009; Goldratt, 2010; Salah et al, 2010) claim that companies should not choose between these methodologies, but rather integrate them to gain more benefit then from their individual application. Even in those integrated frameworks, phases which include selection of appropriate methodology or tools guided by type of problems are recognized.

After brief overview of approaches to selection of CPI methodology and their integrated frameworks, guideline for selection according to type of problem will be shown, followed by main conclusions and future direction for research.

LEAN, SIX SIGMA AND TOC

Lean manufacturing is based on the Toyota Production System (TPS) which focuses on eliminating waste, reducing inventory, improving throughput, and encouraging employees to bring attention to problems

and suggest improvements to fix them (Womack et al, 1990) While there are many formal definitions of Lean, it is generally understood to represent a systematic approach for identifying and eliminating elements not adding value to the process (Simeunovic at al, 2012). It can be also described as system approach to waste identification and reduction through continuous improvement of existing processes, with product and services which flow on customer request in order to achieve perfection. (adapted from NIST, 2000).

Six Sigma evolved as a quality initiative to eliminate defects by reducing variation in processes in the semiconductor industry, notably Motorola (Corbett, 2011). Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes, and it uses a set of quality management methods, including statistical methods, and creates a special infrastructure of people within the organization ("Champions", "Black Belts", "Green Belts", "Yellow Belts", etc) who are experts in the methods (Antony, 2004). Six Sigma uses well structured DMAIC methodology (Define, Measure, Analyse, Improve and Control). Organizations are focused at Six Sigma in order to improve quality of product and services for their customers, and basic problem which prevents high level quality is variation in process (Gershon, 2010).

Ely Goldratt created Theory of Constraints (TOC) as continuous improvement methodology which focuses on system improvement. Goldratt observe system as a chain where the weakest link (i.e. bottleneck) constraints the entire system. TOC CPI methodology consists of five steps: Identify the constraint, Exploit the constraint, Subordinate other processes to the constraint, Elevate the constraint and Repeat the cycle. Nave (2002) says that in manufacturing processes, TOC concentrates on the process that slows the speed of product through the system. By focusing on constraints, this methodology produces positive effects on the flow time of the productor service through the system, and variation is reduced, and quality is improved.

SELECTION OF IMPROVEMENT METHODOLOGIES

In previous decade, many approaches to selecting appropriate methodology and their integration also were developed.

Nave (2002) proposed a model that identifies a hierarchy of cause and effects relationships. First level of the model is identifying core emphasis of methodology (reduction of variations, waste or constraints). Next phase is to identify relationship between core emphasis and primary effects (uniform process outputs, improve flow time, improve throughput volume). Identifying secondary effects of each methodology is third phase and in this phase they start to look similar according to Nave (2002). In order to make selection method easier, Nave (2002) gives advice to managers to concentrate on core emphasis and primary effects of improvement methodologies and culture of organization. If selection is based on primary effects, problems have to be clearly identified.

Bendell (2005) analyses some ways of choosing between Lean and Six Sigma, and ways to integrate them. He advocates cumulative application of different methodologies. He states that "every organization in some moment has to choose methodology for improvement according to nature of problem and external impacts" and presents the way for choosing path by using diagnostic questions that help to identify primary direction. According to Bendell (2005) process mapping is starting point for many organizations involved in process improvement. After this initial step, Bendell (2005) recognize four possible routes according to primary direction: ISO 9001 (market pressure), Lean (chronic waste), Six Sigma (variations problems) and people issues. Bendell's approach requires *ad hoc* or external based reviews of using current methodology and if it is needed transition to another according to new business directions. Selection of methodology is based on nature of problems and external impacts. He also suggests periodically reviews of current programme adequacy.

Madison (2005) gave some directions for selection between continuous improvement, Six Sigma, Lean or reengineering: for radical changes BPR should be used, Lean for reducing time problems, and Six Sigma for quality problems.

Breyfogle (2009) believes that „in some situations, Lean methods should be considered for process improvement, while for other situations Six Sigma techniques should be the tool of choice and another

situation is that both tools have application within a process improvement project." According to Breyfogle (2009), examination of measurement that is to be improved can provide insight into which tool would be most applicable for any given situation.

Harris (2012) suggest simple approach to selection between Lean and Six Sigma methodology based on four simple criteria: which problem must be solved, level of process maturity and availability of data in company, budget and time constraints, acceptance and presence of active leadership and preassure for getting fast results.

Besides different approaches for selecting CPI methodologies, there are many publications about their integration. George (2002) popularized combination of Lean and Six Sigma in his book *Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed.* There are many frameworks that integrate Lean and Six Sigma. Breyfogle (2009) recommends using DMAIC as roadmap with Lean tools beeing used in measure phase (for example, time value diagram, VSM) and improvement phase (for example one piece flow, poka-yoke, 5S, kaizen). Salah at al. (2010) also proposed integrated framework for Lean Six Sigma (LSS), where DMAIC is base for integration, but includes Lean tools in each phase. In Define phase they recommend identifying suitable tools and determining if the focus is on product flow or variability. Besides integration of Lean and Six Sigma, many author use combination with TOC. Sproull (2009) described roadmap to integrating TOC, Lean and Six Sigma named *Ultimate improvement cycle* which consist of three cycles of process improvement. Inner cycle represents the Theory of Constraints process of on-going improvement which provides the necessary focus that is missing from Lean and Six Sigma process improvement initiatives, the second circle represents the Six Sigma roadmap with DMAIC roadmap as base, and the outer circle depicts the Lean improvement cycle. Ultimate improvement cycle includes tools which can be applied in each step, and Sproull (2009) states that all processes different, so type of tool or action required for each process will be diferent. Goldratt (2010) presented SDAIS model that integrates TOC and LSS that consists of five phases: Strategy, Design, Activate, Improve and Sustain. In this model, TOC is prevailing methodology which provides focus for improvement with Lean and Six Sigma tools. Improve phase involves selection list of Lean and Six Sigma tool to solve the problem.

Salah at al (2010) give some recommendation when considering the integration approach for Six Sigma and Lean, and among others they emphasize that integration needs to be tool-based using the best tool that suits the problem faced, and takes into account differences between the two methodologies. They also indicate that each methodology is suitable for certain levels and types of problems.

Having in mind the approaches mentioned earlier in the text, the criteria for selecting the appropriate CPI methodology can be summarized as follows: nature/type of problem, performance that has to be improved, leaderhip acceptance and active involvement, process maturity, time and budget constraints, preassure for getting fast results, and culture of organization. The most frequent criteria that these authors mention is nature of problem which must be solved. Even integrated approaches, such as LSS and TOCLSS, require tool selection at one point, according to nature of problem.

TYPE OF PROBLEM AS A BASE FOR TOOL SELECTION

Stephen Novak (2006) tried to make a guideline for CPI tool selection ih his book *Small Manufacturers Toolkit*. He also considers that CPI tools can be helpful, but they cannot be apllied simultaneously. It is interesting to notice that he observe Lean, Six Sigma and TOC as tools. He states tha basic criteria for tool selection are type of recognized problem, desired results, avaliable resources of organization, culture, and timeframe for improvements. Novak (2006) said that if company wants to get started toward improvements, it need to now where it starts, where does it wants to get, and what are the resources available for that road. Basic question is where to start and which tool to apply? For each type of problem, Novak (2006) developed algorithm with proposition of specific tool for problem solving. Each algorithm starts with question: Does specific problem exists? If the problem does not exists, there is question: Does company still want to improve performance in that area? According to algorithms from Novak, Table 1, which contains brief overview of type of problems and proposed tools, is created. First column named Problem I represent main problem in company, and in second column is Problem II, which represent possible decomposition of Problem I, or possible sources of Problem I. Column Tool represent

proposed tools for problem solving in two situations: the problem exists; the problem doesn't exist, but the company still wants to make improvements in that area. From Table 1, it can be seen that for the most of the problem, Lean is possible solution, followed by TOC, while for quality problems Six Sigma is adequate solution. For quality problems, Lean is right after Six Sigma.

Table 1. Types of problems and proposed tools for their solving (adapted from Novak (2006))

Problem I	**Problem II**	**Tools**	
		Problem exists	**Problem does not exists – improving performance**
Inventory	Customer demand	Lean, TOC	Lean
	„Too much" inventory – sales/demands forecast	Basic MRP	Stable plan – Lean Unstable plan – shipment due date problem
Shipment due date	Lead time	Lean, TOC	Lean
	Production schedule	Plan dos not exist and no material – Basic MRP	Lean, TOC
Customer demand	Shipment due date	Lean, TOC	Lean, TOC
	Enough production capacity	No enough capacity – Lean, TOC	Enough capacity and material – Lean, TOC
Cumulative lead time	Procurement lead time	Lean, TOC	Lean
	Production lead time	Lean, TOC	Lean
	Delivery lead time	Lean, TOC	Lean
Scrap or first time yield		SPC, Six Sigma, Lean	SPC, Six Sigma, Lean
Stable and flexible production schedule	Resousce avalilability	Osnovni MRP	Lean
	Change priorities	Lean, TOC	Lean, TOC
	Quality cause changes	SPC, Six Sigma, Lean	Osnovni MRP, Lean
Suppliers performance	Acceptable quality	SPC, Six Sigma, Lean, Supply chain management	Lean, Supply chain management
	Lead time acceptable	Lean, Supply chain management	Supply chain management
Costs	Material costs	Lean	Lean
	Production costs	Schedule change frequently – Lean, TOC, stable plan – Lean	Lean
	Delivery costs	Lean, TOC	Lean
Flexibility and responsiveness to customers		Lean	Lean
Overall quality		Without stadardized quality system - ISO 9000, TQM, SPC	With stadardized quality system – Six Sigma, Lean
Market share		ISO 9000	TOC, Lean, Six Sigma
New product development time		Lean, Six Sigma	
Increase throughput	Increase revenue	TOC	
	Decrease operating costs	TOC, Lean, Six Sigma	

Castaneda – Mendez (2013) recognizes five types of process problems based on the type of cause: Delay-caused defect, Error-caused defect, Suboptimality-caused defect, Unpredictability-caused defect and Personal reason-caused defect (Table 2). He also suggests a simple three-step procedure for addressing these problems:

1. Identify the type of problem by cause;
2. Find the root cause;
3. Address the root cause;

Delay – caused defect is probably the easiest type of process problem to identify. All process or cycle time issues are delay problems. When the delay and its duration are identified, not only the root cause, but its impact had been identified. The key to successful cycle time reduction through identification is to focus exclusively on the „thing" that is going through the process. Process time gets extended for four reasons: (1) Stopping the flow, (2) Repeating the flow for rework, (3) Doing nonvalue-added actions, and (4) Doing value-added actions slowly.

Each reason for the delay must be identified as each has different solution. Lean is the original source of the tools and concepts of removing time from processes. Five principles of Lean are the basis for the four reasons for delays.

Error-caused defect - Castaneda – Mendez (2013) recomended that it shoud start from where the error is noticed, and then retrace to the origin of the information. While retracing, all the touch points, actions in the process that manipulate the item or information, should be noted.

Errors are best addressed by mistake-proofing. The concept of mistake-proofing and its tools comes from the TPS where it is known as poka yoke. According to McAdam & Donegan (2003) mistake-proofing tools are interchanged between Six Sigma and Lean. In this case, Six Sigma and Lean should not be used in parallel, but simultaneously, so that their synergy can be leveraged (Salah at al, 2010).

Suboptimality-caused defect comprises problems of fit, form or function. The assumption that all processes have variation is the basis for this type of process problem. Two circumstances can occur: (1) the amount of variation in the process is so large that it will always produce some defects; (2) the settings for running machines or standards for raw materials are off enough that it will always produce some defects. If either one or both of these circumstances occur, the process is not running optimally.

Identifying root causes means identifying the factors that are critical and the levels for those factors. The levels become the specifications for the factors. Solving the problem means controlling the process to keep the factors within the specifications.

Design of experiments (DOE) is cited as tool example in Six Sigma methodology (Salah at al, 2010), so suboptimality problems should be solved using Six Sigma.

Unpredictability-caused defect occurs as folows: It is necessery to identify predictors that will "tell" what the outcome will be. Then, the levels of these predictors should be checked, and this level should be inserted in the model. After that, prediction should be made, and compared to what actually happens. If the predicitons and reality do not match sufficiently closely, than the root cause is the model. Hence, the predictors cannot be changed or controlled. One can only predict the outcome. The root cause is a model with uncontrollable factors.

The use of statistical tools and software are essential for unpredictability problems. The correlation analysis is recommended for determining the predictors for this type of problem.

Personal Reason-caused defect can be identified when the person causing the defect does not thing it is a defect, but, from a process perspective, it is a defect. If this problem is systematic, a company can typically get information about it from customer surveys. But, when the situation is personal, a survey is not likely to get at that issue. Some defects of this type are due to forgetfulness or lack of knowledge, and cannot be addressed unless that person is asked, especially when it is due to lack of knowledge.

The reason is the cause, so the most common way to find out that personal reason is to ask the person him/herself. When it comes to address this type of problem, author said: "Do something about it – or move on".

Table 2. Key activities for solving process problems fast and effectively (adapted from Castaneda – Mendez (2013))

Type of problem	How to identify: Key words	How to determine root cause	How to address root cause	Recommended methodology
Delay	On-time delivery, too long, slow, backlog	Identify the type of delay: Flow stopping Rework NVA actions Slow VA actions	Address the type of delay: Remove barriers to continuous flow Reduce defects Remove NVA actions Replace VA actions with fast ones	Lean
Error	Accuracy, mistake, error, wrong	Retrace	Mistake-proof	Lean, Six Sigma
Suboptimality	Scrap, quality, rework, capacity, uptime low / downtime high, cronic or sporadic or intermittent failure, can't make product, unplanned maintenance, broken	DOE: Use scientific laws and theories, historical data, and data-based experiences to select potential factors; then use DOE to identify and confirm root causes and their optimal levels	Set critical factors to optimal levels	Six Sigma
Unpredictability	Customer demand, too many/few, schedule, inventory, …	Correlation analysis: Use subject matter expertise and experience to select potential predictors; then use correlation analisys to confirm predictors and build model	Use current levels of predictors in prediction model	Statistical tools and mhetods
Personal Reason	Accounts receivable, employee turnover, customer loyality, policy	Ask	If the reason is due to other causes, address that cause If not, then determine wheter you are willing and able to address the reason.	/

Table 1. and Table 2. can be used as a guideline for selection of appropriate methodology according to types of problems. There are situations, where more types of problem are recognized in one process (delay, quality, costs), so other criteria must be considered in order to make decision what to tackle first: process maturity, time and budget constraints, preassure for getting fast results, leaderhip acceptance and active involvement, and culture of organization. In the situation of low process maturity, scarce resources and data, and large preassure for getting fast results, Lean is better solution than other methodologies.

CONCLUSION

Business process improvement is one of the main priorities of companies according to Gartner survey from 2009 (Zellner, 2011). There is a challenge for companies to decide which of the popular CPI methodologies to implement in their specific environment. According to different approaches to selection between Lean, Six Sigma and TOC, type of problem was identified as main criteria for selection. Through analysis of integrated framework of CPI methodologies, it is concluded that integration is more about selection of specified methodology or tools according to type of problem than true integration roadmap. Breyfogle (2009) says that „company benefit when considers such an integration so that most appropriate tool is used at right time."

Company should not adopt only one methodology on enterprise level. Company must consider philosophy and tools of each CPI methodology on enterprise level, but on process level, there is

consideration of selecting appropriate tools that belong to these methodologies, according to type of problem. Type of problems and basic guidelines for selection of specific methodologies are given.

Future research is to develop integrated framework for CPI methodologies with criteria and detailed instruction for selecting appropriate approach to improvement, where Lean can be main driver for successful integration.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Lean thinking to support RFQ process modelling: The Hutchinson case

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ABSTRACT

Lean thinking promotes a new vision of habitual processes in order to highlight the hidden obstacles that preclude the achievement of the best performance. Typically, most of the enterprise's processes are currently revised according to the lean thinking perspective and, because of its holistic approach, the analysis also includes the relationships of processes operating along the whole product lifecycle.

In this paper one of these processes - the Request For Quotation (RFQ) – and its impact on the enterprise's overall performance, is analysed. The Request For Quotation is understood as a sequence of activities that companies perform in the initial phase of each project where customer needs are analysed in order to make a proposal that contains both economic and schedule items. The quotation has to be conform with the product specifications and requirements for which the company has been consulted; additionally, it has to be competitive and made in a short time.

This paper presents a model for RFQ developed for Hutchinson Company using mapping of the information flow to support Lean Organization in order to reduce information wastes and allow continuous process improvement activities. The model focuses on efforts and time reduction and evaluates its performance..

KEYWORDS: Request For Quotation, process improvement, product development, product lifecycle, Lean Organization

INTRODUCTION

Nowadays, large companies are conducting business with greater numbers of partners than ever before, and are looking for information and communication technology to better manage these relationships (Li et al., 2005). Relationships between buying and selling organizations in business markets are varied and complex (Seshadri et al., 1991). Vital for most companies, the procurement function must negotiate reasonable prices with suppliers and it must make reasonable efforts to ensure that contracts are made with qualified suppliers able to fulfil the contract (Wan and Beil, 2009).

Among the procurement functions, Request For Quotation (RFQ) is a commonly used process where an enterprise invites suppliers to bid on a specific product or service. Suppliers provide a quotation being conform with the product specifications and requirements as expressed by clients. The process allows the sale to be determined by a variety of attributes, involving not only price, but quality, lead time, contract terms, supplier reputation, and incumbent switching costs (Beil and Wein, 2003).

Hutchinson Group is an important automotive supplier and, in the day-to-day business, it is commonly demanded to offer its products through RFQ's. In the last years, Hutchinson has identified a critical aspect in

its RFQ process: the reply time is bigger than customers' expectation. This is mainly due to an unscrupulous identification, bad dissemination, incorrect management of the information used to produce the offer. For this reason, the company has decided to implement a reengineering process to improve the performance of process responses to clients.

This paper presents the efforts made to identify MUDA (waste and loss) and process failures to reduce the cycle time. The implemented tool, the visualization model, helps also to better define roles and responsibilities, milestones, deadlines, priorities and standard documentation. Moreover, it offers, respect other methods a direct link to the next step of lean thinking, thus the connection to the Product Lifecycle Management (PLM).

LEAN THINKING TO IMPROVE RFQ BUSINESS PROCESS

Lean principles are used to achieve waste reduction and efficiency while increasing product quality. However, in order to understand waste it is necessary to understand first the value added.

A quotation requested by a customer gains value when the supplier meets all the requirements expressed and unexpressed by the customer. It gains even more value if the offer is delivered on time. On the contrary, waste is produce if the quotation does not fulfil all requirements and if it is delivered late. In this example procedures that no one would ever think to change (Chiarini, 2013).

Having discovered the value for the customer, it is then possible to look at the existing processes and expose the waste. The best way to identify waste is to analyse and map the current process.

Whenever there is a product (or service) for a customer, there is a value stream. The challenge lies in seeing it (Rother and Shook, 2003). The value stream can be found only if all stakeholders of the process understand who is doing what, when and how. In addition, according to the Lean Manufacturing principles, information must be managed with just as much importance as the material flow.

There is not such of a standard for the Value Stream Mapping (VSM). Even more, the authors of the Value stream mapping, Rother and Shook, suggest the development of additional icons that represent better processes. Since the RFQ process is a pure information flow, authors have decided to use an alternative representation, the Visualization Model, that is more suitable to the process being analysed.

MAPPING OF THE RFQ INFORMATION FLOW

As stated before, the improvement of the RFQ process is part of a reengineering process which is based in the Business Process Improvement methodology defined by Harrington (Harrington et al., 1997): Phase I, Plan- Organizing for improvement; phase II, Analyse-Understanding the Process; phase III, Streamlining the Process; phase IV, Implementation, Measurements and Control and phase V, Continuous Improvement.

Plan-Organizing for Improvement

An essential first step in getting started on process improvement is the full commitment of the organization and all roles involved in the process. A process analyst was designated as responsible of the improvement under the direction of a senior Project Manager. Goals and project milestones were communicated to all stakeholders.

Analyse-Understanding the Process

The diagnosis of the RFQ process was performed by a direct contact of the process analyst with the process owner, hence the Project Manager. This interaction permitted both a full immersion in the process and the identification of all roles involved.

In order to gain a deeper operative knowledge, an interview and a questionnaire were applied to all process operators. The questionnaire allowed a ratification of what has been learned during the interviews and exposed new findings.

A good opportunity for the company represented the absence of a standard description of all the activities of the RFQ process in the Quality Management System. This situation produced a condition in

which some of the activities of the process did not present a clear set of operations. Instead, the actions were conducted according to the single experience of the project manager in charge. A poor performance in a single activity in the value chain is sufficient to spoil the overall performance (de-Toni and Tonchia, 1996). It was not clear for all project participants how their contribution helped to reach the final goal. The principal aim of this contribution is to clearly define all activities in the process.

Furthermore, Hutchinson does not have a formal management practice for handling information changes. This is particularly severe since it is a usual practice that client requirements change when the process is already in an advance state. In the absence of specific tools that help to keep requirements under control, the Project Manager administers changes in a manual/artisanal way.

Finally, the process did not count with any kind of measurement. Without data it is almost impossible to understand, manage, and improve the process.

Streamlining the Process

There are many modelling languages focused on redesigning and improvement of processes. A literature review (Serrano-Lasa et al., 2008), had identified and evaluated the advantages and disadvantages of some of these different methodologies (Process mapping, IDEF0, GRAIR).

Nevertheless, all these models (along with VSM) are losing the connection to PLM, the business strategy that more and more companies are using as a key to success. PLM is an outcome of lean thinking since it is focused on using the power of information and computers to deliberately pare inefficiencies (Grieves, 2006). Operational efficiencies are improved with PLM because groups all across the value chain can work faster through advanced information retrieval, electronic information sharing, data reuse, and numerous automated capabilities, with greater information traceability and data security (Sääksvuori and Immonen, 2005).

The PLM system controls the triad composed by product information, processes and people. The interactions between these elements are difficult to be represented in a single diagram. We therefore developed a formal Visualization Model (VM) of enterprise processes that offers a graphic representation of the main elements of a product lifecycle to address them on an overall level (Chiabert et al., 2013). The VM efficiency has been proven with a case study involving a small metrology company (Sauza Bedolla et al., 2013). The VM was used as Lean Thinking method to map the RFQ information flow.

The VM follows a Top-Down strategy, breaking down the product lifecycle to gain insight into its Process Areas (PA). Each PA characterizes the aspects of product development to be covered by organizational processes and can be expressed as an UML-based workflow. Every component of the workflow is then described in a Decomposition Diagram (DD) that contains the information of who (role) is responsible of a workproduct (item) generated with an activity that requires particular tools and skills. Figure 1 shows how the VM works.

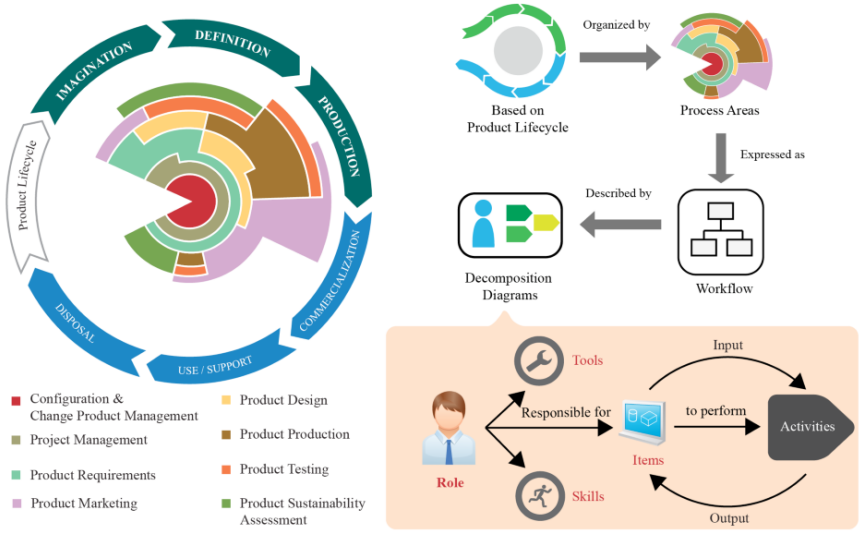

Figure 1: Visualization Model overview

RFQ Process Modelling

The RFQ process is part of the PA Project Management and it is located during the imagination phase of the product.

The RFQ workflow process is presented in Figure 2. The process stars with the reception of the client's documentation through the activity "RFQ Client Requirements". Subsequently, if the information is incomplete, there is a "Request for client information integration". Otherwise, the "Initial Analysis of the Project" is performed. Here, it is identify the kind of product to be developed (fluid transfer high pressure or low-pressure, fuel lines, selective catalytic reduction, blow-by, etc.).

Next, it takes place the "Feasibility Analysis" where technical details are studied and after that, an "Economic Analysis" is performed All information is then gathered in the "Information Integration" activity. At this time, it is assessed the completeness and quality of the information to decide if repeating one of the analysis or to delivered an "Offer proposal" that marks the end of the RFQ process.

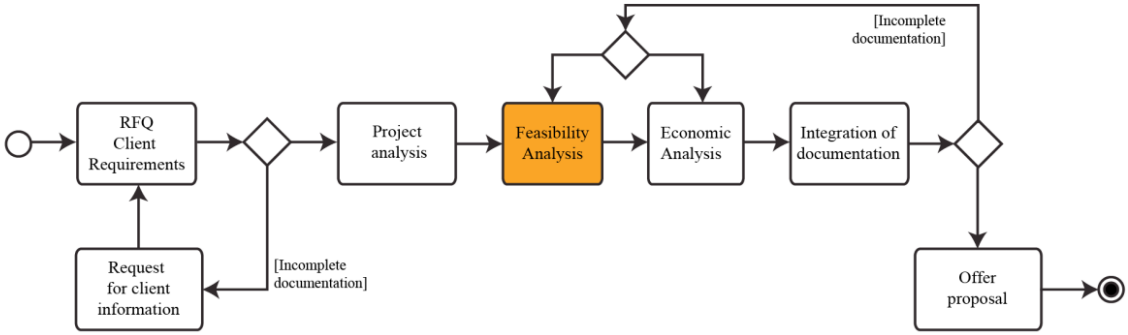

Figure 2: RFQ workflow process

In the sake of brevity, authors have decided to present only the most significant activity (in terms of time consumption and complexity) in the RFQ process. The aim of the "Feasibility Analysis" is to identify the detailed technical characteristics of the project based on an extensive investigation and research to support the decision-making process.

The DD (Figure 3) shows clearly how the Project Manager plays a central role in the execution of the RFQ process. In fact, the Project Manager works with different roles of the organization to get detailed information concerning every aspect of the product. The R&D Engineer presents the validation proposal of the new product; the Quick connector engineer delivers a Dossier with the description of all the necessary elements to connect and/or disconnect the hydraulic or pneumatic lines quickly and easily without the use of tools; the Purchase Manager establishes a Purchase Plan of related parts if required; the Quality Officer determines the necessary quality controls and the CAD Officer realizes a Technical Presentation of the product. Also, it is possible to identify the information that every role needs to consult/read in order to accomplish its activity (i.e. the Quick Connector Engineer needs to consult the Client Specifications).

Once the project manager gathers all the documents, he has all the essential information to write-down the "Feasibility Analysis" and the "Deviation list". The former document will be the principal input for the "Economical Analysis". The second identifies clearly all requirements that the company is not able to fulfil at the time and it is attached to the offer.

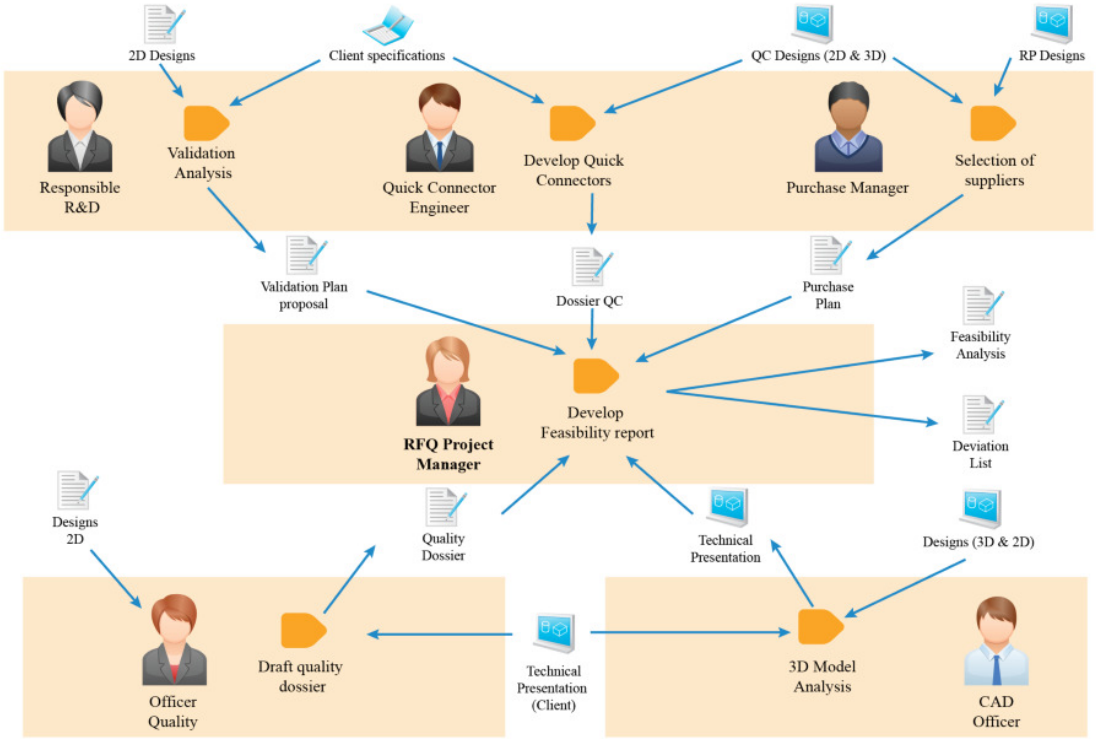

Figure 3: DD of the Feasibility Analysis

Implementation, Measurement and Control

The resulting model of the process has been presented to all roles involved and it is now under implementation. Performance measurements were proposed to the company and they are aimed to measure process efficiency, effectiveness and customer satisfaction. Measurements of process time and variability are still under development.

Process Improvement

Since the actual process is not yet measured and it is not under control it is impossible to define an improvement. Yet, it is possible to outline the change of the management of client's requirements that is a complementary process. The Configuration and Change Management running in parallel, as presented in Figure 4, means that all documents generated along the whole process must be identified uniquely and managed in a PLM system.

In the case of a client requirement's change (Figure 5), a new process must be established to analyse, evaluate and incorporate the modification. Special attention must be devoted to analyse the impact of the change on accordance with other products and the cost that the change implies. At every moment the client must be informed.

This tight control of the information assures that the relevant (technical) information of the product is managed consistently and avoids waste and process delays.

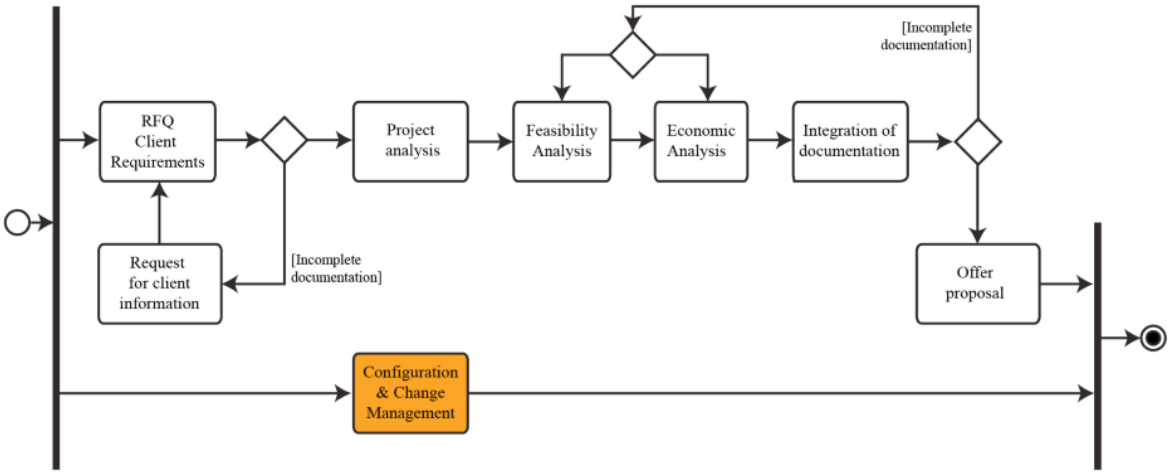

Figure 4: RFQ Process Improvement

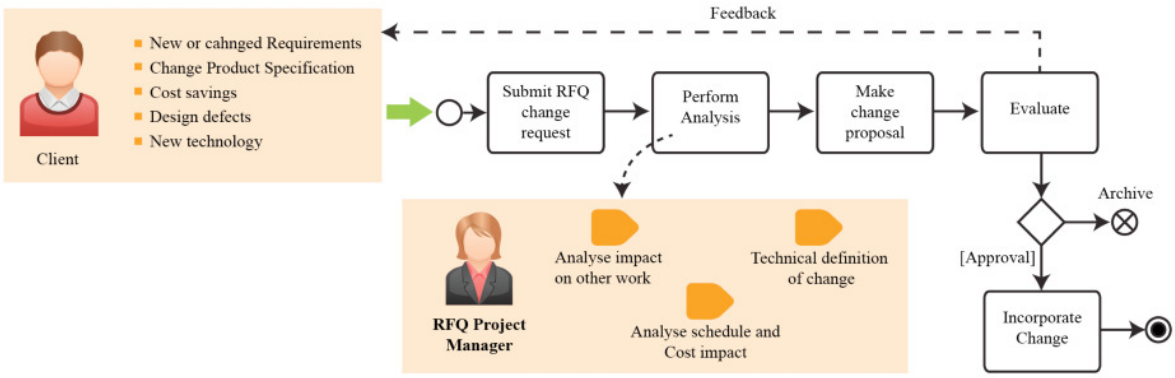

Figure 5: Change Management in the RFQ process

CONCLUSION

Lean Thinking tools are essential to define and improve business processes. This paper presents a formal visualization model to map the information flow. The VM clarifies who is doing what, when and how and it allows the link to PLM, the next step of lean thinking.

The successful use of the VM has been proved by mapping Hutchinson's RFQ process. The workflow and decomposition diagrams show clearly how the different roles of the organization interact. The VM permits to recognise the most critical macro activity as the "feasibility analysis", the roles involved and the amount of information processed, and in particular the information that add value to the product and consequently avoiding waste. The VM permits to recognise the information that add value to the product and consequently avoiding waste.

In order to get a tighter control of the information, the introduction of a Configuration and Change Management has been proposed to the organization.

ACKNOWLEDGEMENTS

Authors would like to thank Hutchinson Rivoli for its collaboration.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Is There a Conflict Between Modeling and Lean in Software Development?

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ABSTRACT

Applying lean principles to software development is not simply a matter of copying or imitating practices and tools that have been successful in manufacturing. The principles, practices and tools would be adapted in order to enable appliance in specific domain, like software development is.

Model-driven software development is an umbrella term for several software development methods that are based on three principles: direct representation, automation and open standards. These principles in a great extent conform to lean thinking principles. However, a conflict may arise between the extensive use of modeling in software development process and lean software development. In the paper we will argue is there a conflict between modeling and lean or the real conflict arises due to the inappropriate usage of models in the context of lean thinking principles.

KEYWORDS: Lean thinking principles, Software development process, Model-driven software development.

INTRODUCTION

Software development is a complex task requiring the investment of significant resources. At the same time it carries major risk of failure. Model-driven software development (MDSD) is an umbrella term for several software development methods that share a common approach to represent systems as models that conform to meta-models, and to use model transformations to manipulate various representations.

Applying lean principles to software development is not simply a matter of copying or imitating practices and tools that have been successful in manufacturing. The principles, practices and tools would be adapted in order to enable appliance in specific domain, like the software development is. We should persist in efforts to improve software development process, software architecture and program code; to eliminate waste; to automate what can be automated; to be better at understanding requirements and delivering them timely; and to iteratively refine our software.

MDSD approaches are mostly based on three principles: direct representation, automation and open standards. The first one expresses a desire to represent a solution as directly as possible in the terms of problem domain. The principle of automation endorses the concept of using machines to perform tasks that require no human ingenuity, freeing software developers to focus on creative problem-solving work, and generating error free program code. The principle of defining standards is important to promote code reuse and to enable basis for solid interoperability.

These principles in a great extent conform to lean thinking principles. However, a conflict may arise between the extensive use of modeling in software development process and lean software development. In the paper we will discuss whether there is a conflict between modeling and lean in software development or the real conflict arises due to the inappropriate usage of models in the context of lean thinking principles.

APPLYING LEAN TO SOFTWARE DEVELOPMENT DOMAIN

Lean (lean thinking) was originally named *Respect for Humanity System*, to emphasize that Lean is primarily about respecting people in order to optimize value and quality. It would make a context in which

people will be mentored to think through about the problems and to find and resolve root causes of problems. At the same time, people would prosper, work would be humanized and society would be improved. (Womack and Jones (2003), Fujimoto (1999)).

Lean thinking principles (LTPs) can be applied to any business process to achieve measurable improvements in customer satisfaction, output, lead time, resource effectiveness, etc. They are derived from the Toyota Production System (TPS). Defining the concepts that are at the heart of lean has been the topic of many works. The first "Toyota Production System house" diagram was sketched by Fujio Cho in 1973. Over the time the interpretation of basic parts of "TPS house" was adapted and changed alongside with the development of lean thinking. According to Larman and Vodde (Web-1) the main goal (the roof of the "house") of lean system is to quickly deliver things of value to the customer in the shortest possible cycle times, while still achieving highest quality and at the most customer satisfaction and at the lowest cost. The main enablers (the foundation of the "house") are manager-teachers that are bottom-up consensus builders and real team leaders who are work experts, and who mentor their team members.

The continuous improvement and the respect for people are two main pillars that support TPS. The term "people" would encompass all actors of the whole system involved in or attached to the lean product development/build, beyond others: customers, employees, teams, supply partners, and managers. Thereby, the "customer" is not just the end customer. An employee working on a workstation from an assembly line, e.g., is a customer too, expecting (pulling) the output from upstream process (Ristic, 2012). No one in the line should trouble his direct customer, having in mind that the customer will consume his work and/or decisions.

In (Liker, 2004) 14 lean thinking principles ("occupants" of "TPS house") are presented and exemplified by TPS. The implementations of LTPs may vary across different manufacturing settings due to contextual differences. Poppendieck and Poppendieck (2003, 2006 and 2010) have made strong distinction between principles and practices. LTPs have been viewed as truths that do not change over time or space, while practices represent the application of principles to a particular domain and should differ from one domain to another and change as a system and its environment evolve.

The success of TPS has motivated primarily manufacturing companies to integrate LTPs into their improvement programs. Afterwards, LTPs have moved into nonmanufacturing companies, too. The next step was the appliance of LTPs to a product development process.

Software development is a form of product development that, like other knowledge works, differs fundamentally in structure from manufacturing, putting in the question the universal applicability of LTPs. It is not repetitive and can't be unambiguously defined. The "material" itself is intangible and the requirements are changeable and unpredictable. It involves expertise and judgment that depend heavily on tacit knowledge. Yet, Staats and Upton in (2011) have concluded that knowledge work can benefit from the principles of the TPS. Their conclusion is based on the results of studies presented in (Staats and Upton, 2011) and (Staats et al., 2011).

Mary and Tom Poppendieck (2003, 2006 and 2010) are the founders of the lean software movement. Their work merge lean manufacturing, lean information technologies and agile, and they present their insights from both a managerial and developing viewpoint. Their adaptation of lean principles into seven software development principles is the main source for interpreting lean principles in the context of software engineering: 1) to eliminate waste; 2) to build quality and integrity in; 3) to amplify learning and knowledge creating; 4) to defer commitment (to decide as late as possible); 5) to deliver as fast as possible; 6) to respect people; and 7) to optimize the whole. Jonson (2012) stresses that Poppendiecks' principles are in line with Liker's principles, but that Liker emphasizes standardization of working methods as very important, whereas the Poppendiecks more focus on self-determination. Anderson (2010) states a set of more practice oriented Kanban principles promoting lean in many domains, including software.

Due to the fact that Poppendiecks have come from the agile community they suggest use lean thinking as guiding principles to develop and adapt agile practices. Unlike Coplien and Bjørnvig (2010) who emphasize the differences between lean and agile thinking, Poppendiecks believe that lean development further expands the theoretical foundations of agile software development by applying well-known and accepted lean principles to software development.

Wang et al. (2012) note that some authors use the names "agile" and "lean" in the context of software development interchangeable, while others consider the differences between agile and lean approaches. They found that lean concepts have been successfully used in combination with agile methods. Dybå and Dingsøyr (2008) in their systematic agile literature review have seen lean software development as an agile development method. Perera and Fernando (2007) have proposed a hypothesis that LTPs can improve agile software development. Durnall in Web-2 summarizes how lean knowledge can blend in with agile thinking. He emphasizes that there is no lean software development process, but that LTPs provide us with a great tool kit for improving the efficiency of any software development process that does not have to be agile at all. Jonson (2012) summarizes what does lean mean to different disciplines within software development like requirement engineering, architecture, programming, testing, integration and project management. Agile methods have primarily been applied to and studied in small-scale software development projects (Dybå and Dingsøyr, 2008). Pernstål et al. (2013) summarize that adoption of lean principles in software development (not exclusively in agile development methods) is beneficial especially when it comes to large-scale software systems development.

There are different approaches to software development. In the paper we will present model-driven approach to software development and the applying of LTPs in MDSD.

MODEL-DRIVEN SOFTWARE DEVELOPMENT

The value of models and abstractions in software development is substantial in order to master system complexity. For a long time, models are most commonly thought of as peripheral to the software development process (Frankel, 2003), since they were mostly used just for analyzing, designing and documenting. Those design models once created could be used for code generation process by means of traditional CASE (Computer-Aided Software Engineering) tools. Unfortunately, during the later stages of project the synchronization between the design model and program code could be lost.

The one of the main assumption of MDSD is that software systems of large complexity can only be designed and maintained if the level of abstraction is considerably higher than that of programming languages (France and Rumpe, 2007). The idea of abstracting implementation details by focusing on models as first class entities is promoted (Stahl et al., 2006). System artifacts are generated automatically from abstract models. A meta-model defines the modeling language, i.e. the constructs that can be used to make a model and, consequently, defines a set of valid models (Assmann et al. 2006). MDSD aims to improve productivity of developers by using Domain Specific Modeling Languages (DSML). By means of DSMLs, semantics in an application domain can be precisely specified using terms and concepts the end-users are familiar with. The focus of software development is shifted from the technology domain toward the problem domain. A complex system may consist of many interrelated models organized through different layers of abstraction. Therefore, a chain of transformations should be completed starting from an initial model at the highest level of abstraction (Platform Independent Model, PIM), through the less abstract models, with different levels of platform specificity (Platform Specific Models, PSMs), and resulting in an executable program code that represents a model at the lowest level of abstraction (fully PSM).

MDSD process would cover: modeling that produces description models from existing systems; forward engineering that produces specification and prescription models; and reverse engineering that produces description models from engineered software systems. Favre (2005) emphasizes the importance of reverse engineering and its integration with forward engineering to support a smooth evolution of software.

OMG's Model-Driven Architecture (MDA) (Web-3, Frankel (2003), Booch et al. (2004)) currently is the most mature formulation of MDSD paradigm. The MDA approach is based on the usage and integration of Unified Modeling Language (UML) models at different levels of abstraction. Although UML is widely recognized and used as modeling standard, as a general purpose modeling language it has provoked a lot of criticism especially from DSM community. In order to cope with that OMG's Meta Object Facility (MOF) defines the metadata architecture that lies at the heart of MDA. MOF standard (Web-4) offers a generic framework that combines both syntax and semantics of models and model transformations and is used to define semantics and structure of generic meta-models (i.e. modeling languages) or domain specific ones.

HOW LEAN FITS WITH MODEL-DRIVEN SOFTWARE DEVELOPMENT

The potential benefits of using models are significantly greater in software than in other engineering disciplines and MDSD is expected to improve current practices in software development. The basic principles of MDSD approaches in a great extent conform to lean thinking principles.

Poppendiecks (2003) translate seven Shigeo Shingo's wastes of manufacturing into the seven wastes of software development: partially done work, relearning, extra features, handovers, task switching, delays, and defects. Fine-tuned MDSD may provide several waste reduction options, like:

- Partially done work – modeling enables to think through complex issues before addressing them via code, forward and reverse engineering keeps code synchronized with models, writing documentation is not a follow-up activity, but part of the model specification process, from which documentation can be generated any time and keep synchronized with PIM, too;
- Relearning – due to the automation of transformation process knowledge about the real system is kept in the PIM/PIMs representing one input point and can be reused even if the platform and environment are changed;
- Extra features – since the transformations are automated designer may decide when and which elements has to be added into model, i.e. to model just in time and just enough to address the issue at hand;
- Handovers – shared understanding is simplified due to the usage of general purpose UML or DSMLs;
- Defects – thanks to the automated generation of artifacts in MDSD error free code is generated. Besides, the prototypes may be generated, and end customers can recognize if their requirements are fulfilled, problems can be spotted and fixed early on.

Software must maintain its usefulness over time and it is expected to evolve as it adapts to the future. Due to the integration of reverse engineering in MDSD process the adaption to changes is easier. Besides, the synchronization of descriptive models with the program code is kept. With the automation of code generation process, MDSD contributes to *bring quality and integrity in* principle of lean software development.

Thanks to PIMs and the chains of automated model-to-model and model-to-code transformations, commitment about the platform selection may be deferred or changed.

Besides these "lean" features "embedded" into MDSD there is a lot of space for making MDSD more "lean". There is a real threat that the models become overly detailed and that the project team is unable to move forward because it is burdened with too many modeling specialist who do not have skills to move forward (Ambler, 2007). Consistent application of MDSD can impair the *deliver fast* lean software development principle (Ristic, 2012). One could say that there is a conflict between "modeling" and "lean" in software development. The question is can we merge lean and modeling in order to take benefit of potential synergies? In the following section the application of lean principles in modeling is discussed.

LEAN MODELING

According to Rothenberg (1990) "*Modeling, in the broadest sense, is the cost-effective use of something in place of something else for some cognitive purpose. It allows us to use something that is simpler, safer or cheaper than reality instead of reality for some purpose*." That "something" is a selectively simplified and deliberately structured form of knowledge and it is called model. A particular view (or aspect) of a system can be captured by a model and each model is expressed by the concepts of modeling language of its meta-model (Bézivin, 2005). MDSD is split in two abstraction levels: meta-modeling which is the modeling of modeling languages and their associated tools, and modeling which consist in using those tools to engineer final software system (Mahé et al., 2009). As can be seen in Figure 1, the third level is business level containing the system to be modeled. Two basic relations may be notified: *RepresentedBy* and *ConformsTo*. In Figure 1, some aspects of system *S* are represented by *Model_A*, some others aspects are represented by *Model_B* and *Model_C*. These models are different views on real system *S*. *Model_A* and *Model_B* are expressed by the concepts of same modeling language *ML_1*, while *Model_C* is expressed by the concepts of another modeling language *ML_2*. These modeling languages may be general purpose or domain-specific modeling languages. *Model_A* and *Model_B* conform to meta-model *ML_1*, while *Model_C* conforms to meta-model *ML_2*.

An attempt to apply LTPs to MDSD must take into account these two abstraction levels. Namely, the first, at meta-modeling level, modeling languages and their associated tools has to be modeled, and afterwards, at modeling level, by means of those tools models of a system will be defined. At both levels there are two generic roles: developer and domain expert. The developer role may be further specialized, but these specializations are irrelevant in the context of the paper. A domain expert at meta-modeling level is a developer at modeling level, and a domain expert at modeling level is an end-user of system to be modeled.

Hibbs et al. (2009) claim that lean principles can be applied to the whole enterprise and that software development constitute just one part of large-scale product development processes, while agile methods mainly focus on specific practices for developing software and usually do not concern the surrounding business context in which software development take place. Keeping that in mind applying of LTPs to MDSD will be beneficial only if holistic approach is used. LTPs have to be applied at both abstraction levels, including the business level. That means that LTPs would be applied to business processes, to modeling level and to meta-modeling level in order to get the best synergetic effect.

While the application of LTPs to improve business processes is widespread, the application of LTPs to improve modeling still is not mature and the application of LTPs to improve meta-modeling is nascent. Further research work should consider different issues, like:

- integration of end-users/business engineers in modeling/meta-modeling process in order to enable human centered modeling/meta-modeling;
- support for not only test-driven programming, but also for test-driven modeling and meta-modeling, to enable further autonomation of MDSD;
- quality metrics for modeling;
- further development of forward/reverse engineering tools and resolving the dependency between modeling tools and DSMLs.

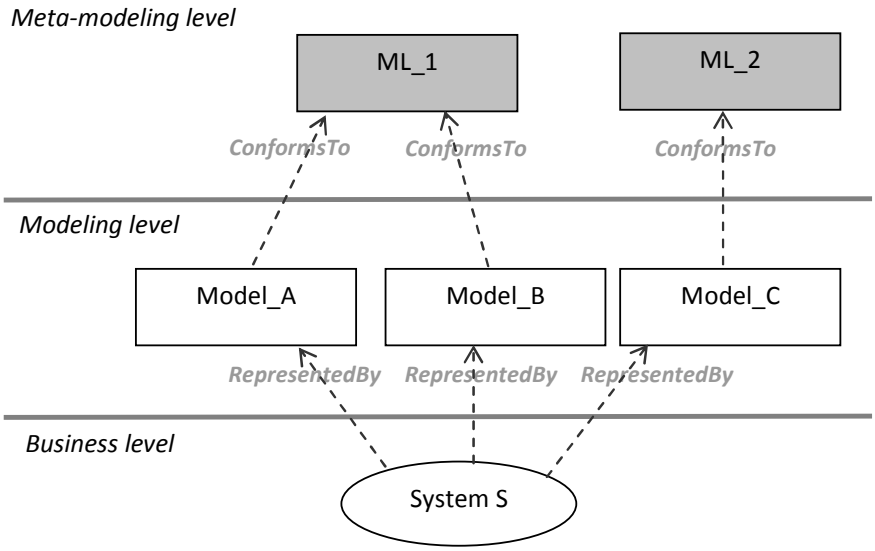

Figure 1: MDSD abstraction levels – coined and adapted from (Bézivin, 2005) and (Mahé et al., 2009)

CONCLUSION

In the paper we dealt with the LTPs in the MDSD context and argued if the application of LTPs to software modeling process can be beneficial. Turning into lean system requires enormous persistent effort. Software development is somewhat innovative and experimental and it should be taken into consideration remembering that lean approach does not bring the same benefits in different domains. The transition from non-lean to lean organization cannot happen overnight but through a series of innovations and changes. Application of LTPs in MDSD currently represents a major challenge due to the fact that LTPs should be applied at business level, modeling level and meta-modeling level concurrently, in order to achieve significant and measurable improvements.

ACKNOWLEDGEMENTS

Research presented in this paper was supported by Ministry of Education, Science and Technological Development of Republic of Serbia, Grant TR-35050, Title: "Development of software to manage repair and installation of brake systems for rail vehicles", for the period 2011th-2014th year.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Lean Approach to Hybrid Innovation Model

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ABSTRACT

This paper describes a lean approach to innovation process bridging academic and small enterprise R&D worlds. As a use case we are to dissect collaborative effort between La Citadelle Inz (LCI) and Department of Industrial Engineering and Management (University of Novi Sad) to develop ContextSENSE (CS) enablers and related services. We call it Hybrid Innovation Model as it blurs the line between academic and engineering activities and encourages a cross-disciplinary team to pursue the right balance between theoretical and applied research.

The CS service is based on transforming WiFi access into an internet sensory network and as such epitomizes R&D challenges in an increasingly agile and broad ICT domain. One of the fundamental lean Hybrid Innovation design requirements is its need to embrace experiments. Innovation leaders have to ensure that learning acquired through the experiments loop back into their lean designs and critical decision making. In the case of CS an experimental outdoor WiFi Mesh network, jointly deployed by LCI and Academic Research Network at University of Novi Sad (ARMUNS), is used to foster learning of user and network behavioural patterns by means of datas analytic. Hybrid Innovation also requires a team of open minded people who are skilled at searching for an unknown business model, who know how to navigate through inter-organizational politics and are creatively focussed on creating competitive advantage for the product and associated services. Nevertheless, mature organizations normally follow a set of implicit rules, norms, and metrics and as such introduce operational constraints to the Hybrid Innovation model. To overcome these risks the CS use case clearly presents the need for agile decisions making; ability to ruthlessly discard unpromising ideas whilst exercising business acumen not to rush with launching a non-viable product.

KEYWORDS: Lean approach, ContextSENSE, Hybrid Innovation

INTRODUCTION

Businesses invest into innovation related activities for a number of reasons of which the following three are most commonly cited: i) impact on the product and/or service portfolio, ii) preserving or growing the market share and raising the bar for the new entrants, iii) improving brand and public perception of the company (Spector et al., 2012). Very often the concepts of innovation and research are interchangeably used although there is a subtle difference in their respective definitions: the term "research" refers to pursuit of new ideas, concepts, theories and technologies while the term "innovation" puts an emphasis on exploitation of the research results in order to advance one or more of the three objectives mentioned above. In this paper we build on this difference to forge a mutually beneficial collaboration between LaCitadelleInz (LCI) and Department of Industrial Engineering and Management (DIEM) to develop ContextSENSE (CS) enablers and related services. Moreover, the academic concept of lean innovation as defined by Steve Blank, Eric Ries, and others (Anthony, 2013) have provided a solid framework to define

strategy to govern and drive collaboration between LCI and DIEM. It is our belief that the next wave of innovation will likely come from the symbiotic relations between market and advance technology focussed companies and agile university teams looking to push their research results beyond futile publications. Such latent transformational power can be realised only by combining the skills and interests across these two domains. Furthermore, when the joint team subscribes to following the lean principles of i) developing a minimal viable product, ii) and pivoting based on market feedback than we have all the ingredients needed to unleash the potentials of the ***Hybrid Innovation Model (HIM)***. In the same manner it enhances the academic environment by validating relevance of the research carried out there and challenging an extreme perspective, taken by some businessmen, that research investments are not justified and that useful learning comes only from hands-on product development and related market trials. And that cannot be right. Proven innovators engage in researching, thinking through the available options and formulating a robust hypothesis in order to maximise their learning from the experimental phase and in our opinion HIM model reinforces this learning loop.

HYBRID INNOVATION MODEL: LEAN PRINCIPLES

There are three types of innovations classified relative to their economic impact (Christensen, 1997):

- ***"empowering"*** innovations: reinvent a costly product, previously available only to a privileged class of people, into affordable products sought by many. An economic growth follows closely behind the "empowering" innovation.
- ***"sustaining"*** innovations: replace outdated products by new ones on the basis of technological advances. This keeps the economy vibrant but it is a zero-sum game in terms of growth.
- ***"efficiency"*** innovations: reduce the cost of making and distributing existing products and services. Allows for higher economic productivity, the same amount of work is done by fewer people, and capital is freed for other uses.

Well established businesses are strongly focused on sustaining innovations which create a blind zone for disruptive innovations to create new markets and push aside the incumbent players. We believe that lean principles due to their agility and interactivity can significantly reduce the size of blind zones and ensure that any investment into innovation is highly effective.

With HIM we blur the line between academic research and development engineering activities and appoint a joint team to pursue the right balance of each and cross pollinate the learning experience. A fundamental "lean" principle we institutionalize is to maintain considerable fluidity in terms of moving individuals in and out of the joint team as dictated by the project's needs. Additionally we work hard to "factorize" the overall task into smaller, shorter term, measurable components. Such division of the work produces timely evidence of concrete progress and in turn fuels team motivation and consequently enhances the potential for commercial benefit. One of the main principles guiding the project factorization is to maximize interaction between the academic and engineering sides of the team. Stronger interaction is likely to produce higher impact in the long run. There's no doubt that people inside a commercial environment subscribe to the known business plans for the purpose of risk avoidance. Nevertheless, the full scale of HIM benefits is only possible if other aspects such as seeking valuable feedback, educating prospective hires, and planting new ideas are also recognized as valid business objectives.

For innovation to happen it is not sufficient to formally follow a specific set of rigid guidelines. Installing the culture of innovation requires a systematic solution and it is where the lean methodology comes to fore. The lean methodology fuels persistent innovation as a means to create

a disruptive growth business. To maximise the benefits from following lean start-up methodology it is important to install the following three principles as the main pillars of innovation effort:

- **Promote experimentation**: Experiment with your ideas, with your equipment, with your materials, with your messages … and although experimentation can take different forms and shapes it is very consistent in doing one thing: encouraging creative thinking! Entrepreneurs need to learn in the marketplace, engage their prospective customers, experiment with different product and/or service offering till they arrive to the mutually desirable minimum viable product, one for which the marketplace is ready and equally one that will produce healthy margins for the business.
- **Assemble the right team**: The team who is running the current business operations is not necessarily the best placed to drive for disruptive innovations. This will require people who are agnostic to the business model practices and are proven lateral thinkers with the ability to search for an unknown business model. A management team which aspires to have a persistent business growth based on innovation has to create perpetual flow of new people and ideas through its ranks. As it is important to have management continuity by including people in innovation initiatives who know how to work internal systems, it is equally important to include new people who often live at the fringes of a given organization in order to insert unique, difficult-to-understand outlook into the process. This composite set of competencies, outlooks and interests is much more likely to produce a practical competitive advantage.
- **Make informed, courageous and timely decisions**: The lean methodology rests on the assumption that the business framework supports rapid decision making. It is essential to be able to quickly discontinue work on innovation ideas that hit too many roadblocks. Any cooperation between business and academia that requires a rigorous planning process or is biased with political consensus-based decision mechanisms is very unlikely to create the lean environment conducive to disruptive innovation. Leaders on both academic and business sides have to ensure that their resource allocation, project management and internal value system encourage the rapid-fire experimentation that characterizes a lean process.

There are indeed substantial opportunities for HIM to build a lean methodology culture which bonds engineering and academic innovation processes and teams. The impact of the collaborative innovation can be maximized by management practices that rest on the three pillars explained above.

HYBRID INNOVATION MODEL: ASSESSMENT PROCEDURE

Any innovation model eventually distils to a set of implicit rules, norms, and requires performance metrics for proper governance of its operation. The assessment metrics which usually consist of a set of questions has for its objective to help us determine how effective HIM based efforts are in practice. Asking the five questions below can give you a sense of how HIM is well suited for the problem at hand.

1. **Are objectives of engineering and academic sides well aligned?** It seems obvious that two sides must not have orthogonal objectives for the planned collaboration. Certainly, even the lack of clear objectives on either of the two sides will not create an environment for innovators to thrive within because it won't get management's attention and adequate prioritization relative to other activities. Equally, the inability to clearly explain mutual motivations behind the drive to co-innovate is likely to

produce confusion which in extreme situations might expand into mistrust. To be valued and produce a strategic impact HIM needs to involve engineering and academic organizations of which both are prepared to take on the uncertainties that come with innovation. HIM will be most impactful when the pace of transformative change is not dictated by early signs of tectonic industry shifts.

2. **Is the team committed to innovation and lean practices?** Admittedly, this assessment should be done prior to assembling the team. Nevertheless the question should be continuously answered throughout the duration of the project. At the earliest clear signal that the team is failing to meet the deadlines the leadership has to critically assess its own work, whether all necessary competencies are brought into the mix, whether the objectives are exciting and energizing, whether the mutual objectives are still aligned, whether it is making timely and transparent decisions, etc.
3. **Does either the engineering or academic partner already have firsthand experience with lean principles?** It would be very difficult for HIM to be managed as a lean process if neither side had prior experience with successfully using lean methodology. Theoretical understanding alone won't be sufficient, ensure that the HIM team feels comfortable with aggressive deadlines, collaborative problem solving, frequent evaluation and transparent decision making. A HIM team stacked with close minded industry veterans fighting back or being afraid of disruptive change is very unlikely to produce a desired result.
4. **Is collaboration part of two partners' DNA?** Some companies encourage collaboration, looking to learn from the partnerships and are comfortable with the engagements both inside and outside their immediate line of work. Such companies believe in humility as a cultural value, recognizing that they don't have all the answers. Signs pointing to inquisitively collaborative companies include participation in cross-industry consortiums and support for a moon-shot style of academic research.
5. **Does HIM address a practical problem?** Every and each HIM effort should aim to solve practical problems, produce innovative and creative solutions which are implementable and have significant business potential. Business relevance should be assured through careful assessment of the market trends and current state of the art of solutions used. It is often said that necessity is the mother of all innovation, thus an understanding that competition is active in their search of a disruptive technology is likely to ensure relevance of the effort. Equally it is important to ensure that demonstrations are built into the experimentation projects in order to gauge the level of possible impact that innovation can produce.

If you happen to be planning to use HIM to address any development needs then these five questions have to be answered in a convincing way before and during the implementation phase. Any ambiguity in answers adds to the odds that the collaborative effort is to have difficulties with following the lean process and lowering the business impact of the innovation conceived.

EXAMPLE HYBRID INNOVATION PATTERNS: ContextSENSE CASE STUDY

Innovative technology solutions are dramatically affecting the way modern service operates. By means of mobility and cloud computing, services are consumed by users whenever and wherever they are. The changing nature of the application lifecycle is forcing developers to take a user-centric approach to service offerings and it is where our innovative product named ContextSENSE comes into play. Strong proliferation of smart phones and tablets and ever growing number of WiFi users is creating an opportunity for better utilization of WiFi infrastructure by its operators in terms of strengthening their business development. One way for achieving this is

learning the needs and requirements of WiFi users/customers by their segmentation and responding to those needs by adaptive content/information delivery thus improving their service offering.

In a joint brainstorming session between DIEM and LCI this opportunity was further analysed and it was decided to create a joint project between the two organizations. The main objective of the project was to "sketch usage of WiFi" infrastructure in terms of localized collective user behaviour. Localization is provided by intrinsic WiFi coverage limitations which can be approximated as a circle with a 50m diameter and the AP in its center. The ContextSENSE Portal solution will provide its stakeholders including, but not limited to network providers, public enterprises, shopping malls, food and beverage SMEs, with useful data in respect to consumer behaviour and preferences within the coverage area of a given AP.

There are two components to the envisioned solution:

a) WiFi controller providing Captive Portal feature for wireless networks. The controller is based on commercial hardware components and open source software. The advanced features of this controller are reflected in its ability to collect WiFi user's related data which cannot be gathered using standard monitoring systems for WiFi networks. User's related data are classified in three main sets: social network related data, technology related data, and geo-location/mobility patterns data. Data are gathered using web analytics tools.

b) User friendly application/service for processing the collected data in order to recognize usage patterns that are of interests to corresponding Market and User research activities within geographical area/locations covered by a given WiFi network.

A joint team between LCI and DIEM was put in place with clear assignment of responsibility: DIEM was focussed on business development, LCI on the solution architecture while the user cases and applications were discussed across entire team. The activities of the joint team were guided by the three principles as prescribed by lean start-up methodology (Blank, 2013):

1) Rather than making elaborate research plans, the team accepted the challenge to deal with ambiguity of initial objectives. A business model canvas was used to flash out different business hypothesis and eventually the team agreed to test the "Sketch your WiFi usage" hypothesis as the central theme to the proposed business value.

2) The team wasted no time waiting to test its hypothesis and engaged international partners in discussing the value proposition. A partner from Italy with extensive IT experience provided valued feedback on all elements of the business model and planned product features. Within two weeks from the start of the project the hypothesis was validated and the "joint venture" was ready to move to the next phase of development. Through further discussions with the ARMUNS team we received the additional input on possible implementation challenges and we changed our product requirements and final design accordingly.

3) Engineering team started to work on implementation in an iterative fashion, had quickly implemented initial set of features and tested it in a lab environment. Development stayed agile in order to accommodate development of additional functionalities and features needed before the ContextSENSE service can be integrated with live wireless network jointly operated by LCI and ARMUNS.

The ContextSENSE^{TM} solution was deployed on campus at the University Novi Sad, Serbia, in May, 2013. The outdoor Wi-Fi network infrastructure is based on wireless mesh technology. It comprises 2 gateways and 5 APs which are deployed across different locations on campus as shown in Figure 1. Numbers in map pins indicate number of users per AP in the moment when the snapshot was taken. The database of registered users for this network includes more than 5000 accounts. The ContextSENSE^{TM} portal is deployed in the core side of the network, thus enabling

seamless roaming of users without the need for re-authentication. ContextSENSE^{TM} controller is based on MikroTik (Web-1) router-board and open source embedded Linux OS called OpenWrt (Web-2). OpenWrt is primarily used for configuring diverse network elements.

Figure 1: Wireless mesh network with ContextSENSE controller at the University of Novi Sad

CONSCLUSIONS

Lean start-up principles were initially designed to propel technology ventures to fast growth. Here we have adapted it to handle a collaborative process used to govern development of a disruptive innovation as related to turning ordinary WiFi access point into a sensory network. As the lean principles are used to expeditiously search through vast amounts of information already available in today's Internet era, although here associated with an empowering disruptive innovation, the model is equally applicable to the other two types of innovation, namely "sustaining" and "efficiency" types. Moreover, by combining engineering pragmatism and academic rigor within the lean team we were able to focus our attention and get beyond the initial product, engage both potential users and customers and eventually build a ContextSENSE platform which is capable of supporting the fast evolution and addition of supplemental features. The innovation is successfully developed and deployed in less than four months from its kick-off start date and as such it vouches for the effectiveness of lean methodology when applied to govern innovation processes across engineering and academic domains.

ACKNOWLEDGEMENTS

The authors acknowledge the financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia, within the Project No 47005.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

2008-2012 Employee Expectations About Lean Six Sigma Education in Manufacturing Companies Experiences From Comparison Study in Slovenia 2008-2012

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ABSTRACT

Results of the comparison study between 2008 and 2012 show us, that employees and participants had before training high expectancies from lean six sigma on the field of learning practical use of lean six sigma, getting knowledge about experiences of lean six sigma projects and on the field of access to professionals on the field of lean six sigma. On the other hand their expectations became true on the field of getting knowledge about lean six sigma quality tools, getting access to the new quality tools and learning how to use lean six sigma for practice. Questionnaire was sent to 100 Slovenian manufacturing companies based on the similar research in 2008. The primary implications of these findings are related with comparison study between 2008 and 2012 on the field of lean six sigma employees in the Slovenian manufacturing companies. Results of the comparison study show us, those expectations of the employees before lean six sigma trainings are in 2012 lower than they were in 2008. This topic hasn't been applied in Slovenia and present unique and first study on this field. Results of this study can be useful for practioners and researchers on this field in similar economies such Slovenian are, for example in Serbia.

KEYWORDS: lean, six sigma, education, expectancies, employees,

INTRODUCTION

In the extreme dynamic business environment, different corporations look at any possible opportunity for business and process optimisation (managing time, costs, processes and products). Many different tools can be used on this field. Some of them are Deming's (1982) cycle, total quality management assessment methodologies including Malcom Baldrige National Quality Award Assessment or the European Foundation for Quality framework, the much popularised Dorian Shainin's Statistical Engineering , etc. (Antony et al, 2005). One of last decade's very exposed and growing methodology also in Slovenia is six sigma. It emerged in the late 1980s from the quality improvement efforts at Motorola, and has since been embraced by companies around the world as a comprehensive framework for business management (Buch et al, 2006).

Lean Six sigma, processes, products and customers

Lean Six sigma is a well-established approach that seeks to identify and eliminate defects, mistakes or failures in business processes or systems by focusing on those process performance characteristics that are of critical importance to customers (Snee, 2004). Lean Six sigma is also an approach to organizational change that incorporates elements of total quality management, business process reengineering, and employee involvement (Quinn, 2003). Manufacturing companies are aligning their products to their final customers (Gošnik, 2006). Customers are becoming more and more aware of their power and quality of the product perceive in its functions (Gošnik, 2006). The lack of market aspects of the product can lead to project wrong project objectives (not customer focused) and to unsuccessful products (Gošnik, 2005). The absence of customer focused product and project lead to increased risk on the project and is related with the defining

phase of every project and capability of project management (team leader and team) (Gošnik, 2008). Partial views on the project are related with many risks (Gošnik, 2006).

Lean six sigma as a learning structure

Most lean six sigma programs adopt the hierarchical level of involvement that evolved at Motorola, and its associated terminology. At the center of the hierarchy are Black Belts and Master Black Belts; these individuals receive extensive training in experimental design, data analysis, and process control in order to serve as company-wide six sigma resources. (Buch et al, 2006). The Black Belt role is said to have emerged from what were previously labelled "local statistical resources" at Motorola (Larson, 2003), with the label changing in the early 1990s. (Buch et al, 2006). Today, it is common for the Black Belt role to be a rotational one, where the individual serves as a fulltime six sigma resource for 18-24 months, and is then expected to re-enter the organization and apply six sigma tools to normal business activities (Bertels, 2003). Master Black Belts (MBB), on the other hand, are Black Belts (BB) who receive certification and do not rotate back into normal business roles. (Buch et al, 2006). Master Black Belts serve as the liaison between six sigma project teams and what is typically referred to as the six sigma committee, which is comprised of process owners (managers in whose areas six sigma teams are chartered), and champions (executives sponsoring cross-functional projects) (Buch et al, 2006). The six sigma committee is thus at the top of the six sigma hierarchy in a typical organization, as all projects must be traced back to a process owner or champion (Bertels, 2003). At the bottom of the six sigma hierarchy is the project team. Green Belts (GB) receive much less extensive training than Black Belts (BB) in team dynamics, problem-solving, and quality improvement tools, and typically spend 20-25 percent of their work time on six sigma projects. (Buch et al, 2006). Green Belts (GB) can be from all levels of an organization, and companies vary in how employees are selected for the Green Belt role. In some companies, Green Belt candidates must be recommended by managers; in other companies, such as the one in the current study, employees may volunteer to become Green Belts. The six sigma structure assumes the form of a parallel learning structure (Buch et al, 2006). The extent to which the parallel structure is integrated into the existing organization structure will impact the success of the program (Shani and Docherty, 2003).

RESEARCH METHODOLOGY

Main objective of this study is to research expectancies of lean six sigma employees before six sigma education and compare to what extent they were fulfilled after the education. The research is focused on Slovenian manufacturing organisations and is a comparison study between 2008 and 2012.

The questionnaire was e-mailed in April 2008 out to 100 production companies in Slovenia. Of the 100 questionnaires mailed, 21 total completed questionnaires were returned in 3 month time. This represented a response rate of 21 per cent which is similar to other researcher worldwide using this tool (survey). In 2012 survey was made in april 2012 on the field and there were gathered 33 fulfilled questionnaires.

Areas of industry

Number of companies participated in this study in 2008 included the mechanical engineering (34,5 per cent), automotive (23 per cent), electro (9,5 per cent), chemical (19 per cent) and telecommunication (14 per cent). Number of companies participated in this study in 2012 included the mechanical engineering (73 per cent), automotive (24 per cent) and chemical (3 per cent).

For the analysis of the companies were used data available in Six sigma academy of Slovenia and also in the Six sigma association of Slovenia. Companies and members of this association are active experts from different companies in Slovenia and were also interested in this research. The number of companies is limited by the number of companies which have implemented lean six sigma. Participants were middle management experts and managers which work on the field of quality management.

The research questions in this research were:

RQ1. What were the expectancies of lean six sigma candidates before lean six sigma education?

RQ2. To what extent the lean six sigma education fulfilled their expectations?

and finally;

RQ3: What differences show us comparison study between 2008 and 2012?

In this study, a survey questionnaire was defined based on experiences, literature and previous researches of the authors on this field. The survey was developed for Slovenian manufacturing companies and is useful for further researches and continuous studies on this filed and further possible comparison studies.

Some previous researches on this field were made by the author already in 2009. (Gošnik, 2009; Gošnik, 2009-1; Gošnik, 2009-2; Gošnik and Hohnjec, 2009; Gošnik et.al, 2010) and present a basis for a comparison study for 2012.

RESULTS AND DISCUSSION

Characteristic of the sample

In the first part of the questionnaire analysis help us to understand better the findings of the study. Several crucial aspects have been analysed such as; number of employees, therefore, aspects such as the number of employees in the organisation, the position occupied by the respondents, the areas of industries, the status of six sigma implementation, number of years of presence of six sigma in the company and number of finished six sigma projects within the organisation.

Status of lean six sigma and other quality iniatives of companies

Only 8 out of 21 companies (38%) were actively involved in the lean lean lean six sigma programme. These are the focus of our research. 49 percent of the companies have been using lean six sigma less than one year, 38 percent of the companies have been using lean six sigma for one to three years and 13% of the companies have been using lean six sigma more than three years. It clearly shows us that lean six sigma is relatively new methodology in Slovenian manufacturing companies. Eight lean six sigma manufacturing companies in Slovenia were included in the research. The majority of all respondents in those companies (about 61,6 per cent) to the questionnaire were lean six sigma green belts (GB); 15,3 per cent were lean six sigma black belts (BB), 15,3 per cent were lean six sigma yellow belts (YB) and 7,8 per cent were lean six sigma master black belts (MBB). The authors strongly believe that this figure might change with the increased sample size. Respondents were asked to rank each of the claims on the five stage (1 to 5) Likert scale meaning; 1-I did not expect at all, 2…, 3…4…, 5 – I expected very much). Higher the rank is, bigger the expectations were. As described below, item and subscale means were first calculated for the total sample. In the research in 2012 there were included 33 practioners on the field of lean six sigma who daily work on the field of quality, production process management, primarily on the level of middle management. (See also Area of the industry upper on in this article).

Table I shows results of the comparison study about the expectancies of employees before lean six sigma (SS) education involvement in 2008 and in 2012.

Table 1: Expectancies of lean six sigma candidates before first lean six sigma education

Expectancy items	Mean value (1 to 5) 2008	Mean value (1 to 5) 2012	Higher score in 2012	Lower score in 2012
"I'll get know how to get involved in SS"	**4.610 (1)**	**4,00 (1)**		-0,610
''I'll get adequate knowledge about processes"	**4.300 (2)**	**4,00 (2)**		-0,30
" I'll get adequate access to quality professionals"	4.200	3,50		**-0,70**
" I'll get adequate management support"	4.070	2,50		-1,57
"I'll get adequate knowledge of quality tools"	4.000	3,50		-0,5
" I'll get adequate access to quality tools"	4.000	3,50		-0,5
" I'll get the knowledge needed to use step to step approach in processes on the field of quality''	3.840	3,00		**-0,840**
"I'll get adequate knowledge of statistics"	3.610	3,00		**-0,610**
"I'll get the knowledge needed to scope a project"	3.150	3,50	**+0,35**	
"I 'll have adequate time to work on a project''	2.760	3,50	**+0,74**	

As shown in Table I, overall means (for the total sample) were calculated. As described above, the "skill" subscale allows us to make conclusions about the strength of the training as a driver of lean six sigma. Calculated mean value in the studies in 2008 and 2012 show us practically the same results on the top positions. Some expectancy items such as: " I'll get the knowledge needed to use step to step approach in processes on the field of quality'' and "I'll get adequate knowledge of statistics" are in 2012 detected much more lower than in 2008 were. This might be related with the profile of the employees involved in this research. Some of them took only a basic lean six sigma training and before the training actually didn't know

about the power od lean six sigma tools. On the other hand results in 2012 show us much higher expectations on the field of the items such as: "I'll get the knowledge needed to scope a project" and "I 'll have adequate time to work on a project'' which is on the other hand related with the organisational structure within the manufacturing companies. They are often organised in a rigid hierarchy and lean six sigma force us to use process/team approach. Therefore this might be related with the companies profile included in this research and is understandable. Full time lean six sigma trainings also offer us well organised project road map and require also adoption of less rigid organisational structure which support continuous improvement by the use of lean six sigma tools.

Further on Table II show us results of the comparison study between 2008 and 2012 about fulfilment of the expectations which after lean six sigma education. Table II.

Table 2: Comparison study for 2008 and 2012 about expectations before lean six sigma education and fulfilment of the expectations after the education

Fulfilment item	Mean score (1 to 5) 2008	Mean score (1 to 5) 2008	Expectations higher in 2012	Fulfilment lower in 2012
" I'll get adequate access to quality tools"	**4,38 (1)**	2,50	/	**-1,88**
"I'll get adequate knowledge of quality tools"	**4,20 (2)**	**4,00(1)**	/	-0,20
"I'll get know how to get involved in lean six sigma"	**4,15 (3)**	**4,00 (1)**	/	-0,15
" I'll get adequate access to quality professionals"	4,15	3,00	/	**-1,15**
" I'll get the knowledge needed to use step to step approach in processes on the field of quality''	4,07	**4,00 (1)**	/	-0,07
" I'll get adequate knowledge of work processes"	4,00	3,50	/	-0,50
"I'll get adequate knowledge of statistics"	3,84	3,00	/	-0,84
" I'll get adequate management support"	3,76	3,50	/	-0,27
"I'll get the knowledge needed to scope a project"	3,69	3,50	/	-0,19
"I 'll have adequate time to work on a project"	3,00	3,00	/	/

Analysis between 2008 and 2012 show us some differences. Item: " I'll get adequate access to quality tools" seem to be in 2012 detected as the lower rate of the fulfilment in comparison to 2008. This might be

explained with the fact that participants in 2012 took only a basic lean six sigma training. So, results might be related with the level of the education. Higher the level of the lean six sigma education is (for example: lean six sigma black belt training), much more powerful quality tools are included in the training. Item such as: " I'll get adequate access to quality professionals" also has a lower fulfilment rate as in 2008. This is understandable, because majority of the trainings in 2008 were in Slovenia held on the market, where participants from many different companies participated on the training, but later on prevailed so called in company trainings, where the training was performed only for the participants form the same company. From this point of view there wasn't possibility that during the training participants meet other lean six sigma experts.

CONCLUSIONS

Calculated mean value shows us that the top three higher expectations of employees before lean six sigma education were;

- I'll get know how to get involved in lean six sigma;
- I'll get adequate knowledge of work processes; and are for 2008 and 2012 practically the same.

Analysis of the fulfilment of the expectations shows us that the following top criteria were fulfilled: "I'll get adequate knowledge of quality tools" and "I'll get know how to get involved in lean six sigma". Results from 2008 and 2012 show practically the same priorities. Some differences show us item: " I'll get adequate access to quality tools", which as explained might be related with the level of the lean six sigma training which participants in the study in 2012 actually participated.

Monitoring employee expectancy allows us to fit training, facilitation, and oversight to be targeted in terms of who needs what and when. Challenging content and claims low expectancies suggest the need to carefully examine the intervention training – at all levels – in terms of the amount and length of the training, its timing, and the pedagogical techniques used to convey the material. Our results suggest that experiential approach to lean six sigma training, where employees receive initial training in the context of their first lean six sigma project. Further analysis could be oriented in analysis of the expectations by comparing the expectancies of yellow belts, green belts and black belts. The authors strongly believe that this figure might change with the increased sample size or companies profile included in the research. Future researches will be oriented in the comparison studies with similar economies such as Slovenia is.

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Belgrade, Serbia, 5th-6th September 2013

Characters of Lean Six Sigma project managers in manufacturing companies
Experiences from comparison study in Slovenia 2008-2012

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ABSTRACT

The results of the comparison study between 2008 and 2012 indicate that Slovenian manufacturing organisations include that some perceived characteristics of lean sigma project managers differ in time, and include project manager characteristics such as: team builder, objective oriented, manage changes, defend customer, think positive, motivates, oriented to real problem solution, respect others, innovative, effective communicator and takes risk. Questionnaire was sent to 100 Slovenian manufacturing companies based on the similar research in 2008. Results from 2012 show us high level of expectations from lean six sigma project managers on the field of innovativeness, required orientation to defend customer interests and to the risk taking. This is related with the current situation of Slovene manufacturing companies and theirs challenges in 2012. The results of this study are very useful for future education of six sigma project managers and will help to focus on attributes required and perceived in this research. Future research will be oriented in continuous research in this field and comparison studies with similar economies such as Slovenian are. This topic hasn't been applied in Slovenia and present unique and first study on this field. Results of this study can be useful for practioners and researchers on this field in similar economies such Slovenian are, for example in Serbia.

KEYWORDS: Lean, six sigma, project, characteristics, manufacturing,

SIX SIGMA PROJECT MANAGERS AND THEIR CHARACTERISTICS: LITERATURE REVIEW

Six sigma provides the opportunity for project managers to be leaders of business improvement. Six sigma project managers candidates should be: (Antony et al, 2007)

- a self-starter who can work on their own initiative;

- able to lead, mentor and work in a team;

- an effective communicator at all levels;

When searching for a six sigma project manager candidate the desirable qualities include a mix of technical aptitude, leadership skills and soft skills such as meeting management. Hoerl (2001). Also Harry and Schroeder (2000) list the following characteristics to be considered as an effective six sigma project manager (black belt):

- ability to understand the "big picture" of the business;

- possesses excellent communication skills, both written and verbal;

- inspires others to excel;

- allows room for failures and mistakes with a recovery plan;

Adams et al. (2003) and Antony et al, (2007) have come up with the following criteria for the selection of six sigma project managers candidates (black belts):

- Performance. Do not select the people for BB training that no one else in the company wants.

- Management potential. Experience in managing people and also to leading a team of people.

- Technical capability. Demonstrate the technical competency by showing how various tools and techniques of Six Sigma can be applied to a problem solving scenario.

- Self-starter. Select the people who have initiative.

- Passionate-about the application of Six Sigma methodology and tools.

The interaction between marketing, development and technology supports the process of innovation, the defining and development of innovative product (Gošnik, 2005-1).

RESEARCH METHODOLOGY

Main objective of this study is to research basic characteristics of six sigma project managers and to compare study results between 2008 and 2012 The research is focused on Slovenian manufacturing organisations.

The research question in this research is:

RQ1. What are the essential characteristics of characteristics of lean six sigma project managers in Slovenian manufacturing organisations ?

RQ2: What show comparison study results between 2008 and 2012?

In this study, a survey questionnaire was defined based on experiences, literature and previous researches of the authors on this field. The survey was developed for Slovenian manufacturing companies and is useful for further researches and continuous studies on this filed and further possible comparison studies. Some previous researches on this field were made by the author already in 2009. (Gošnik, 2009; Gošnik, 2009-1; Gošnik, 2009-2; Gošnik and Hohnjec, 2009; Gošnik et. al, 2010) and present a basis for a comparison study for 2012.

RESULTS AND DISCUSSION

Characteristic of the sample

In the first part of the questionnaire analysis help us to understand better the findings of the study. Several crucial aspects have been analysed such as; number of employees, therefore, aspects such as the number of employees in the organisation, the position occupied by the respondents, the areas of industries, the status of six sigma implementation, number of years of presence of six sigma in the company and number of finished six sigma projects within the organisation. The questionnaire was e-mailed in April 2008 out to 100 production companies in Slovenia. Of the 100 questionnaires mailed, 21 total completed questionnaires were returned in 3 month time. This represented a response rate of 21 percent which is similar to other researcher worldwide using this tool (survey). In 2012 survey was made in april 2012 on the field and there were gathered 33 fulfilled questionnaires.

Areas of industry

Number of companies participated in this study in 2008 included the mechanical engineering (34,5 percent), automotive (23 percent), electro (9,5 percent), chemical (19 percent) and telecommunication (14 percent). Number of companies participated in this study in 2012 included the mechanical engineering (73 percent), automotive (24 percent) and chemical (3 percent). The author strongly believe that this figure might change with the increased sample size.

Six sigma project manager characters in six sigma organisations

The following table (refer to Table I) shows the mean responses of top 12 essential characters for six sigma project managers (Table I).

Table 1 Results of the comparison study of Six sigma project manager characters

Characters	Mean value 2008 (1 to 5)	Mean value 2012 (1 to 5)	St.dev. 2012	Higher Mean value in 2012	Lower mean value in 2012
Change agent	**4.920 (1)**	4,21	0,74		**-0.71**
Results oriented	4.640 (2)	4,24	0,83		-0,4
Motivated to lead	4.500 (3)	4,42 (1)	0,75		-0,08
Effective communicator	4.420 (4)	4,39 (2)	0,75		-0,03
Positive thinker	4.350 (5)	4,36 (4)	0,78	+0,01	
Networking ability	4.350	4,36 (3)	0,70	+0,01	
Respect for others	4.280	4,27	0,76		-0,01
Problem solving ability	4.210	4,30	0,77	+0,09	
Team builder	4.140	4,21	0,86	+0,07	
Innovative	4.140	**4,42 (1)**	0,75	**+0,28**	
Defends customer interests	3.570	4,03	0,88	**+0,46**	
Risk taker	3.070	3,82	1,01	**+0,75**	

Results of the comparison study show us some differences in perceived characters of six sigma project managers, such as: Item ''Change agent'' is in the study 2012 detected to be much less important character of six sigma project manager as it was in the study in 2008. This can be explained with the fact, that after 2008 when a crisis occurred a main impulse for change was external crisis, rather than an internal cause. On the other side, some items such as: ''being innovative'', ''defending customer interests'' and ''risk taker'' became much more wanted personal characteristics of six sigma project managers in 2012 than in 2008 were. This can be explained also with the fact that from 2008 to 2012 we have 4 years more experiences with six sigma as we had it in 2008. So different priorities and different project occurred in the companies in 2012 as they were in 2008. Many projects in 2008 and at the beginning of six sigma implementation were focused on quick wins and easy earnings. (Gošnik, 2009). After all this period 2008-2012 also a structure of six sigma project has changed and priorities has changed too, and consequently that can be related with detected personal characteristics of the six sigma project managers in 2012.

CONCLUSION AND FUTURE RESEARCH

The paper illustrates the role and the essential attributes of six sigma project managers in Slovenian manufacturing organisations and show us comparison study between 2008 and 2012. The authors make an attempt to compare the essential attributes of six sigma project managers proposed by many practitioners and academics who have carried out research in the field. The top five essential characteristics for six sigma organisations in 2012 include: Being (1) innovative six sigma project manager, (2) being effective communicator, (3) having networking ability, and (4) being positive thinker. In 2008 the top positioned character was (1) being change agent and (2) results oriented. Six sigma projects in Slovenia 2008 were more oriented on quick wins with a high probability of success. Today, in 2012 after 4 years more of experiences of Six sigma in Slovenia projects are much more risk and customer oriented which reflect today's economic situation. Author strongly believe that this figure might change with the increased sample size or companies profile included in this research. Future researches will be oriented in the comparison studies with similar economies such as Slovenia is.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

The Five Killers of Lean Implementation in Sustainable Food Supply Chain

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ABSTRACT

This paper discusses the barriers to successfully implement Lean production systems in food industry in China. Data from two cooked food firms were collected through interview. For each case, the interview involved senior management, project managers, engineer and workers. The five main barriers of lean implementation are identified from the study: employee turnover, knowledge gap, shop floor working culture, management style, and poor employee training. This paper discusses the wider implication of this research and potential future research directions.

KEYWORDS: Lean, China, implementation, barriers, food supply chain

INTRODUCTION

This paper examines the barriers to successful Lean implementation in Chinese food industry. The reasons to focus on the Chinese food industry are: a) China consumes one third of the world food production and reducing food wastage through Lean is a current top priority; b) China has the most dynamic and complex food industry in the world, no research on Lean food study can be done without China; and c) China food industry shares many similarities with the rest of the developing countries, thus insights gained from China could shed light to Lean food production in Asian countries. In this study, two Chinese cooked food firms i.e. manufactures and sell primarily a large variety of prepared food such as roast chickens, roast ducks and sausages, were conducted.

Lean production was first defined by Womack, et al. (1990) as a system that creates outputs using less of every input, similar to the traditional mass-production system but offering an increased choice for the end user. This definition of lean production was based on the concept of waste ("muda") introduced by the Toyota Production System (Dues et al, 2012). Waste means non-value-adding activities that, in the eyes of final customer, do not make a product or service more valuable (Hines and Taylor 2000). Womack and Jones (2003) summarized five principles of Lean in their book Lean Thinking: specify value by specific product, identify the value stream for each product, make value-flow without interruptions, let the customer pull value from the producer, and pursue perfection. Since then, various empirical studies were conducted in automobile and engineering-oriented and assembly industries.

Nonetheless, research on lean implementation in the food industry is very limited. More so, on the food manufacturing environment in the context of China. Thus, this paper will make significant knowledge contribution to existing Lean and food manufacturing literature. This paper is structured in three main sections. Firstly, we provide a comprehensive literature review regarding the current issues and barriers of lean implementation in China food industry. Then, the findings from two empirical case studies were discussed. Finally, we discuss how these barriers to lean implementation could be overcome.

FIVE KILLERS OF LEAN IMPLEMENTATION

From review of existing Lean and strategy implementation literature, following five main barriers i.e. killers of lean implementation were identified. Figure 1 illustrates the five killers of lean implementation.

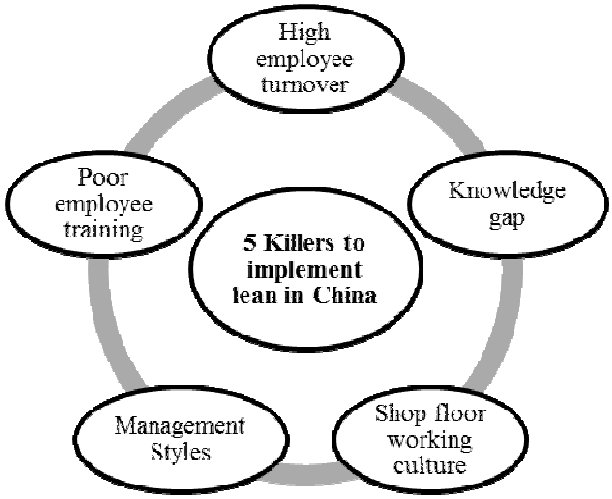

Figure 1: Five Killers of Lean Implementation in China

Killer 1: High employee turnover

Several authors (Brown and O'Rourke, 2007; Aoki, 2008) described that high employee turnover usually act a central obstacle for lean implementation in Chinese firms. They argue that lean transformation of shopfoor is a time-consuming process and may involve costly employee education. Taj (2005) stated that ten percent of the firms who took part in the survey described an employee turnover of over 30% each year. Paolini et al. (2005) indicated a general flow of experienced staff to firms that pay higher salaries is a main challenge faced by Chinese food manufacturers. In short, existing literature pointed out high employee turnover in Chinese firms could lead to negative impact on Lean implementation as managers is not willing to train workers accordingly. Hence, creating a knowledge gap (on Lean) between management and workers.

Killer 2: Knowledge gap

Knowledge gap of the Chinese workforce has also been widely cited as a major challenge to implement lean production. The Chinese manufacturing industry has grown rapidly in the last decade. To run the production, manufacturing firms recruit an increasing number of workers. Knowledgeable workers with Lean manufacturing experience are rare in the job market. Furthermore, driven by cost-saving strategies, many factories purposefully attract less educated workforces from countryside areas: agricultural villages with little exposure to basic manufacturing techniques (Brown and O'Rourke, 2007). However, the employees within a Lean production system provide individual improvements within the system (Ohno, 1988). A highly skilled workforce is therefore critical for realising continuous progress (Liker and Hoseus, 2008).

The skill deficits are not just limited to the shop floor level. Academics also discuss skill insufficiencies within the management team. Paolini et al. (2005) claimed a lack of skills of local managers which do not enable them to conduct skills development trainings. Lee (2004) supports these claims by focusing an absence of direct coaching by local academic organizations and professionals as a difficulty to introduce TQM in Chinese firms. Aminpour and Woetzel (2006) recognized a shortfall of manager's problem solving skills.

Killer 3: Shopfloor Working Culture

The Chinese working culture plays a fundamental position in employing Lean manufacturing in China. The working culture cited as impediments are: absence of initiative, little involvement, absence of team working, and tolerance of untidiness. Aoki (2008) showed that there is absence of self-initiative of the Chinese shop floor workers in a study of transferring Japanese Kaizen activities to Chinese plants. The

researcher described that the Japanese executive team found it difficult to inspire Chinese workers to present self-initiative.

Aoki's (2008) case study disclosed that only staffs above team leader level made proposals to advance work practices. Chin and Pun (2002) also found that workers were found to be unenthusiastic or unaware on how to make contribution to improve work practices. Similarly, Chen and Bo (2008) found an absence of staff participation when employing the 5S in Chinese plants: shop floor workers saw 5S as extra burden and resist it.

Paolini et al. (2005) justified that the non-attentiveness to product quality by the top down method was the main culprit: a low empowered operator is not able to raise their own ideas successfully and take inventiveness. Together, a high power distance of Chinese workers from their managers is very likely to limit worker's suggestion. Lee (2004) also mentioned that a low empowered organization and poor allocation of power impedes lean production.

Teamwork is an essential part of lean manufacturing. Paolini et al. (2005) argued a nonexistence of team-working culture among the Chinese workers. The authors further explain the shortages may be raised with one-child programme of China government, which lead to 'spoiled-child-syndrome'.

Furthermore, a tolerance of untidiness among the Chinese workers has been mentioned. Wong (2007) suggested that Chinese workers tolerance for a disorganized workplace contradicted to housekeeping tools such as 5S.

Killer 4: Management style

The firm's management culture was impeding the employment of Lean production (Aminpour and Woetzel, 2006; Oliver et al., 1998). Consistent with the Lean concept, shop floor workers need to be authorized to propose suggestion from the bottom (Liker, 2004). Bottom-up improvement is pretty new to Chinese management (Oliver et al., 1998). Lee (2004) also mentioned that little authority has been delegated to operators, leading to little operational improvement. Lee further cited the hierarchical structure of Chinese organizations as a possible reason. Paolini et al.'s (2005) justified a top-down approach over empowerment in Chinese organization: middle managers being anxious of dropping power when introducing lean concept.

Killer 5: Poor employee training

Chin and Pun (2002) studied the implementation of Lean concept in China and found that poorly trained workforce in their investigation. Generally, HRM departments in Chinese firms did not recognize the significance of training (Lee, 2004)

Current employees have often misunderstood Lean as a "leaning of the workforce". Adopting a new manufacturing philosophy requires absolute buy-in with everyone from top-level managers to process line employees being a stakeholder. This cannot happen without proper worker education (Langhauser, 2008).

ISSUES OF LEAN IMPLEMENTATION IN FOOD INDUSTRY

The main focus of lean manufacturing is to relentlessly reduce waste and quicken the flow of the product to the consumer. The removal of waste is fundamental to the lean value stream (Hines and Taylor 2000). The food industry, however, working with perishable products that cannot accumulate, is no stranger to continuously flowing product out the plant door and into the hands of the consumer. Therefore, there has been a misperception that lean is not necessary in the food industry. Once this market began to realize that waste could come in other forms, lean thinking became more practical. To define waste in a particular process is difficult especially in food industry. Specifically, production process could be conducted at specific period within a year, such as some agricultural products that need to be harvested in specific period, while the sales process could be throughout the year. Thus, inventory waste must exist with practical reason.

Furthermore, lean production was considered not to be easily applicable in large batch processing industry which produce products consistent with a long term forecast as the breeding and framing of raw material take a lot time, which lead to disproportion between the production level and actual demand.

The equipment and machines used should be reorganized as a way to minimize all kinds of waste during food processing. However, it is also a big challenge for food industry because much of the industry's traditional equipment tended to be large and difficult to move. Such obstacles potentially limited the reorganization of workspace in a plant.

RESEARCH METHODOLOGY

The study of barriers to implement lean production has relatively little theoretical background. Case study research is especially appropriate for studying how to overcome barriers in the context of a Chinese food manufacturer. Many researchers (Meredith, 1998; Tan et al, 2011) point out that the aim of a case study may be exploratory (to define questions or hypotheses), descriptive (to depict a phenomenon within its context), or explanatory (to identify cause-and-effect relationships) in nature. The selected research design involves describing implemented lean practices. These practices are a subset of the whole set of lean implementation strategy, which also include customer, supplier and workforce management practices.

Participating Firms

Two Chinese food firms have been selected. The reason for these two firms selected are: 1) similar regional coverage; 2) both of them produced similar cooked food (Duck, chicken, pig, beef, and some vegetables) and was established at the same time; 3) The lean performance outcome of these two firms are different, even though both of them embraced Lean about the same time. Under this similar background, case study would be a deliberate research design strategy chosen, which would augment validity of finding of research. Table 1 provides the synopses of the two firms.

Table 1 Case Background

	Annual turn over	**Production**	**Number of shop floor workers**
Case A	¥150 million	Cooked food (duck, pork, beef, lamb, vegetables)	379
Case B	¥50million	The same as Case A, but the species are less than Case A	137

The research was conducted through a series of interviews in 2012/2013. The interview involved the managers (purchasing, distribution, market) who are able to provide some valuable information in these two firms. The multiple interviewees assist to provide a richer picture of each case, because of the information ignored by one interviewee may come out from other interviewees (Yin, 1994). The tape recorder was used to avoid researcher's bias in data collection and analysis. Moreover, the interview also included the suppliers of both firm in order to confirm the managers' viewpoints.

Data Analysis

In order to understand each individual firm's context, cross case method has been used for exploring how these two firms implemented lean. This approach allows us to understand each individual firm's context in more depth.

RESULTS AND DISCUSSION

Cooked food is easy to perish. From the two case studies, these two food firms were suffered high food wastages in their supply chain (Table 2). This was partly due to poor demand/forecasting technique employed by the firms.

Employee turnover

Both case firms has suffered high employee turnover problem. A respondent of Case A describes that a 30% employee turnover per year in the plant, relative to near half of Case B. The senior managers of Case A points out that a strong management worker relationship can prevent high employees turnover. Thus, the firm tries to increase social ties in order to foster loyalty. In order to decrease the employee turnover and make them reconsider changing their employers so frequently, both firms has built on-plant accommodation for their workers. Case A move their plant from city to an industrial park. The industrial park, nearby the rural area, allows the employee to both work in the factory and stay with their family. Under this way, the employee turnover has been reduced to 18% a year. However, Case B only reduces to 43% without manufacturing near rural.

Table 2 Common reasons to identify lean implementation in food supply chains

Farms	Case Firm	Supermarket
No long term forecasts of consumer demand	Conveyors create significant waste in processes	Waste in goods receiving/checking processes
High percentage duck, chicken, pig, beef or out of spec' on weight or fat	Lack of consistent demand analysis	Systems for alerting the need for shelf replenishment
Opportunities for more efficient control of feed costs	Too many non-value added steps in the processes	Demand data given to suppliers in user unfriendly formats
Food production is a push system not directly related to consumer demand	Poor systems to feedback quality and performance data to farms	Multiple forecasts from different department
	Poor scheduling systems	
	Lack of standard operations	
	Demand amplification	
	Too much stock and WIP	
	Lack of consistent demand analysis	
	Deliveries not tightly controlled	

Lean knowledge

Cooked food has short shelf life and can lead to high wastages in not handle properly. Moreover, from the suppliers' side, the production of pig, chicken, or duck is on a push system and not directly related to consumer demand. Thus, a good lean knowledge could help both firms to reduce waste and improve their operations performance. Therefore, lean knowledge is necessary. Case A recruited lean experts to work with their managers and their suppliers for 3 months in 2005, which resulted a mini workable lean system in the shopfloor. By rolling out the lean system to their suppliers and stores, eventually help Case A to reduce approximately 32% food wastages in production in 2006. But Case A only managed to achieve 2%-3% waste reduction in the production process in the following years. However, Case B uses a different approach to kick-start the lean initiative. Case B establishes a 'Lean implementation team'. This team role is to support and consult other employees in different departments in terms of Lean expertise, and at the same time consider the role of the organizational context. Case B treats lean as a long-term strategy. The rate of waste reduction was 27% in 2007, and continuing achieving a reduction of 5%-10% process waste from 2008 to 2012.

Shop floor culture, management styles and poor employee training

To increase commitment of operators to follow instructions, maintain standards, and join in problem solving, it is crucial that firms invest in additional training programs. Even through the high fluctuation rates there may be a threat of losing intellectual property and investment, building up a Lean understanding among shop floor workers is crucial enrolling bottom-up improvements.

As we mentioned, the high employee turnover lead to the missing experience of young workers and require additional training. Therefore, both of these two firms first build up basic skills of manufacturing such as quality awareness. Second, lean basics are taught in an appropriate way to make operators aware of how importation role for production system. Compare with Case A, the lean implement for Case B is long-term strategy. The lean team supervises helping operators to develop an understanding of lean even when the operation way and operators change. Although Case A and Case B used same way to reduce the waste in process, Case B is better than Case A.

Table 3 Solutions Identified in lean implementation within Case Firm

Problems	**Case A Solutions**	**Case B Solution**
High Employee Turnover	Build loyalty to leader; investing in group building events to increase social ties; build on-plant accommodation for unskilled workers near rural	Build on-plant accommodation for unskilled workers in the city.
Knowledge gap	Recurring lean experts work with firm for few months.	Establish Lean implementation team.
Work & Management styles, poor employee training	Building up a quality improvement and quality awareness; appropriate teaching schemes.	

CONCLUSION

This paper describes why lean concept cannot be successful adopted by firms under Chinese context factor. Some scholars mentioned that lean is workplace technology. Therefore, to solve the problems in lean performance in China, employee plays an important role to implement lean. In these two cases, they overcome Chinese context factor with several solutions. Although Case A solved all them problem when they implement the lean, the short term lean thinking are not help Case A in the following years. Case B's lean thinking, as long term strategy, which has lean team in a firm to response the variance of supply or market each year.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

100% Beef versus Honest Food: The Role of Lean in Food Integrity

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ABSTRACT

The trade-off between cost and quality has been debated widely in literature. Within this context, the lean approach has been championed for balancing these two dichotomies. At the same time, consumers are facing increasing food integrity issues (such as the horsemeat scandal in the UK) which could lead to life threatening consequences (i.e. melamine milk contamination in China). It seems that cost and quality lie in opposite directions. Or do they?

This paper aims to investigate and establish how lean could help managers to achieve the cost and quality balance. The research will especially study lean applicability in safeguarding the integrity of the credence quality attribute of food products, e.g. kosher, halal or organic food, while maintaining low cost.

Case studies covering seven food supply chains were used to examine how and when: a) lean leads to low food integrity; and b) lean compels high food integrity. The results provide strong empirical evidence for lean application and for opening a new horizon in the lean food supply chain. Furthermore, the paper will discuss how firms could juggle between cost, quality and integrity, whilst staying competitive.

KEYWORDS: lean, food integrity, halal

INTRODUCTION

The recent scandals of horsemeat in the United Kingdom and melamine milk in China raise doubt over the honesty of food labelling. Responding towards the impact of the scandals, many firms currently address public doubt by using attractive "marketing" such as 100% beef, 100% UK products or exclusions, e.g. this product may contain nuts. The product associated with the lethal impact on health such as in the melamine milk scandal is an explicit case which is easier to detect and mitigate. However, despite that, the production of credence quality attribute products like halal and kosher requires an extra vigilance for wholesomeness during the process along the supply chain (Campbell et al., 2011; Karijn et al., 2007). The inability to ascertain and evaluate the product characteristic by individual customers (even after its consumption) daunts the task of ensuring the quality and integrity of the food (Ali et al., 2013). The shortfalls leave voids for manipulation, especially on the integrity aspects which are a relatively new concept and not comprehended by all (Roth et al., 2008). Furthermore, an extra added value on the product will directly influence the total production cost.

Seen in the light of the food supply chain complexity, the disadvantage involved in ensuring credence quality, and the impact of its safeguarding towards the total cost, a lean enterprise model is sought to be the basis of the study in achieving a cost and quality balance. In this essence, the model that is defined by Womack and Jones (1996) as an operationally synchronized company is seen as suitable when credence quality requires wholesomeness in its production. Furthermore, very little is known of lean applicability in the food industry (Lehtinen and Torkko, 2005). Thus, this paper aims to corroborate towards the conventional wisdom of lean goals in the context of halal food industries within the perspective of balancing cost and quality.

LITERATURE REVIEW

Lean and credence quality production interface

Lean application can be very difficult due to the nature of food industries that have large batch processes (Heymans, 2009). The industry requires a long forecast as the breeding and farming of the raw materials require a significant time for production. In the same essence, the disproportion between demand and production is highly expected and may lead to overproduction, higher inventory, and even short production. Therefore, a lean implementation can be problematic in the food industry. Exacerbating that, the food quality control concept is expected to cover from "farm to fork" (Tunçer, 2001), making it more challenging as there are no power and leverage resources to allow the lean approach to be implemented along the supply chain (Cox and Chicksand, 2005).

Applying lean in the food industry can start with implementation of 5S housekeeping in preparing for the wider concept of lean production (Langhauser, 2008). A better organized workplace equipped with visual signalization, bulletin boards, daily demands, etc. helps in foreseeing the upcoming problems and allow reactions in due time in order to keep the production flow continuous. Seen in this light, 5S is also significant with credence product quality control; for example, the update of the ingredients halal certification status used in the production. There are few cases where the certificate for certified halal food products has been revoked, and where the contamination or mixture of the non-halal type of product with other halal products has jeopardized the integrity of the halal status of the product. The necessary wastage that occurs during the production of halal food, such as transhipment of the product (to reduce the risk of logistics), storage and inventory (to reduce the risk of contamination), lead time (to reduce the risk of food security), etc. can be addressed from the reorganization of the workplace and/or cell layout (Langhauser, 2008).

The example indicates that lean principles have a significant role in the food processing industries where it can reduce cost and increase the overall efficiency, and especially food integrity (Mahalik and Nambiar, 2010). However, if seen from a production perspective, current food production very much in line with the just-in-time approach and possibilities for improvement seem very small.

Lean and food integrity trade-off

Despite lean implementation benefitting other industries like the automotive and manufacturing industries, Cox and Chicksand (2005) highlight that commercial return for all involved companies in the chains working together and adopting lean principles turn out less than expected. This is further supported by Lehtinen and Torkko (2005) who showed that the impact of the Lean tools in production processes on the costs and value added time is very small, and waste is everywhere, especially in inventories.

Credence quality attribute products like kosher and halal foods for instance, have more specific and stringent production requirements that are required to be followed (Ali et al., 2013). The additional requirements, such as a special labour force (slaughter person), special machinery (stunner and special knife), dedicated transporter (halal and kosher transporter), dedicated space for inventory, etc. significantly contribute towards the extra cost in production. Food production is a continuous process which restricts the set of the operations and machines, which are impractical to move, resulting in a requirement for higher investment (Heymans, 2009). Even though the constant demand leads to a continuous flow, eventually reducing work in progress and finished goods inventory (Langhauser, 2008), the integrity aspect of kosher and halal foods is far from over, as it should be compelled with the "farm to fork" concept, which reflects a broader scope of context. In contrast, the demand for an individual producer is often variable and there are no strict contracts (the halal certification is voluntary) which would enable stable flow of products through the system and supply chain; thus it is difficult to ensure JIT in different stages (Cox and Chicksand, 2005) by a certified halal or kosher producer.

METHODOLOGY

In building up this conceptual paper, we decided to do the study on halal food because of the following compelling reasons: (1) halal food shares many important common processes with non-halal food,

thus halal food integrity can shed light on other food supply chains; (2) halal food accounts for more than 17% of the world food industry; and (3) halal food markets are growing. Improved understanding of halal food risk will have huge practical implications for food firms that intend to venture into the growing markets. In this essence, the study focuses on the Malaysian context as Malaysia is a global brand leader in halal food. As suggested by Eisenhardt, (1989), seven case studies and interviews as depicted on table 1 were done on similar company settings selected from the list by JAKIM (Government of Malaysia's Halal Certification Body). In-depth interviews were carried out with key informants, ranging from 45 minutes to 2 hours, and were performed in English. All the interviews were tape recorded to avoid researcher bias in data collection and analysis. The data was analyzed in two stages, firstly within case analysis and followed by between case analysis. The similarity and variety in the cases were a deliberate research design strategy chosen to increase the external validity of the study's findings, and to ensure the findings were generalizable and not specific to any one type of process or market (Yin, 2009).

Table 1 Case overview

Case	Category	Prod.	Outlet	Informant	Years in post.
A	Fast Food	181	457	Senior General Manager	7
B	Fast Food	141	188	Purchasing Manager	15
C	Casual Dining	190	117	Halal Executive	3.4
D	Casual Dining	245	42	Operation Manager	10
E	Kopitiam	531	151	Senior Halal Executive	5
F	Fresh Processed Meat Product	76	0	Islamic Related Officer	2
G	Fresh Processed Meat Product	27	0	Halal Co-ordinator	5

RESULTS

The study focuses on lean implementation in safeguarding the integrity of halal food. Thus, we are shaping and limit the argument according to the most significant and commonly mentioned goals in halal food integrity perspectives: improving quality, i.e. understanding the consumer's demands and needs; design processes to meet the expectations and requirements; and reducing total cost, i.e. produce only to consumer demand.

The major insight obtained from the study was the quality aspect of halal food. The product's halal quality should at all times be maintained throughout the process and supply chain in ensuring its integrity. However, the cases highlight the difficulties in maintaining halal quality in its complex supply chain:

> *"(…) is facing problems regarding controlling the imported raw materials and we are unable to fully ensure the raw materials sourced are halal" (case F).*

Seen in this light, the supply chain improvements should be done for the sake of customers in ensuring halal food integrity. Despite the claims of the unstable flow products in the supply chain which inhibit lean application, there is always room for improvement. For instance, the value adding activities (halal processing) are what customers (Muslims) are willing to pay for; elsewhere wastes can be leaned through.

> *"We appoint and control our own distributor. All information will come from head-quarters such as list of suppliers the distributor can sourced, the specific prices on the supply, types of products, and so on (…) the distributor is different entity than us (…)" (case B)*

The example shows that lean implementation in ensuring food integrity can be successful by fulfilling most of the principles highlighted by Spear and Bowen (1999): (1) the work is highly specified by imposing halal quality control in the supply chain, sequencing and timing of process are determined by information from the headquarters; (2) the customer-supplier connection is direct where the appointment of the supplier and the communications are controlled by the focal company; and (3) the pathway of the product and services is simplified as the selection of supplier is done in advance. However, there is very little room to leverage improvements on scientific methods in ensuring halal integrity, as there are very limited scientific ways in ascertaining whether food is halal or not (Talib and Johan, 2012). In the same line of reasoning, it is detected

that the focal firms are over reliant on the halal certification mechanism without focusing the philosophy and culture of lean in the supply chain. It is highly probable that lean practice is implemented in the same way.

"We are relying massively to the (…) halal certification body in certifying product" (case F)

"(…) we do not do any extra audit as it is JAKIM role (…) we just make sure they have halal certificates (…)"(case C).

Furthermore, the food industry has to compromise on employee turnover, which eventually affects halal food integrity once the lean are implemented.

On the other hand, the goal of reducing total cost using lean while safeguarding integrity is a daunting task for the halal focal company. It is important to highlight the nature of the food industry, which comprises large batches, long forecast, and high disproportion between demand and supply, leading to high levels of "muda" in halal food production, i.e. overproduction (push system production), high inventory (large batches production), over processing (higher and stringent halal requirements), defects (ensuring the halal conformance efforts), waiting (halal certification approval), or not meeting consumer demand or specification. In managing the wastage, there are many ways that halal food integrity can be jeopardized if not governed carefully. The push system has led the focal companies to source the materials from overseas as the local industry is unable to accommodate the requirements:

"(…)we are depending on the supplier from overseas as the local supplier is seems unable to help and meet the requirement (certification) (…) the industry is immature (…)" (case D).

In the same essence, the focal companies are unable to fully ensure the integrity of imported halal raw materials due to the non-uniformity of halal standards and traceability tools. In contrast, food industry production is claimed as almost just-in-time. This suggests that, the more advanced lean practices do not promise better food integrity. In parallel, the rigidity imposed by having limited suppliers in order to tackle the integrity issue do not offer cost advantages towards the focal company. Furthermore, continuous production and push systems cause higher inventory levels and storage. On the same note, one of the major issues in ensuring halal quality is proper segregation to avoid contamination. In this perspective, the halal specific requirement can push lean implementation, which can play a significant role in increasing halal integrity by having organized storage and eventually, a lower total cost.

Associating with normal non-halal food products, halal food production needs to observe and fulfil extra requirements. From the perspective of normal food production, it can be seen as over processing, as additional movement and transport standards are deployed. Thus the competitiveness of halal food in the outer dimension of its target markets is restricted to the extra cost allocated for such requirements. Attributed to the integrity of its wholesomeness, the halal conformance check is crucial to identify any defects (non-halal) on all the materials. The cases are not remote and the focal company needs to be extra vigilant by investing in more hours and labour for mitigation where significant costs are related.

"(…) in the year of 2012, a halal certified butter founded containing prohibited elements (swine's DNA). We do not use the butter, but through flyers, JAKIM instruct the firm using it to conduct a ritual cleaning" (case A).

On the other hand, the process of obtaining the halal certification requires 6 months of lead time. The high lead time conflicts with lean practices. Thus, it indicates that lean is not appropriate for this section. Exacerbated by the complexity of the halal food supply chain, the halal food products are vulnerable, as the risk of halal integrity can be jeopardized in various ways while awaiting the certification, as the products are highly dependent on the halal status of all the ingredients and materials used along the supply chain. In the light of this, lean needs to be practised along the supply chain in order to gain benefits for the halal integrity. However, it is highlighted that the local industry is not ready for the lean practices, which leads towards the overseas company; this is more difficult due to the distances, i.e. geographical, cultural, and in terms of power.

"(…) the calibre suppliers are not readily available locally that we can have a win-win situation (…)" (case of C, Halal Executive)

DISCUSSION

A dominant insight from the studies shows that lean implementation in halal food industry can result a product with different level of integrity. Principally, lean and halal integrity compelling each other and it indicates that lean is applicable in halal food industry and there are room for improvement in current halal food production. As being highlighted widely in the literature on relationship of lean and competiveness, the

halal food companies that successfully implementing lean have advantages in staying competitive. Despite the paper acknowledges the comprehensiveness of lean literature and its application in many industries, the findings highlighted that the role of lean in reducing wastage in halal food industry are still vague. It indicates that lean application may negatively affect the food integrity due to the nature of the industry and products. Figure 1depict the relationship of halal food and lean from the perspective of quality and total cost. It is important to highlight that the total cost is the result of the wastage management and the lead time effects differently on both settings. In the case of halal food, longer lead time is required for the crucial process; halal certification. However, higher lead time conflicts with the lean goal, lower lead time. Furthermore, the result empirically validates the extra value-adding activities in the halal food production increases the total cost. The result also highlights the crucial trust element i.e. reliance upon halal certificates as representative of the product's quality is crucial in the halal food production, which is absent from the lean paradigm. In this essence, the ultimate goal and application of lean in the production of credence quality product such as halal food is difficult to achieve if it is not impossible. .

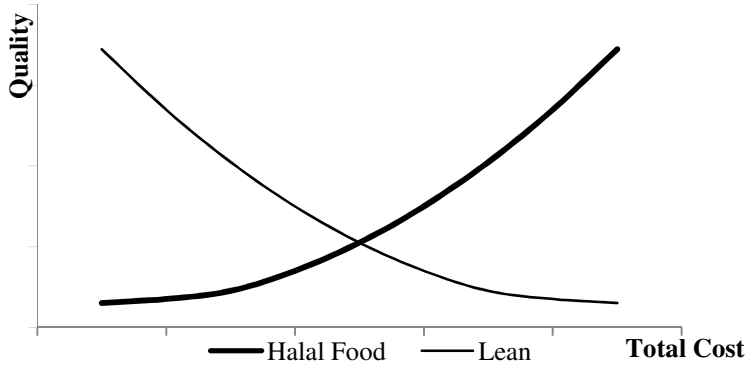

Figure 1: Halal food and lean profile on the total cost and quality

CONCLUSION

This paper shows that the implementation of lean can result in a double effect on the integrity of food. In the same argument the lean goals in improving food quality and reducing total cost are difficult to achieve simultaneously in the halal food industry. Upholding halal integrity dictates that associated costs are necessary and lean application can only be implemented on certain segments. Furthermore, due to the novelty of lean in the food industry, the paper also highlights the possibilities of lean implementation, i.e. on the aspect other than quality related issues during halal food production. Further lean testing on the optimum point of lean and halal food production and food allergen perspectives can be regarded as potential research in the field.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

The Shades of Lean Self-Assessment Tool

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ABSTRACT

Much has been written about business excellence assessment frameworks, i.e. Malcolm Baldrige National Quality Award (MBNQA), European Foundation for Quality Management (EFQM) and the Shingo Prize. Under these frameworks, a firm's business excellence assessments are coded into cumulative scores aiming to highlight the firm's status within the industry. Notwithstanding this, each assessment framework is driven by its preferred paradigm (e.g.process excellence, quality, etc.) as a measure of excellence. For managers, what they want to know is what the assessment score means for their operations. There is confusion as to whether a good performance in EFQM or MBNQA is equal to success in lean implementation. Or could lean performance be measured by the existing business excellence frameworks? This paper aims to untangle the scope and application of existing self-assessment tools through a series of case studies.

KEYWORDS: business excellence framework, lean assessment, excellent management system, lean tools

INTRODUCTION

In the context of lean practices towards overall results, firms seek out the lean self-assessment tool as a measure of their business excellence. Potentially, there are large numbers of available business excellence assessment frameworks in practice, such as the Malcolm Baldrige National Quality Award (MBNQA), European Foundation for Quality Management (EFQM), Lean Enterprise Self-Assessment Tool (LESAT) and the Shingo Prize, that can be adopted by firms. However, very little is known about their comparability and similarity; at which point can the results of the tools be validated against each other? Furthermore, tool selection and result may clutter managers' pre-decisions and post-decisions of the self-assessment.

In light of the shortcomings of existing literature on the comparison of lean self-assessment tools, this paper aims to uncover the shades of lean self-assessment tools by highlighting their commonality and differences by benchmarking LESAT in contrast to the existing business excellence assessment tools. Moreover, the paper aims to propose a generic lean self-assessment framework highlighting harmonized characteristics which offer synergies among the tools, as well as assisting managers in selecting the appropriate self-assessment tool. It is also important to note that this paper does not aim to provide a checklist for managers to choose the suitable assessment tools for their operations. Rather, it seeks to identifykey lean characteristics in the self-assessment tools in explaining business excellence. The outputs of the paper will provide the following benefits to managers: to understand (a) the benefits and drawbacks of the business excellence models, and (b) the similarities and differences between the business excellence models.

MOTIVATION OF LEAN BUSINESS EXCELLENCE MODEL

By the mid–1980s, leaders in the United States began to realize that the leadership of the United States in product and process quality was facing an increasing number of successful challenges by foreign competition and that the nation's productivity growth had been lagging behind other countries over the last two decades (NIST, 2011). Enlightened by this, the Baldrige Awardwas established to create awareness of business quality as a competitive advantage, and to stimulate American companies to improve productivity and achieve world-class quality.

At the same time, the term of lean management as a multi-faceted concept that derived mostly from the Toyota Production System (TPS) was coined in about 1988.It can be viewed from two major perspectives: operational and philosophical. Operationally, lean is seen as a set of management principles, tools and techniques for reducing waste within plants and via extended enterprise, through time reduction, kaizen (i.e., continuous improvement), kanban signals, and on switches, just-in-time supply systems, six-sigma quality, poka-yoke and preventive maintenance (Treville&Antonakis, 2006; Hopp& Spearman, 2004; Narasimhan et al., 2006; Shah & Ward 2003, 2007; White &Prybutok, 2001). On the other hand, from the philosophical lens the interrelationship and simultaneous effects of these practices when used in unison are to improve overall levels of productivity and quality, along with reduction of waste in the functional departments of the organization.

The two pragmatic paradigms have a significant impact towards the market place and have instigated various business excellence awards in order to convey the possession of quality to customers. In this essence, the Shingo Prize aims to become the standard of excellence in educating, assessing and recognizing organizations that achieve the highest level of operational excellence around the globe. The model engages proven lean manufacturing concepts and best-in-class business practices to focus on customer satisfaction and profitability through a systemic view of the organization. On the same note, LESAT is intended to be a guide for leaders of enterprise to understand lean,to act as a lens through which to view the current state of "leanness" of their enterprise, as well as highlighting the potential for improvements that can be achieved in the future (Nightingale and Mize, 2002). Meanwhile, EFQM aims to help European companies to become competitive in the international market place following the example of the American MBNQA (Conti, 2007).

The facilitators' guide suggests that the process of self-assessment creates a common vocabulary for discussing lean improvement issues that increases the effectiveness of communication throughout the enterprise. The self-assessment process also identifies and creates the case for the need of Lean Education amongst employees.

BUSINESS EXCELLENCE MODEL'S CRITIQUE

The major benefits that an organization can reap from the business excellence model include the engagement of all the managers in implementing quality programmes. The effect of the assessment criteria (Saunders (2004), Ferguson et al. (2000), Tummala (1994), Anderson and Kaye (1998), Evans & Jack (2003), Flynn (2001), Wisner (1994) and Dow (1999)) towards entrants and winners are numerous.

The programmes can outreach to the extended enterprise and the feedbacks are shared among selected applicants. The feedback report, which has been described as one of the best value consultancy documents available (Taylor, 1997), is a written summary of the various strengths and areas for improvement for an organization for each criterion for performance excellence (Babicz, 2002).

However, there are shortfalls in existing assessment models. The integrity of the awards is questionable; as it is claimed they can be "bought" and are financially futile. The most commonly cited example is the 1989 winner, Xerox, and Corning, a 1989 finalist, both having to spend, respectively, $800,000 and 14,000 labour hours in drafting and finalizing the award application and in preparing employees for site visits by Baldrige examiners (Garvin, 1991 & Jacob et al.,2004). Sherman (1992) reviewed a worldwide study undertaken by Ernst & Young on quality and concluded that many businesses waste millions of dollars per year on fruitless quality improvement programmes, an unintended consequence of meeting the assessment criteria.

The second shortcoming is that the award is not indicative of superior product quality, e.g. Cadillac, a 1990 winner that had never achieved the top ranking ratings of any automobile quality survey (Garvin, 1991 & Jacob et al., 2004). Thirdly, the poor financial performances of some past winners have raised concerns that the award is not an accurate measure of the firm's competitiveness and profitability as Cadillac, Motorola and Wallace Company of Texas went bankrupt after winning the Balridge awards a year earlier (Garvin, 1991 & Jacob et al., 2004), and the effectswere the same for Delphi – 22-time recipient of the Shingo Prize (Baudin, 2006). The possibilities of the winners replicating the lean tools without a proper understanding can be a contribution towards this (Baudin, 2006).

On the other hand, the requirement on companies to share their performance-enhancingstrategies with any requesting organizations result an expensive "cost of winning", especially for small companies (Taylor, 1997). Illustrating this, 1988 winner, Globe Metallurgical's Kenneth Leach was required to give 134 speeches the following year.

RESEARCH METHOLODGY

The objective of this research is to create clarity about the similarities and differences among the MNBQA, EFQM, Shingo and LESAT excellence models to examine whether they are all converging on a singular path. The research was conducted by an EMBA student who worked in one of the case companies as part of his dissertation project. He has a good contact within the firms and was thus able to be granted permission to access to people who are best informed about the data being researched. The case study involves the Managing Director and his assistants. Using multiple interviews brought a richer portrait of each case (Yin, 2009), and also to mitigate bias when it came to historical data interpretation (recollection). For instance, interviewees may not recall important events and even if they did, their recollection may be subject to bias.

Data Analysis

The models were mapped onto each other to find similarities and confirmation with the respondents. Furthermore, a quick assessment was conducted of Company X (the firm name was made anonymous due to the sensitivity of the research data) using the LESAT V1.0 Self–Assessment Tool by the MD with the help of the researcher. The selection of LESAT V1.0 is due to its standardized nature that allows for the quickest coverage of all criteria items.

RESULTS

The four models are each built upon a set of fundamental principles that guide the construction of the assessment framework. After a thorough analysis of the principles, key linkages could be drawn between several of the principles that the models are built upon, and thus various similarities and a few differences were noted. Figure 1 summarizes the findings of this section.

The Gist of Business Excellence Model

The similarities between the fundamental principles amongst the models were staggering. It can be said that except for a single critical difference, all four models were found to be built upon the same guidelines and hold the same view as to how the best organizations should be run. These similarities run parallel to the guiding principles of TQM as mentioned by Dale et al. (2007) and all four of the models agreed upon the importance of the following:

1) Senior Management Commitment and Involvement

The full commitment and involvement of the senior leadership is critical to allow any change to occur and be sustained. They have to take charge personally, lead the process, provide the direction and exercise forceful leadership including dealing with those employees who block improvement and impetus.

2) Customer Focus

This principle was found also to be as equally important to the leadership commitment and all four models dictate that organizations depend on their customers and therefore should understand current and future customer needs, meet customer requirements, and strive to exceed customer expectations.

3) Balanced Results

Excellent organizations meet their mission and progress towards their vision through strategic planning, and achieve a balanced set of key results that meet both the short and long term needs of their stakeholders and, where relevant, exceed them.

4) Creativity and Innovation

Research and development is a critical function of any excellent organization. Excellent organizations generate increased value and levels of performance through continual and systematic innovation by harnessing the creativity of their stakeholders.

5) Employees are the Key to Success

Employees' education and training are important inempowering them through transparent engagement in improvement. The culture of empowerment and teamwork has to be sustained for the balanced achievement of organizational and personal goals.

6) Building Long Term Relationships

Excellent organizations seek, develop and maintain trust in relationships with various partners to ensure mutual success (win-win).

7) Systems Thinking

The impact of synergy is far greater than the sum of the parts. This requires seeing the reality of the current state, a clear focus on long term objectives and an alignment of all systems and employees so that there is a "constancy of purpose".

8) High Quality Processes

Excellent organizations are managed through structured and strategically aligned processes using fact-based decision making to create balanced and sustained results. There is a lot of stress on continuously developing systems and processes with the involvement of employees through regular review and formal improvement frameworks.

9) Sustainability

The MBNQA, Shingo and EFQM models explicitly state that excellent organizations embed within their culture an ethical mindset, clear values and the highest standards for organizational behaviour, all of which enable them to strive for economic, social and ecological sustainability.

10) Agility

Commitment of the senior leadership and proper execution of all the above principles are important. Excellent organizations must have the speed and resources free to take instant action on new opportunities that may arise.

The only principle which fundamentally divides the four models is the original lean principle. The concept of flow, pull and just-in-time manufacturing is evident in the LESAT V1.0 and the Shingo Excellence models but is absent in the MBNQA and the EFQM Excellence models. In other words, the LESAT V1.0 and the Shingo Excellence models are more oriented towards the principles of lean than the MBNQA and the EFQM. This posed a problem for the research team while assessing Company X because although Company X is an excellent organization in all aspects of the fundamental principles, they did not relate to themselves as lean.

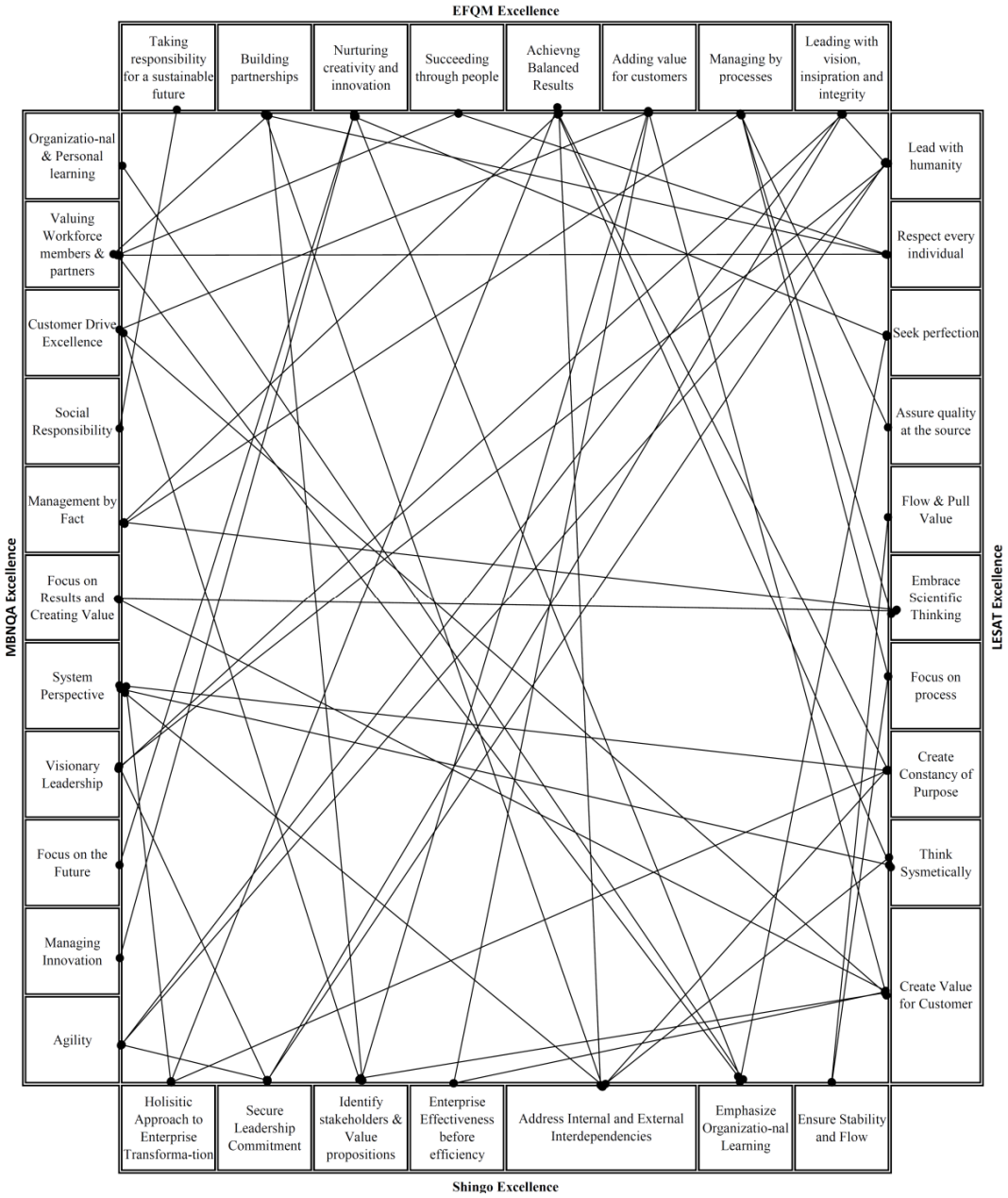

Figure 1: Key linkages between the fundamental principles of the MBNQA, .EFQM, Shingo and LESAT V1.0 excellence models.

Verifying the Common Background

Using the 2010 annual report of Company Xand sources from related websites, assessments were carried out with the Managing Director. Figure 2 depicts the results from the LESAT assessment on Company X.

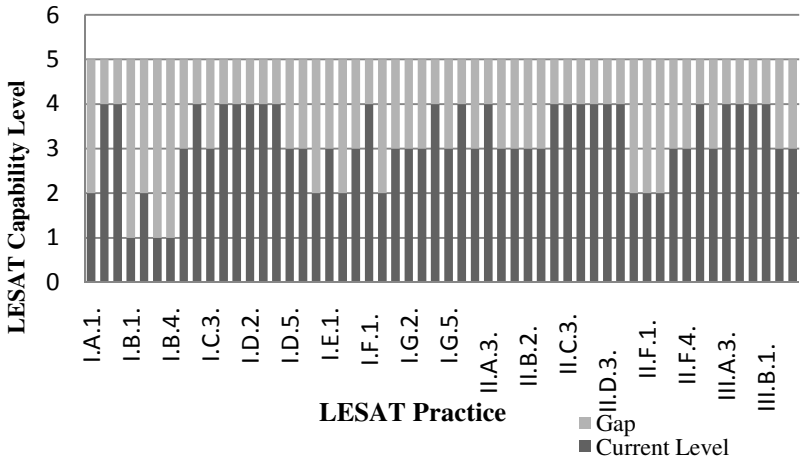

Figure 2: LESAT Current State Maturity Levels

The x-axis represents the 54 lean practices of the LESAT V1.0 tool while the y-axis represents the maturity level of the organization with respect to the corresponding lean practice. Level 5 has been assumed to be the desired maturity level decided by the senior management. Thus gap is the value of the desired level minus the current state. The mapping of LESAT practices onto the other models allows for transposing the LESAT scores onto the other models. Of note is that the results scale was harder to quantify as neither did the LESAT model focus too much on results nor did the manager want to share internal company data; the other business excellence model verification was done using information solely from the annual report.

It is important to highlight that the scoring itself is more complicated than the LESAT model as it is difficult to place a percentage on behaviour based on only the scoring guidelines. The scores are mostly subjective, i.e. what is the difference in behaviour from 60% to 62%? On the same note, in facilitating the comparability, each element within the scope of transformation, i.e. Customer Relations, Product / Service Development, Operations, Supply & Management Support Processes,has certain weightage assigned to it by the model for each dimension.

Table 1:Lean Self-Assessment Model Score summary

	EFQM		**MBNQA**		**Shingo**	
	Criterion	Points	Criterion	Points	Criterion	Points
1	Leadership	74	Leadership	87.5	*Cultural Enablers	*102.45
2	Strategy	68.75	Strategic Planning	65.75	Continuous Improvement	227.4
3	People	70	Workforce focus	59.25	*	*
			Customer focus	53		
4	Partnerships and Resources	61	Knowledge management	60.75	Enterprise Alignment	153.92
5	Processes, Products & Services	75	Operation Focus	59.25		
6	Results	300	Results	292.5	Results	150

Total Points Awarded/ 1000	**648.75**		**678**		**633.77**

Table 1 shows the results of self-assessment scores using EFQM, MBNQA, and Shingo on Company X (conducted by the MD with the help of the researcher). The results of Table 1 and Figure 2 showconsistency in terms of performance in many categories.

DISCUSSION AND CONCLUSION

This paper'saim is to attain a distinct understanding oflean in four assessment models: LESAT V1.0, MBNQA, Shingo and EFQM, and to validate insights through the test onCompany X.From the test, the paper concludes that it is empirically evidenced that common fundamental criteria are shared between the models.

From lean perspectives, all four models are in the same spirit, especially the LESAT and Shingo models, which are more focused by explicitly mentioning the lean characteristic highlighted by Womack and Jones (1990) in the assessment. All of the individual criteria and principles map onto each other,indicating that all the models "come from the same background".

Intensifying that, all four models'scores are about the same. The LESAT and Shingo scores are slightly less than the EFQM and the MBNQA scores. This is probablycaused by the clear "lean principles" in the LESAT and Shingo and which are absent in the other two. As the score differences are not that distinctive, it can be concluded that they are fundamentally and categorically identical.

ACKNOWLEDGEMENT

The authors gracefully acknowledge Ajayjit Singh's contribution in this paper. The data collection and case analysis was conducted by Ajay as part of his EMBA dissertation project.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Redesign of Production Layout Based on Implementation of Lean Principles – Gomma Line Case Study

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ABSTRACT

Global competition and market demand influence on companies to find new ways in order to provide advantage with new products, prices, quality and given service. Lean production is philosophy that improves, among other things, quality and efficiency. This paper describes practical implementation of lean methods and their benefits on real example in one enterprise from production sector in Central Serbia. The most used lean methods were for redesigning and improvement of layout for assembly process.

KEYWORDS: Layout Improvement, Waste, Practical Implementation

INTRODUCTION

All activities in company spend resources. The goal of Lean company is to reduce and eliminate superfluous activities which no value added of product. Organization has possibility to reduce costs and more efficient dispose with the resources. Lean concept is mainly focused on production processes, but also includes all aspects of management and aspires to maintain relationships with all interested stakeholders. Lean concept finds its place wherever where is a possibility for improvements. [1]

In this paper will be consider possibility of implementing Lean concept in modern industry with specific problems and will be offered concrete solutions in order to provide improved production. Troubleshooting, waste and analysis of their solution is presented in the example of installing the brake hose in production department of Gomma line doo, Kragujevac. Defined the greatest waste, calculated all time of the process, and on the base of this, given solutions.

Lean concept advance the entire enterprise eliminating the waste incurred during the work process. Waste can be at many different forms, but in a Lean enterprise accurately analyze all processes, in order to understand and eliminate the unnecessary elements and redundant processes. Process analysis and improvement work in Lean companies is continuous. There is no ultimate goal of eliminating wast, there is aspiration of the company to all the processes it to be better and more efficient. [2]

To remain competitive in the global market, they must produce high quality products with the least resources involved as soon as possible. Only for those products the customer is willing to pay even more than the price competition. That lean would have full effect it is necessary to adjust the entire company philosophy of continuous improvement of the production process and eliminating unnecessary costs. We need everyone, from top management to the workers in the plant, know the essence of Lean and committed to its implementation. Then it can speak about the Lean enterprise, not just the production of Lean elements [3].

IMPLEMENTATION OF LEAN PRODUCTION AT GOMMA LINE D.O.O.

Production of companies Gomma Line is oriented primarily to parts of rubber wich produced with equipment for extrusion, injection molding and pressure, as well as other systems of production and assembly. Implementation of Lean concept and tools will be made in one (pilot) part of the total production, ie. on the part of the brake hose assembly.

Having determined the area of implementation and selected those with which it will cooperate in the implementation, it was essential to follow some steps in the analysis, setting the current state and the future implementation of the improved situation.

Primarily, it was necessary to:

1. Weigh all of the operations that are in the process of assembling, time, quantity according to the material, record all the waste that can be seen, all operations within the process of sort of NVA (Non-Value-Added) and VA (Value-Added) and based on that, form chart of a current flow values and flow of materials.
2. Monitor the movement of workers, photographing and possibly record their behavior based on what could be determined which operations are redundant and which operations non value added, and to identify operations that are unsuitable for health workers.
3. All material flows monitor and draw, sketch the paths of material from warehouse incoming raw materials to warehouse finished products, isolate critical path intersection points and try to remove with organization.
4. Sort operations and produce by the degree of use and based on that, establish a production, if there are machines whose level of use is primary and it is not possible to transform, organize the production of the same.
5. Mark all the places it is possible to transform and thus improve production (kaizen). [4]

The Current Process Flow of Brake Hose Assembly

Analyzing the overall state of assembly could be obtained by linking the analysis of each particular element assembly. In the analysis it was identified numerous errors and waste in production. To faithfully display loss, was measured during each operation with different workers and thereby obtained are different times, which indicated to a non-standardized production methods as well as huge waste when performing unnecessary surgeries. Assembly of brake hose consists of several separate operations, each was analyzed separately.

Assembly operations are:

1. Cut hose
2. First crimp connector
3. Assembly of the intermediate ring
4. Crimping of intermediate ring
5. Crimping of second ring
6. Testing the pressure hose
7. Hose-twitch testing
8. The control probe
9. Applying labels with the date of manufacture and the manufacturer (stamping)
10. Packing

Prior to the analysis of each position separately, is important to note that in addition to waste during assembly will be analyzed, followed the flow of materials and information, obtained by the so-called "spaghetti" diagram (Figure 1.1) [4] and the production is based on the PUSH system, which could be seen

from a bunch of boxes and bunch of non-finished products. This paper describes the activities that served to add no value to the product in relation to other activities in the assembly process (Table 1.1) [4].

Table 1 The characteristics of the assembly process

Operation	VA/NVA	T_T(s)	Unit/min	Unit/shift	N_o of sub-operations	N_o of VA	N_o of NVA
Cut hose	VA	2	27	11000	5	1	4
Intermediate ring	VA	7	9	3500	4	1	3
Crimp I	VA	6	9	3800	4	1	3
Crimp II	VA	6	11	4500	4	1	3
Testing	NVA	7	20 units/150s	3500	7	0	7
Stamping	NVA	6	10	4000	5	0	5
Paking	VA	125 units/5 min	/	4500	9	1	8

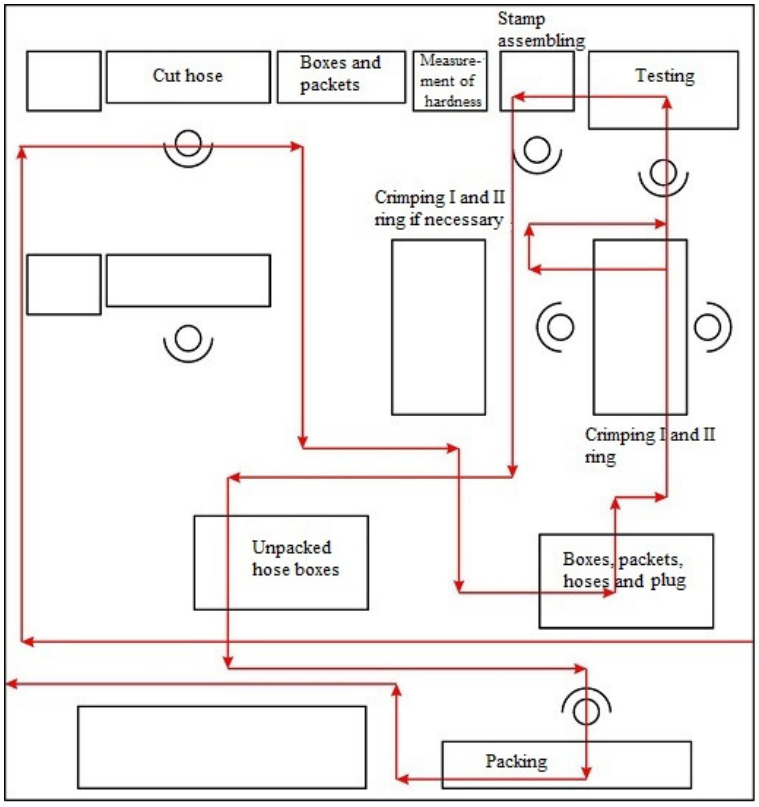

Figure 1.1: Diagram of the current material flow

Testing the Pressure Hose

It is one of the operations in the assembly in which has observed maximum waste. Worker after crimping second plug gets the hose in a box which is on the floor and placed them on the table or while moving every time prior to the surgery takes and brings to the table on that are-deposited. After bringing hoses, a worker puts them into a machine, 20 pieces for one control, setup process takes an average of 42 second, depending on who is worker and how sets hose to the machine. When all hoses set, worker closes the machine and lets it work, the process control of pressure is automated and takes 1min and 25s, need to hose withstand a minimum of 300 bars, during that time the worker clean previously removed hoses with air pistol and then waiting for the machine to complete its cycle.

The biggest disadvantages of these operations are non standardized principle of performing the operation, which leads to a different time and the amount of processing which workers finish during the shift.

The movement is primarily about bringing hoses while waiting and underused staff makes this operation critical and perhaps the key to relieving some of the other operations and balancing process. The huge problem with this operation is that all sub-operations NVA, namely the buyer does not pay its value, but on the other hand it needed to ensure the quality and therefore retained by the customer.

Stamping

During this operation in the process, with plastic deformation inserted serial number and manufacturer of hoses, for easier control in the event of errors or deviations in quality. Previously controlled the pressure hose and cleaned arrive in boxes (blue boxes) or downward ledge from which it takes the worker and sets the table then checks the passage of the probe (NVA), which is different for each type of hose and calibrates itself for a specific period. Stamping (VA) is done separately for each hose and carried out by the one side of the hose placed in the machine tool while the other hand holds, and the machine runs a foot pedal. Then the so branded hose stored in a box (NVA), which is charged to a certain amount depending on the type of hose and deposited at defined positions in the work unit, waiting their turn on the packaging (yellow boxes. The process takes an average of 6s and can earmark 10 to 12 pieces of hose per minute, ie about 4000 hose in one shift.

Dissipation occurs mainly in warehousing after the operation, great spending is also probing and that is done in this operation, and can switch to the previous one, which would increase efficiency.

REORGANIZATION ASSEMBLY USING LEAN TOOLS AND TECHNIQUES

In order to begin with a basic reorganization brake hose assembly should be defined which errors need eliminate to achieve an improvement in the quantity, quality and temporal accuracy hose assembly, that are:

1. 7 types of waste (overproduction, errors, transportation, waiting, inventory, motion, unnecessary processing)
2. Push system
3. Unrelated material flow
4. The bad visualization
5. Non-standardized processes

The tools which will be used to optimize the process and improve are the basic tools of the Lean concept:

1. Pull system
2. Just in time
3. Process standardization
4. Eliminating waste
5. Pacemaker
6. Constructing a supermarket
7. Kanban

The idea is based on the fact that, based on demand which will in the future create a customer form a kanban board on which will be based on the card to know exactly the amount and period of hose assembly, which is used connections and hose length, and which will make the assembly line and so on. Based on the cards that will be attached to the end of production, shall be acquisition of certain goods (Pull) so that the flow of information for the acquisition of manufactured goods going from the end of the assembly to the beginning, while the flow of materials going in the opposite direction. The course and the assembly would be standardized and established flows U-shaped, so will be able to form a continuous stream to monitor kanban cards and to thereby reduce any unnecessary surgery, movement and piles of material.

What will define the operations is the tact that assembly must have, which will dictate the machine control bowel pressure because it has a standardized time control 20 hose 1min and 25s and operations are to be adjusted so that they can provide enough bowel control and at the same time there is no build up after control. Some of the operations will switch just to control operation of the pressure, and that the employee will perform during the process of bowel control.

Future look of the assembly is shown in Figure 2. Yellow shows the flow of material from the storage of raw materials to packaging, and then the output of finished goods material is shown in green. Red presents boxes which incompatible production a blue box for hose cut. Boxes are ejected into the crimping operation, inspection, stamping, which is one of the improvements in the organization of production.

I can see the two strands of the U-shaped which can double the level of production. The process begins by cutting located at the entrance to the warehouse for raw materials, cut hoses are positioned in the middle of the warehouse which used for the storage of cut hoses and connections and storage assembled but not packaged hose and is designed so that the warehouse with unpacked hose in the middle and so prevented any possible access unpacked hoses. Hose movement from position to position until insertion into boxes for storage with unpacked hoses is doing performs drop-down sloping shelves or directly through the addition of the table, which has decreased the crowd and among less operation between those that give value intestine.

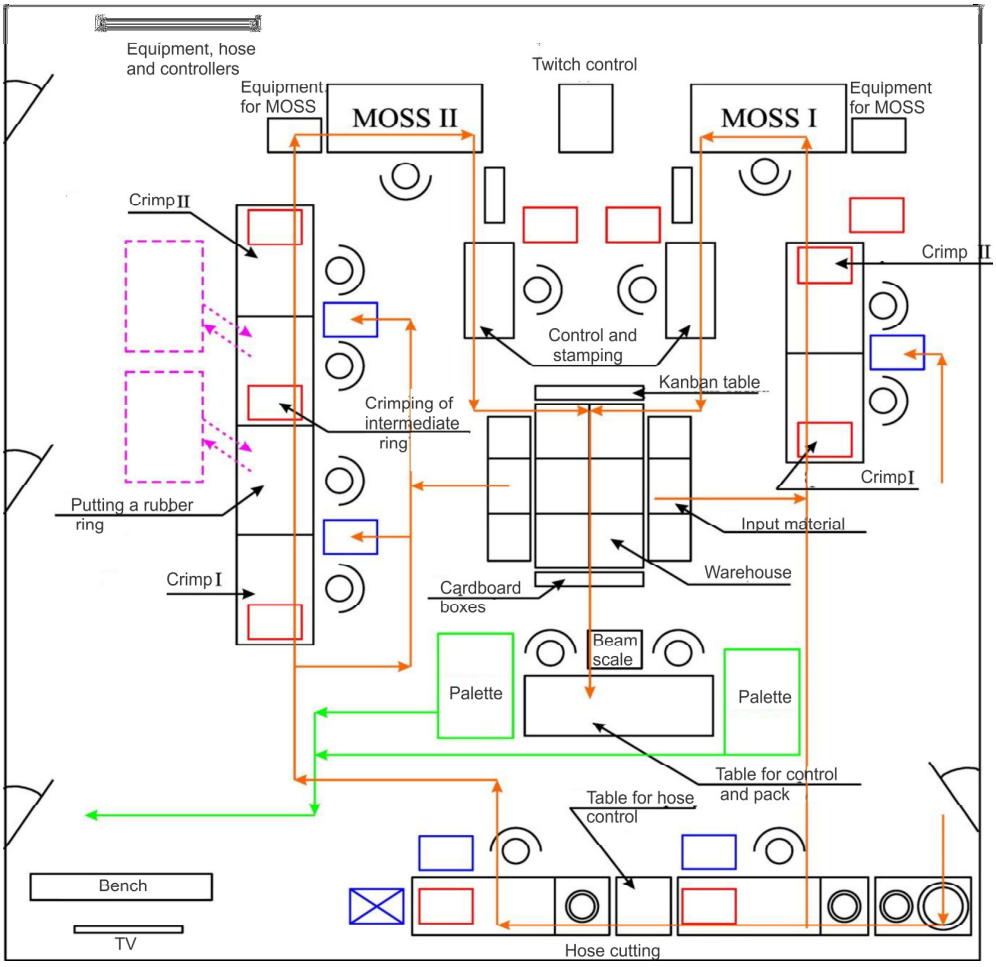

Figure 2: Future layout assembly

Taking into account the fact that the production of brake hose in Gomma Line d.o.o. is continuous process carried out in three shifts, the implementation of proposed and accepted proposals for the improvement of the overall system has its own flow that must be carefully planned and prepared so that at any point does not interrupt the production system.

It has been noticed as the dissipation of the pressure control is waiting for workers during the control. The solution is to control the probe which has so far performed in workers leaves a mark on the hose to transfer the MOSS machine (testing mashine) operators and so a worker who stamping hose and get the time to visually review hoses and so prepare for surgery packaging hose at the end, thus speeding up the process and reduce the waste. In operation control pressure ejected all the boxes that are delivered to the intestines of the operation, thereby reducing inventory and transportation which were great waste in this operation, the future will be delivered intestines falling shelves or directly on the table, so that there won't be waste as in the past. Standardize the process of placing and removing the hose of the machine is the next step, so it always has roughly the same time control, and not to depend on the worker performs.

Stamping operations will unite with visual control and will be set up shelves for storage with unpacked products, so that upon completion of the operation and filled boxes effortlessly worker pushes a box down the shelf and deliver it to the packaging operation.

Police for unpacked products are designed to go in one direction with boxes full of hoses, and to otherwise return empty boxes, so that workers on both operations (packing and marking) are always equipped with the necessary boxes.

CONCLUSION

Lean is a journey, not a destination. It takes some time to achieve and requires continuous learning and improvement. Lean concept is successful only if the management team is dedicated enough causes. Management must understand Lean methods, tools, and a philosophy of Kaizen. For the successful introduction and implementation of Lean concept takes experience and time, until it becomes part of the daily activities of management and employees. Methods and techniques of Lean concepts are not complicated and do not require great wisdom to understand, but need the full commitment of management and employees in order to get the desired results.

Gomma Line d.o.o. is a young and successful company in the field of rubber components for the automotive industry and management of the company is aware that the only constant progress and change for the better can be traced tact automotive and that only in this way can remain within it. In order to achieve this must be followed current trends of production, which certainly is Lean. The changes that have been defined as the future and that they start already, will bring results from the moment they start to apply. Reduce waste, errors, reduce production of far greater quantities than now and most importantly, the customer will be satisfied and thus access to the manufacturing of its products as well as cost, quality and delivery time, thus will remain and be present as long as the relationship within required.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

An Approach to Lean Inventory Management by Balanced Stock Cover

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ABSTRACT

Stock cover refers to the length of time that available inventory will last if forecasted consumption occurs. It is represented by the key performance indicator calculating the number of days of forecasted consumption which the current stock level can face. The identified problem is that production companies in the fast changing environment are facing an increasing pressure to reduce working capital in order to manage planning and replenishment of a growing variety of products and to deliver a certain level of customer satisfaction. In practice, when calculating the "Stock Cover" indicator companies opt for one of three ways, among which there are large deviations in planning frequency and launching the orders for procurement or/and production, as well as a wide aberration in the volume of customer orders (hence stock); which directly affects costs and competitiveness of enterprises. Lean management of inventories assumes keeping a stock in defined corridors, triggering replenishment at the right time and continuously reducing working capital. The idea of the authors of this study was: make "Stock Cover" indicator more efficient and effective in the operational management of production and/or distribution companies using the "Balanced Stock Cover". The goal of this paper is to recognize the possibilities to apply "Stock Cover" as a key performance indicator set in a balanced way to support the decision making process in inventory replenishment.

KEYWORDS: "Stock Cover", key performance indicators, lean inventory management, planning in supply chain

INTRODUCTION

The rapid development of technology and the shortening of product life cycle create a business environment where competitiveness is increasingly important for company's success. Modern customers expect an increasing variety of products and permanent improvement of the quality of products and services (delivery, for example) as well as low prices. Such business conditions require the needs for constant development of products / services, improvement of the production, supply and distribution processes (and maintenance of inventories of raw materials and (semi) products), as well as advancement of management (and planning) - using new methods and techniques of business management.

The aim of this paper is to present one of the possible ways to improve the performance of a production/distribution company using a new approach to inventory management. The authors discuss the development of the inventory management concept based on key performance indicators (KPI). Specifically, a "Stock Cover" indicator (StC) is considered as a managerial performance and the improvement of its application through three manifestations / indicators that are presented in this paper.

LEAN INVENTORY BASED ON KEY PERFORMANCE INDICATORS

According to Chase et al. (2006) lean concept means an integrated set of activities designed with the aim to reach a high volume of production and meet customer requirements at the highest possible level using minimal inventories of raw materials, semi finished and finished products. According to Demeter & Matyusz (2011) one of the sources of waste and expenses is overproduction, write-offs, unnecessary waiting, excessive transportation and inventory.

The main task of inventory management is to coordinate the realization of common stock policy adopted by different actors in the supply chain; there by the common goal is balancing the asset flows and minimizing the costs along with rapidly meeting customer requirements (Giannoccaro & Pontrandolfo, 2002). Inventories arise in operations (Slack et al., 2010) because the timing of supply and timing of demand for products are not the same. Inventories often represent the largest portion of working capital, thus binding capital that could be otherwise used in a more profitable manner. Excess inventories can lead to the risk i.e. to their damage, loss and/or obsolescence. On the other hand, too low stocks can lead to the risk of running out of stock, impossibility to meet the demand and thus miss the sale. Accordingly, the overall objective of inventory management is to achieve the planned / projected levels to satisfy customer requirements, keeping inventory costs within acceptable, pre-set limits. In this context (Roy, 2005), decision-makers must make two fundamental decisions - concerning the timing of order, and the size of the order.

Lean manufacturing philosophy considers stock as a form of waste and the cost that should be permanently reduced. According to Zipkin (1991), Cooper & Maskell (2008) and Eroglu & Hofer (2011), inventory management in accordance with the lean philosophy has become a synonym to a good inventory management.

KPI in inventory management, considered and used in this study, means "the cover of demand by stock - Stock Cover" (StC) which sets the priorities for the replenishment of certain products and thus determines the timing of the launch of production orders and/or purchasing (Omerbegovic-Bijelovic, 2006). Based on StC it is possible to make a decision on a timely replenishment.

StC as KPI cannot be considered independently of other KPIs by a production company (or in chains in which it operates), but it is important to realize the impact of a decision on the overall operation and other KPIs which are used. According to Lin & Chen (2005), besides using KPI in inventory management, production companies have defined (among others) a KPI that measures the level of customer satisfaction - Customer Service Level (CSL), its values, indicating to those who monitor management quality (Omerbegovic-Bijelovic, 1998) whether the established concept of inventory management achieves desired results. The basic concept of determining customer satisfaction and appropriate ways to measure the satisfaction is given in Meyr (2009), while further research on the application of CSL indicators, with a selection of customers, is presented in the paper by Lecic-Cvetkovic et al. (2010). Also, Babarogic et al. (2012) pointed out the possibility to maximize the level of customer satisfaction at a production company that operates with a limited production capacity. The value of CSL is in direct correlation with the available stock (which meets the demand). According to Okulewicz (2009) it is possible to create a supply system that provides the necessary stock to meet customer requirements without causing unnecessary costs. In order to achieve a certain level to meet customer requirements, the same authors emphasize the importance of appropriate levels of safety stock to prevent possible situations of missing opportunity to meet orders and miss sales.

BALANCED STOCK COVER

The main role of a KPI is "in conjunction with other KPIs, to be a useful indicator of meeting business goals" (Thatcher, 2011). Stock cover, expressed by StC indicator represents the time period in which the available stock can meet the projected demand (Omerbegovic-Bijelovic, 2006). Another accepted term for this KPI is "Inventory to sale ratio"; it observes the amount of current stocks compared with the average historical sales or planned/forecasted monthly demand. StC indicator allows monitoring the increase or decrease in inventories and ordering of new stock. In particular, the basic form of the StC indicator is calculated based on the stocks that are available at the company and that can meet the current demand for the products:

$$StC = \frac{Inventory\ on\ hand}{Monthly\ sales} \quad (1)$$

The complex structure of StC indicators, in addition to the currently available stock, takes into consideration inventory that will be available in a short period of time (inventory in transit, inventory on the way) - by the time it is necessary to meet already received customer orders:

$$StC = \frac{(Inventory\ on\ hand + Incoming\ goods\ in\ transit)}{Monthly\ sales} \quad (2)$$

The authors have identified three different approaches to measuring StC:

a) Based on historical sales:

$$StChs = \frac{Inventory\ on\ hand}{Average\ monthly\ historical\ sales} \quad (3)$$

b) Based on sales plan:

$$StCsp = \frac{Inventory\ on\ hand}{Average\ monthly\ sales\ plan} \quad (4)$$

c) Based on last estimation sales plan:

$$StCle = \frac{Inventory\ on hand}{Average\ monthly\ last\ estimation\ sales} \quad (5)$$

As the different perspectives of consideration may give different values of StC (which becomes a vector StC = (StChs, StCsp, StCle)), the authors of this study suggest measuring the balance of these three indicators - the components of the vector StC = (StChs, StCsp, StCle). One of the possible ways is achieved by measuring the distance of realized values of these three StC indicators from the corresponding values in the ideal point (IP).

The IP of balance of StC indicators is the intersection of desired values of all three StC indicators. Taking into account that the company tends to have the optimal stock (StCopt, without discussing here the way of their determination), the target value of the indicator is StCopt = StChs = StCsp = StCle. The intersection of realized values of the three StC indicators represents the realized value of StC (Realized Point, RP). The difference between the coordinates of IP and RP indicates the compliance of the indicator StC in RP; it is a new three-dimensional indicator (BStC) - an indicator of balance of StC in RP with values ScT in IP (Figure 1).

IP (with the three dimensions of the target values of the indicators) and RP (three realized values of indicators StC) represent an ordered pair (p (p1, p2, p3), q (q1, q2, q3)). For distance measurement the Euclidean metric is used - whose formula is based on the Euclidean distance. Euclidean distance between points p and q is the line that connects pq. According to the Cartesian coordinates, p = (p1, p2, p3) and q = (q1, q2, q3) are two points in Euclidean space. The point position in Euclidean space is the Euclidean vector. The specified distance between p and q is represented by the following formula:

$$d(pq) = d(qp) = \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2} \quad (6)$$

In the given case, when the balancing of the three indicators of StC is being done, two points can be defined: the desired value of the indicator M (in this case: IP) and the actual value of the N (RP), shown on Figure 1.

$$M = (StChs_m, StCsp_m, StCle_m) \tag{7}$$

$$N = (StChs_n, StCsp_n, StCle_n) \tag{8}$$

$$d(MN) = \sqrt{(StChs_n - StChs_m)^2 + (StCsp_n - StCsp_m)^2 + (StCle_n - StCle_m)^2} \tag{9}$$

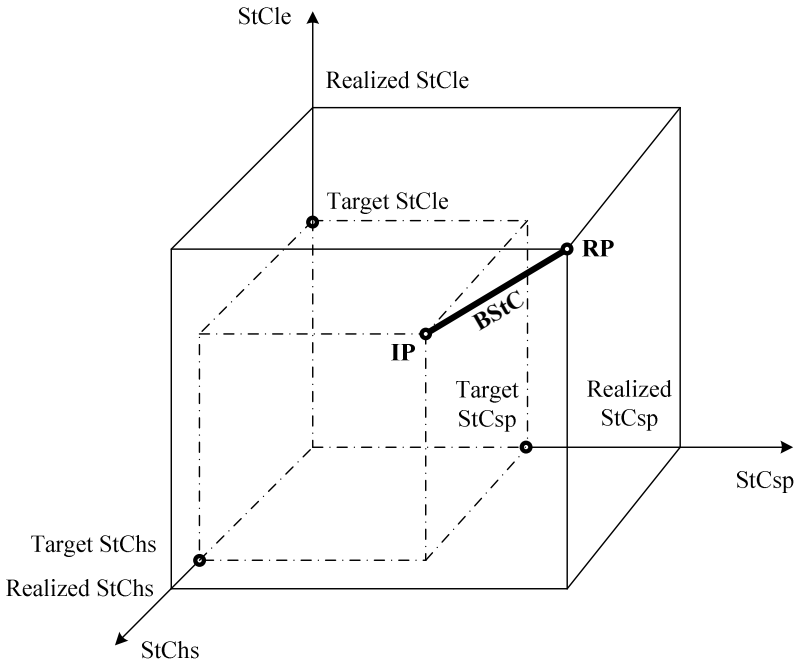

Figure 1: Graphic display of balance indicators (BStC)

According to formula (9), the distances of any point of a specific value of StC indicators (three dimensions) from its IP (i.e. the desired value for each dimension) are measured. The distance of pairs of StC indicators in points IP and RP is now a new vector "balance indicator" (BStC):

$$d(MN) = balance\ indicator\ StC\ (BStC) \tag{10}$$

Depending on the position of the RP relative to IP and the vector direction, the BStC can be defined as the "BStC cube of belonging." Possible "BStC cubes of belonging" (8 of them) are represented by the matrix of belonging (Figure 2).

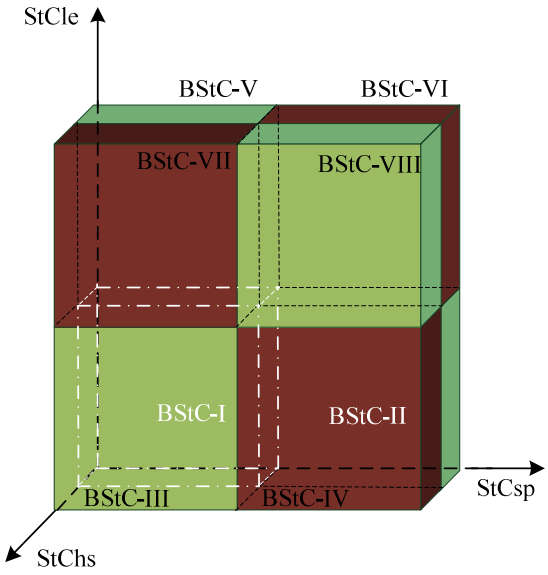

Figure 2: Matrix of cubes of belonging of balance indicator BStC

Table 1: Possible business impact/relevant actions for BStC cubes

BStC cube	StC hs	StCsp	StCle	Possible business impact; Relevant action
BStC-I	↓	↓	↓	Anticipated sales "LE", Sales Plan "SP" and Historical Sales "HS" are high compared to the available stocks; Supply should be in accordance with the needs to eliminate the potential lack of supplies (out of stock)!
BStC-II	↓	↑	↓	Sales Plan "SP" is very pessimistic; to avoid potential lack of supplies, it is necessary to order in accordance with StCle!
BStC-III	↑	↓	↓	Anticipated sales "LE" and sales plan "SP" are optimistic; Consider whether the planned sales activities can generate increased yields, otherwise, to avoid unnecessary "piling up" stock, it is necessary to order in accordance with StChs!
BStC-IV	↑	↑	↓	Anticipated sales "LE" is extremely optimistic; Consider whether the planned sales activities can generate increased sales!
BStC-V	↓	↓	↑	Anticipated sales "LE" is extremely pessimistic; Consider whether the planned sales activities can generate more sales than expected!
BStC-VI	↓	↑	↑	Anticipated sales "LE" and a sales plan "SP" are pessimistic; Consider whether the planned sales activities can generate increased yields higher than expected/planned to avoid the potential out of stock! Order according to StChs!
BStC-VII	↑	↓	↑	Sales plan "SP" is extremely optimistic; to avoid unnecessary "piling up" of stocks, make orders in accordance with StCle!
BStC-VIII	↑	↑	↑	Anticipated sales "LE", sales plan "SP" and historical sales "HS" are low compared to available stock; take measures of JIT supply!

The position of "BStC cube of belonging" in the Matrix of belonging points out to possible business implications and actions to be taken in order to improve the performance of inventory management (Table 1).

CASE STUDY

The concept of lean inventory management, using balance indicators StC (BStC), is applied to a real practical case at the company whose core business is Fast Moving Consumer Goods - FMCG in Serbia. The planning horizon is one month.

By using Excel spreadsheet tables, a system for calculating the StC according to three different approaches to measuring StC (historical sales, sales plan, and the last estimation sales plan) as well as the balance indicator BStC for four products was created (Table 2).

At this company the system for the calculation of indicator StC has the following purposes:

- Presentation of the summary display of current inventory, historical sales (HS), the sales plan (SP), anticipated (last estimation) sales (LE);
- Facilitation of the calculation of indicator StC (in IP);
- Facilitation of the comparison of indicators StC in RP (with those in IP) and enabling simulations of potential volume of new orders, i.e. assessing whether it is necessary to create a new order and its quantity.

Table 2: The system of the calculation of indicators StC and balance index BStC

Product description	Actual stock	Stock in transit	Next order	Histor. sales	Sales Plan	Last estim. Sales	StC hs	StC sp	StC le	BtS C
Product A basic	1.137	0	1.100	1.645	600	860				
TOTAL_Product A	1.137	0	1.100	1.645	600	860	1,4	3,7	2,6	2,5
Product B basic	8.355	2.010	0	2.765	4.500	3.100				
Product B promo 1	155	0	0	1.429	0	0				
TOTAL_Product B	8.510	2.010	0	4.194	4.500	3.100	2,5	2,3	3,4	2,3
Product C basic	5.117	8.064	0	1.547	0	0				
Product C promo 1	30	0	0	799	5.400	3.700				
Product C promo 2	263	0	0	939	0	0				
Product C promo 3	436	0	0	251	0	0				
TOTAL_Product C	5.846	8.064	0	3.536	5.400	3.700	3,9	2,6	3,8	3,5
Product D basic	549	0	2.200	1.423	3.500	4.500				
Product D promo 1	2.607	0	0	1.187	0	0				
Product D promo 2	45	2.304	0	447	0	1.100				
TOTAL_Product D	3.201	2.304	2.200	3.057	3.500	5.600	2,5	2,2	1,4	1,2
TOTAL	18.694	12.378	3.300	12.432	14.000	13.260	**2,8**	**2,5**	**2,6**	**1,9**

The target value of indicator StC (defined by company management) is 1.5 [month], so that the IP of balance is positioned in M (1.5, 1.5, 1.5). Based on the position of realized point N ($StChs_n$, $StCsp_n$, $StCle_n$) and the balance indicator vector, BStC cubes of belonging can be identified for any of the featured products. For product A the obtained value is $BStC_A = 2.5$ (and belonging to the cube of BStC-VI), the obtained value of product B = 2.3 $BStC_B$ (BStC-VIII), for C the value $BStC_C = 3.5$ (BStC-VIII) and the product D is $BStC_D = 1.2$ (BStC-II). Based on the above it can be concluded that the balance indicator is the smallest with the product D, while it is the biggest with the products C, which means that the inventory and planned orders for the product D are closest to the desired state. The company has been advised to apply recommended actions (Table 1) for each product, depending on its BStC cube of belonging, with the aim to improve the performance of inventory management of these products.

CONCLUSION

As stated earlier, the main task of inventory management is balancing the inventory in accordance with the policy of the company. Seen from only one perspective, it can be concluded that it is necessary to reduce inventory if sales in the previous period has decreased. Or, from another perspective, it can be concluded that it is necessary to increase the level of inventory if the planned sale faces optimistic expectations - an increase in demand for a particular product. Different perspectives can generate unfounded criteria for decision-making in the inventory management. To avert this situation the authors of this paper have proposed the concept of inventory management using balance indicator BStC and the matrix of belonging to one of the eight different BStC cubes of belonging, pointing to the possible business implications and appropriate actions.

The authors have identified various opportunities for further improvement (in different directions) of presented concept of inventory management. The first possibility is to use the formula for the calculation of balance indicator, upgraded by means of variance or standard deviation, to identify also the direction of the vector of balance indicator BStC. There is also the possibility that the formula for the calculation of indicators StC, in all three approaches to measuring, be expanded to include the planned orders in accordance with the concept of ATP (Available to Promise), which would facilitate the simulation of the influence of the decisions of restocking on the other KPIs (e.g., CSL).

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Case Study: Implementation of Lean methodology for improvement of storage process in the company PINOLES

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ABSTRACT

This paper presents successful project of Lean methodology implementation. Lean concepts are implemented in order to solve problems in the operations of storage processes, in the company PINOLES DOO, Belgrade, Serbia. PINOLES company is a leader in wholesale and retail of raw materials (panel material and plywood) for furniture manufacturing. This company has over 5000 different items in the sales program. The paper describes state of warehouse operations in the company before and after Lean concept implementation in the main logistics and distribution centre. As a result of Lean concept implementation, key performance indicator named as time-to-customer in distribution is reduced from 48 hours to 24 hours.

KEYWORDS: Lean methodology, 5S concept, storage process, time-to-customer

INTRODUCTION

Pinoles D.O.O. is one of the leading wholesale companies in the field of semi-finished goods for furniture production in Serbia. The company has experience of 15 years in the field of importing and distributing semi-finished goods for furniture production. By investing in infrastructure, staff and new products, company managed to maintain a network of customers and expand on the all territory of Serbia. Pinoles company is one of the most significant manufacturers, which partially or completely supply the plate material. The list of partners is consisted from more than 600 companies. Company have gained leader position in the market primarily, by bringing panels to manufacturer and to the final customer as close as possible, thereby providing the best possible service. The punctuality and timely delivery, quick and adequate response to the needs of customers, continuous education in one direction and timely recognition of market demands in the other are basic characteristics of company business.

Company has two logistics distribution centers (LDC), more than 5000 m^2 in total, LDCs in the Nova Pazova city and LDC in the city of Nis. LDCs are equipped with storage shelves and pallet racks for sorting and simple combining of goods, according to the request of customers, which allows cheap and fast operation. They are dimensioned and designed in order to meet needs of not only our market but also of markets in the region. In company assortment of products, there is more than 7000 stock keeping units (SKU), such as: chipboard , plywood strips (more than 5000 SKU), OSB panels and QBS panels, waterproof plywood, laminate flooring, laminate moldings, laminate substrate, transition strips, angles and extensions for laminate, mounting clips, dry-fitting doors, entrance doors, dry construction system, roof windows, insulation materials, roof membranes, building chemistry, powder materials and channels for surface water drainage, as can be seen in (Web-1).

The strategy of Pinoles company is defining of concrete goal and its realization by employees motivation securing, through the management support. Company is aiming towards the process orientation by focusing on specific figures, trends, benchmarks, regular measurements (such as conducting customers' surveys and statistical monitoring) and improvement possibilities detecting. The company has defined

number of KPIs for logistics operations efficiency monitoring. One of the most important indicator of logistics operations productivity is an indicator Time-to-customer (TTC), which shows how efficient logistics operations are in the products delivery process, i.e. how long clients have to wait for delivery of goods. This indicator is defined as a key indicator because the most of customers are furniture manufacturers, who already have contracts with end customers for furniture delivery. Any delivery postponement or delivery delay initiates situation where manufacturer chooses another supplier. Logistics services specificity of the company is reflected through manipulation with relatively large number of similar items and in the hiring of 3PL providers for transportation services. Before 5S concept implementation, a key indicator TTC in storage operations was more than 48 hours.

In order to improve logistics operations, in collaboration with external consultants company has identified problems in the warehouse operations, which caused delivery time increasing:

- Incorrect quantity of commissioned goods and high percentage of replaced items during commissioning,
- Inadequately distributed and unmarked items in the warehouse,
- Inadequately placed pallet racks,
- Lack of system for commissioning and deployment of goods,
- Undefined internal transport routes,
- Lack of dispatch area for commissioned items,
- Slow handling with goods on receiving or in the shipment of goods
- Inadequate system for 3PL carrier planning, due to long delays in preparing goods for shipment.
- Dependence of storage operation system from individuals,
- Improper use of special storage equipment (special forklifts)
- Lack of defined KPIs for employee performance measuring in storage.

The main requirement of company was to create solution that will not jeopardize existing operations and that does not require expensive WMS (Warehouse Management System), i.e. solution must be cheap and functional.

Lean methodology, tools and concepts are very well known and aimed at maximization of customer values while minimizing waste. This popular concept is introduced through idea and implementation examples by many books and papers, as can be seen in George (2005), Hobbs (2004), Kilpatrick (2003), Knowles (2011), Leach (2005), Womack and Jones (2010), Zylstra (2006) and others. Lean methodology, i.e. concepts and principles of 5S - visual management are used in order to define solution for solving problems in warehouse operations in the Pinoles company. Basic rules or principles of 5S concept are (Web-2):

- *Sort* – to get rid of anything that is not required,
- *Set* – properly arrange necessary things and restrict supplies,
- *Shine* – clean all, the outside and inside,
- *Standardize* – define rules to maintain the first 3S,
- *Sustain* – ensure respect of the rules.

Implementation of these rules has led to the successful project realization.

SCOPE OF PROJECT

Scope of project was very demanding, so it was very difficult to determine point of beginning for lean transformation. As 5S - visual management represents the first tool of Lean transformation, project was initiated by applying the concept of 5S. Working team was established and it was consisted of project managers from company, several employees from department of logistics, IT technicians and consultants.

Within one LDC, there are two separate storage spaces, for panels warehousing and storage of strips and smaller items.

Project team conducted analysis of warehouse for strips and smaller items, and analysis of working operations and found following:

- Orientation of storage shelves was wrong and rack passes were "dead ends". Because of that fact commissioners had to make unnecessarily large number of steps and losses in commissioning time.
- Goods were stored on the rack passes and on transport passes for forklifts. In that way some quantities of goods were trapped, i.e. goods have remained misplaced.

Figure 1: Pallet racks and racks orientation

- Racking shelves with goods ware not adequately located, so there was big loss of storage space on the rack shelves.
- Goods on the shelves were unevenly and inadequately distributed. Two or three different items of same colour were stacked one over the other on shelves. Items were mixed. Products were not arranged according to frequency of use or commissioning.

Figure 2: Transportation routes

Figure 3: Mixed and inadequate labels on shelves

- Different labels for items were on the rack shelves. There were many different codes for particular articles, while other items had no any code.
- Sides of shelves were not connected with upper levels of the storage area, so that was a waste of space in higher storage locations.
- All items of similar or the same colour, but different sizes (width, length, height, thickness) were stacked next to each other or on top of each other, so items were often mixed up during commissioning. As the strips for plywood were delivered in defined length, there was possibility of material scrap (loss), due to commissioning error in required length strips cutting.

Figure 4: Goods arranged according to colors

Figure 5: Panel materials warehouse

Analysis of second storage area, for panels storing, has shown the following:

- Panel goods ware placed into pallet racks in warehouse according to suppliers and type of goods, i.e. univer on one side and mediapan on the other. That was a big problem during commissioning, because commissioning orders are mixed and forklift needed too much time to get out from racking pass, to turn around and go back again for commissioning on the other side.
- Orders commissioning in panel materials warehouse lasted too long, in average 45 to 60 minutes for orders up to 30 panels of mixed goods, because rack locations were not marked and items were commissioned according to the "memory". The only known was part of warehouse where needed items were stored.

Figure 6: Panel materials commissioning

- Forklift with bucket had crossing unnecessary long path. For one commission order forklift was entering several times in the pass between racks. Also, there was a special commissioning forklift in the warehouse, which was very old, so waiting time due to forklift failures was significantly long.

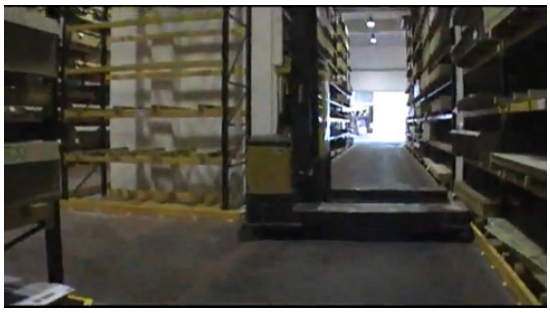

Figure 6: Special commissioning forklift for one side of racking passage

- Often, warehouse clerk did not have complete information where the goods are situated, or about commissioning location, and panel materials searching was very long.

Based on recorded state of warehouses, it was concluded that warehouse operations has very serious waste, causing serious threat to the delivery process time. The main waste recognized in warehouse operations were: waste of space, waste of working time of employees, time of equipment working and material scrap (wastage). In order to eliminate wastes incurred as a result of "uncontrolled" processes, it was necessary to gain control of equipment spatial distribution, materials and supplies.

PROJECT REALIZATION

Sorting, organizing and cleaning were the first of 5S concept principles, implemented in order to optimize storage process. According to these principles, following activities are realized in the warehouse for panel materials and strips:

- In the strips storage, all items are removed from pallet shelves and listed according to output frequency form warehouse. Articles that represent "dead" stocks are defined. As "dead" stocks are considered articles without any turnover in previous 30 days, 60 days, 90 days or over 90 days.

Figure 7: Stock sorting in the strips warehouse

- Pallet shelves are removed and reoriented in order to increase flow in the rack passages.

Figure 8: New orientation of rack passages in order to increase flow in the warehouse

- Levels for items storage are increased in racking fields.

Figure 9: Racking field with increased number of levels for items storage

- Commissioning locations on the shelves are marked with regal address. In that way is allowed movement through rack passes without return paths. Structure for commissioning location address of item is defined according to the principle of hotel rooms, where guest can stay at the hotel, which is located in a particular area of city, as follow: code for commissioning location of item is B/2/28/4 /2, which means warehouse B, second pass, twenty-eight shelf field on the fourth level and second commissioning location.

Figure 9: Commissioning location address

- Areas of frequency are defined as parts of warehouse, which do not require long commissioning tracks. Articles are located according to output frequency.
- Reception area, reception control area and dispatch areas are defined.

Figure 10: Reception area in the strips warehouse

- Commissioning locations are marked in the warehouse for panel materials and items are arranged on commissioning locations, according to output frequency.

Commission locations in strips storage are defined and placed on shelves in increasing order, criss-cross in one passage. In that way is enabled that employee works equally on the left and on the right side of one rack passage. Commissioning locations, in the plate material storage, are set in order to allow that special forklift can commissions plate materials on one side of shelves in a single pass.

Commissioning location is added as new attribute for article in the information system of company. In accordance with new encoding system, every article has its own code, bar code and commissioning locations code. When order is entered into the system, commissioning order for warehouse is generated in ascending order according to commissioning locations, and commissioner can follow commissioning locations in ascending order. Items with higher output frequency have position closer to warehouse exit.

In the second phase of project remaining principles of 5S concept, standardization and sustainability of existing situation, are implemented. During this phase of project following is defined:

- rules for commissioning locations maintenance, which are very important for the sustainability of entire solution,
- training for employees to use and create new commissioning locations,
- new work organization, responsibility for certain positions and communication paths are proposed,
- procedures and guidelines for working in the warehouse are defined and posted on the visible places in the warehouse,

- set of indicators for monitoring of warehouse workers performances is defined (commissioning time, number of orders, number of errors in commissioning and so on).

CONCLUSION

Achieved results of project implementation, i.e. 5S concept implementation in the PINOLES D.O.O. company, are represented in Table 1.

Table 1. 5S concept implementation effects

Indicators	Before the project	After the project
Time-to-Customer	48 (hardly 24h)	24h
TTC less than 8h up to 50 km	No	Yes, 23% of total No. of deliveries
Picking Time per order (less than 30 panels per order)	45-60 min	15 -20 min
Pick-up orders daily	30	100
Daily No. of load trucks	6	15 to 18
No. working ships (No. of employees)	2 (3+4)	2 (6+6)
Average No. of pick orders per employee	4.2	8.3
Education of storage operations	No	Yes in total for all employees
Culture	Sales + Logistics = No team efforts	Sales + Logitics = Team effrots

Also, according to the competition analysis, PINOLES company is the only one in this kind of industry that has the organization for warehouse operation described in this paper, and that has shortest time to customer in delivery. Effects of applying 5S concept significantly helped in logistics support of company to sales growth in 2011 and 2012.

ACKNOWLEDGEMENTS

Realization of this project was significantly supported by Pinoles D.O.O. employees. Employees have seriously understood LEAN methodology and 5S concept benefits. There is also great contribution of company management, who dare to start the project and financially support its realization.

Students from the Faculty of Organizational Sciences, Department of Operations Management ware actively involved in all phases of project. At the end of project one of students became employee in the company Pinoles.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Review of Methods and Tools for Practical Lean Implementation

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ABSTRACT

Large number of companies encounters difficulties when trying to implement lean production and it is caused by different influence of lean methods on production system. Using various and different methods, without knowing which are compatible could be very confusing. This paper presents review of methods and best practice for practical implementations which are successfully applied in companies. The main objective was on methods that are easy to implement with extremely small investments but which influence a lot on improvement of production process in company. The most attention has been given on visual management.

KEYWORDS: Lean production, Implementation, Visual Management, Tools and Methods

INTRODUCTION

Lean production is now very important part of manufacturing companies all around the world and it is directly descended from Toyota Production System (TPS), which evolved from Taiichi Ohno's work. With publication of the first industrial bestseller book *The Machine That Changed the World* (Womack and Jones 1990), lean has found applicability in many manufacturing operations. It is often regarded as the best standard of modern operations and supply chain management (Goldsby et al., 2006). Frequently it is associated with elimination of waste as excess inventory or excess machine or human capacity in order to improve effects of variability in supply, processing time or demand. In order to pursue lean production and to eliminate all kinds of waste, companies have to manage variability in supply, processing time and demand (Hop and Spearman, 2004).

One of the definitions which capture many aspects of lean represent lean production as an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability (Shah and Ward, 2007). Variability in supply occurs when suppliers fail to deliver specific amount of products at the right time or the right place (Womack and Jones, 1990).

Companies are always looking for new ways to stay competitive and to improve their work and products by making them better, cheaper, safer and adding value. Lean production and all tools that are used in this philosophy are recognised by a large number of companies, and not just large but even the small ones. Research conducted by Shah and Ward (2007), show that larger firms are more likely to implement lean production then small ones. Larger companies are more open for bigger investments in production improvement while small companies are trying to find ways for improvement which are not very expensive. One of this ways can be found in implementing proper lean tools, one by one, starting from essential stuff which usually makes radical change in company. These tools focus on waste removal and adding value to products such as value stream mapping, 5S method, visual management and others (Hofer et al., 2012).

The purpose of this paper is to present best tools and methods which do not requires large amount investments but improve a lot the way of business in small companies. Some of them are easy to implement and may seem like ''common sense'' but they are crucial for waste removal and adding value. This is crucial for small companies which are struggling for survival on competitive world market.

VALUE STREAM MAPPING

Value Stream Mapping (VSM) is tool which is used to reduce or eliminate waste in production process. This tool identifies all steps in process and track changing of product from activity to activity. By recording duration of every activity performed, manager can see weak spots in production process and act to improve it. Time delay between activities and flow of the data and information are also identified. When this is all done based on current information it is called current state map. Based on current state map it is possible to identify value added time and non-valued added time. Current state map gives possibility to decide which changes are crucial for improving process. Map of future state is created when the whole current state map is revised. After creating future state map it is necessary to develop work plan how to accomplish all necessary steps and activities. Also all costs and savings are analyzed between current state map and future state map. With Value Stream Map, workers can see problems in their production process and find ways to solve it (Mastroianni and Abdelhamid, 2003).

THE 5S PROCESS

5S was developed to eliminate hidden factory waste by describing a set of actions in order to maintain an organized work place (Monden, 1998). There are several steps in 5S implementation which describe those actions – Sort, Set in Order, Shine, Standardize and Sustain. This tool creates organized, clean and standardized work environment in order to improve profitability, effectiveness and safety by lowering losses in production area. Implementation of 5S needs to be conducted through next steps:

1. Creating organization for promotion of 5S
2. Set up promotion plan of 5S
3. Prepare materials for 5S campaign
4. Education inside of company
5. Implementation of 5S and
6. Evaluation.

In organization for promotion of 5S usually it is necessary to include external consultants and top management of company in order to create detailed plan of promotion and to find best way of education for employees. In smaller companies employees are usually open to new ideas and improvements. If new ways of future implementation are presented from start on the right way fitted to employees, so participation in presentations and workshops after work will not be problem.

VISUAL MANAGEMENT

Visual management is lean tool which can improve awareness and which can change behavior of workers through visual displays and visual controls (Monden, 1998). Written letters and words represent most common way for visual presentation of information but they are not the best one. Also, there are signs, symbols, lines, shapes, labels, colors, pictures, diagrams etc. Visual management is one of the easiest ways of getting the message across. If there is a need for understanding how thing should be done and what is the wrong way, easiest way is to take a picture and compare them as correct and incorrect way, figure 1.

Figure 1: Practical example of visual management for easy understanding of the dress code in company

It is designed so that anyone entering a workplace, even those who are unfamiliar with the details of the process, can very rapidly see what is under control and what is not. Workers with this tool get real time information and feedback regarding status of workplace. Visual Management helps in: employee safety, overall efficiency, lowering costs, correct materials and flow, streamlining operations, information sharing and teamwork. Large number of companies has some visual instructions, marks, signs, pictures of products or processes, but these information sometimes help but sometimes don't. This is because they become part of the background, they lost on their importance and nobody noticed them anymore even they are still there. In order to solve this problem management need to have right and effective approach to visual management. Implementation of visual management can be divided into four phases:

1. Workplace organisation
2. Visual display
3. Visual measures
4. Visual management.

The best lean tool for workplace organization is 5S. The target of lean 5S is to create a safe organized and comfortable work environment by keeping the area in order by the workers themselves. Thus motivation in the workplace is fostered. This organization tool works on the principle that a workplace full of clutter is less productive and motivating than a clean and ordered area. Unnecessary items and dirt get in the way of employees and negatively impact productivity. Practical example in company before and after conducting workplace organisation with 5S is presented on the figure 2.

Figure 2: Practical example of 5S tool in company

Second phase of visual management starts after successful implementation of 5S. Visual Display (figure 3) represents a method to visually communicate important information in the workplace. There are several types of visual display:

1. Designated locations

2. Floor labeling
3. Information boards
4. Work instructions
5. Checklists.

Figure 3: Practical example of floor labelling and information board

Work instructions are very important part of workplace. One of the best ways to present workers necessary information is lean tool One Point Lesson (OPL). This is simple way and can be used to train workers in just 10 min because OPL focus on one small task or breakup larger tasks into steps, figure 4.

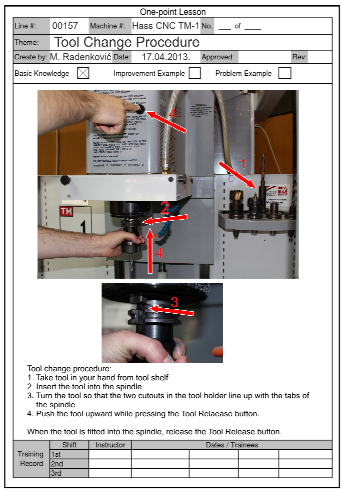

Figure 4: Practical example of OPL for Tool change procedure

Visual controls are one important part of visual management because they constantly reinforce focus on process by using intuitive graphics and colours that can be quickly understand by workers from a certain distance, figure 5. Focus on process makes it easier to see contrast between expected and actual process performance. This is very important because it help employees to identify opportunities for improvement.

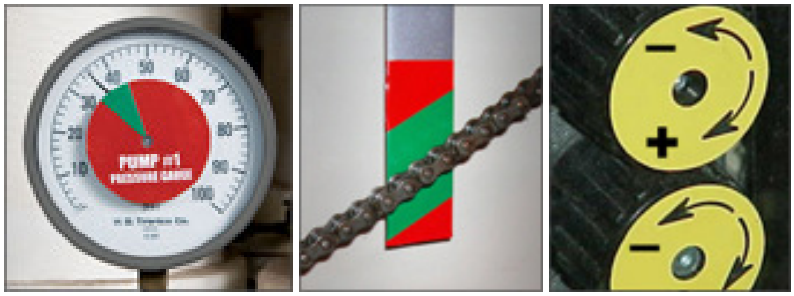

Figure 5: Practical examples of visual controls

Visual measures can be used to understand the performance of implemented improvement, part or whole department. This can also be used to demonstrate achievements of performance in a certain period of time, for this measuring of initial condition before making improvements is vital. One of lean tools that can be used in this step is andon. Using andon boards (figure 6) can help industry guide, monitor and ensure productivity.

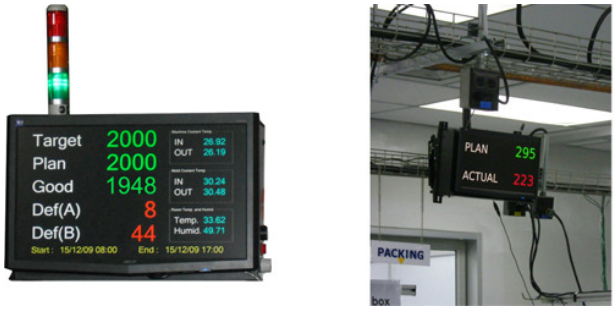

Figure 6: Example of andon boards

With andon boards workers can see order status, priorities and many relevant productivity measurements even from a distance. These boards are basic but very expensive addition for lean production. Because of bigger investments smaller companies rarely implement this tool.

Visual safety is also very important. Safety calendar or green cross, figure 7, is one of must-have item in any company based on lean philosophy. With safety calendar every cut, bruise, or minor injury is recorded. By recording all safety problems and paying attention to all of the near-misses helps to prevent serious injuries and deaths that can occur. It is very important that employees see concern from company management for safety so they will feel comfortable in safe working environment.

GREEN CROSS FOR SAFETY

(MONTH)					
		1	2		
		3	4		
		5	6		
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
		25	26		
		27	28		
		29	30 / 31		

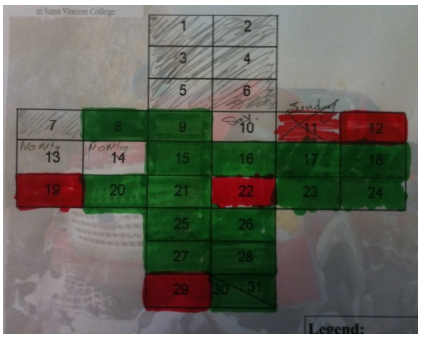

Figure 7: Blank safety calendar and example

Safety cross helps employees to see when and where is necessary to make improvements. Even if employees have become desensitized to an unsafe workplace, red marks day after day for minor injuries will raise awareness immediately. Nobody wants to be seen managing an unsafe workplace, so safety issues will be fixed.

CONCLUSION

It is very important to properly chose and implement right lean tool. For small companies larger investments are very difficult, because of that in this paper are presented tools and methods which do not require a lot of money to implement. Regardless of cost of investments these lean tools have big influence on production process and whole company, so there are a lot of benefits and reasons for their implementation.

Changing behaviours of employees to think lean will be the key to survival since in this competitive world there are no room for mistake. It is necessary for companies to improve themselves every day. Lean production through lean tools and methods can help to achieve that.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Lean and Green

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ABSTRACT

This paper considers how increasing environmental degradation and human population will impact the life on Earth, and how LEAN philosophy is one of the potential answers to this rapidly escalating problem. This paper also considers how individual elements of LEAN philosophy could become in future tools that will help business respond to the demands of environmentally aware consumers, in competitive market arenas, as well as these elements can help companies to increase their efficiency with minimizing negative effect toward the environment. This paper also analyzes how LEAN philosophy with its elements and pursuing perfection also represents a pursuit for a long term global sustainability.

KEYWORDS: sustainability, lean, lean manufacturing, lean and green

INTRODUCTION

> *"It is not the strongest of the species that survives, or the most intelligent, but the one most responsive to change."*
>
> Charles Darwin

Human civilization has never been closer to ecological collapse: one third of humanity lives in poverty, and another 2 billion people are projected to join the human race over the next 40 years (Worldwatch Institute, 2012). As a result of population increase and economic development, humans have exerted a considerable impact on Earth and are facing a series of misbalances among the natural resources, environment, and economy, such as the dichotomy of population growth and depression of resources and environment deterioration (Jeremic et al., 2011; Petrović et al., 2011; Petrović, 2012). Otherwise, human activity and the entire economic activity of a country affect the natural environment and reduce the volume of the existing natural resources (Trifu, 2011).

The implication of this ecological situation is obvious: A growing awareness of the necessity to reverse the process of environmental degradation and move toward sustainable business practices currently appears (GLRI, 2005).

On the other hand, lean manufacturing as a management philosophy, aims to eliminate the seven classic wastes into the sustainability production concept: minimizing the amount of waste from manufacturing, reducing energy use, and using the materials and resources in a more efficient way.

SUSTAINABILITY

Sustainability represents a systemic concept of the integration of economic, social and environmental aspects of human society. The term sustainability is in the relation with sustainable development The

most often quoted definition of sustainability comes from the 1987 report published by the World Commission on Environment and Development (WCED, 1987), also known as the Brundtland Commission.

Environmental sustainability and development are defined as a single, indivisible issue, which, consequently, led to the following definition: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Likewise, sustainability is a multidimensional concept, which means that economic, social and environmental aspects must be considered and integrated, too (Pawlowski, 2009; Pawlowski 2010; Tuziak, 2010). Figure 1 above presents a representative scheme of sustainable development vectors.

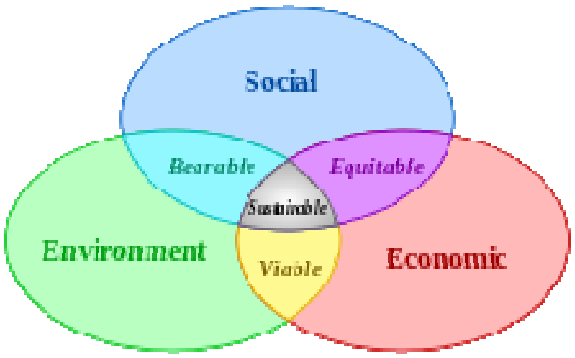

Figure 1: Sustainable Development vectors (WCED, 1987)

Further, economic and social demand of environmental sustainability urges companies to embrace the strategic importance of environmentally sound practices and strategies of management for competitive advantage (Porter & Van der Linde, 1995; Sroufe, 2003; Kleindorfer et al., 2005; Pagell & Gobeli, 2009; Yang et al. 2010).

LEAN MANUFACTURING

When in 1990 a book appeared by the title, "The Machine that Changed the World", often referred to as the "MIT study", no one anticipated the repercussions which the ensuing debate would have (Womack et al., 1990). In this book, the history of the automobile industry was studied and the quality and productivity improvement techniques applied by Toyota were termed "lean production".

The concept of lean thinking describes the working philosophy and practices of the Japanese vehicle manufacturers and in particular the Toyota Production System (TPS). In general terms, lean thinking is defined and described by five key principles (Womack & Jones, 1996):

- *Specific value* - define value precisely from the perspective of the end customer in terms of the specific product with specific capabilities offered at a specific time.
- *Identify value streams* - identify the entire value stream for each product or product family and eliminate waste.
- *Make value flow* - make the remaining value creating steps flow.
- *Let the customer pull value* - design and provide what the customer wants only when the customer wants it.
- *Pursue perfection* - strive for perfection by continually removing successive layers of waste as they are uncovered.

Lean manufacturing represents a multifaceted concept that may be grouped together as distinct bundles of organizational practices (MacDuffie, 1995; McLachlin, 1997). A list of bundles of lean practices includes: just in time (JIT), total quality management (TQM), total preventative maintenance, and human resource management, pull, flow, low setup, controlled processes, productive maintenance and involved employees (McKone et al., 1999; Swink et al., 2005; Linderman et. al., 2006; Shah & Ward, 2007).

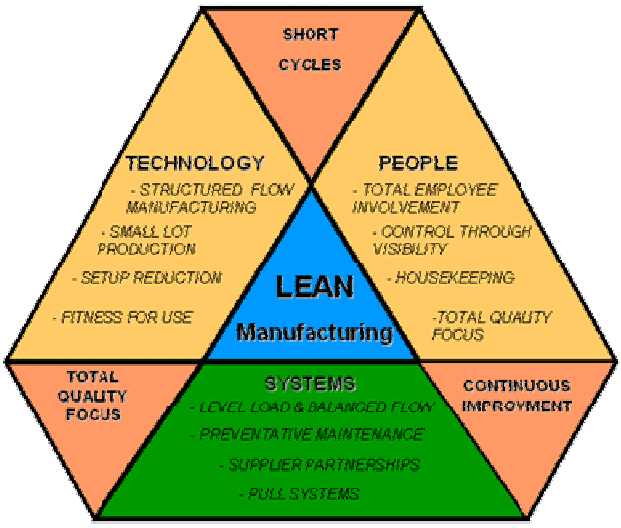

Figure 2: Lean manufacturing (Web-1)

In literature, lean manufacturing is defined as a set of practices focused on reduction of waste and non-value added activities from a firm's manufacturing operations (eg. Womack et al., 1990; McLachlin R.,1997; Shah and Ward, 2007).

Lean manufacturing focuses on the systematic elimination of wastes from an organization's operations. Within the context of manufacturing systems seven types of waste can be identified (Ohno, 1988; Womack & Jones, 1996):

1. *Overproduction* – Occurs when operations continue after they should have ceased. This results in an excess of products, products being made too early and increased inventory.
2. *Waiting* – Sometimes referred to as queuing and occurs when there are periods of inactivity in a downstream process because an upstream activity has not delivered on time. Sometimes idle downstream processes are used for activities that either do not add value or result in overproduction.
3. *Transport* – Unnecessary motion or movement of materials, such as work in progress is being transported from one operation to another.
4. *Extra processing* – Extra operations such as rework, reprocessing, handling or storage that occur because of defects, overproduction or excess inventory.
5. *Inventory* – All inventories that is not directly required to fulfill current customer orders. Inventory includes raw materials, work-in-progress and finished goods. Inventory all requires additional handling and space. Its presence can also significantly increase extra processing.
6. *Motion* – Refers to the extra steps taken by employees and equipment to accommodate inefficient layout, defects, reprocessing, overproduction or excess inventory. Motion takes time and adds no value to the product or service.
7. *Defects* – Finished goods or services that do not conform to the specification or customer's expectation, thus causing customer dissatisfaction.

In addition to these seven types "deadly waste", eighth categories of waste have been identified - *underutilization of people* and in particular their ideas and creative input for improving the processes and practices (Womack & Jones, 1996).

Based on the analysis of customer value, lean presents a set of tools and techniques for continuous improving processes and eliminating wastes (Rotther & Shook, 2003).

LEAN & GREEN

Minimizing the amount of waste that is produced, reducing energy consumption and making more efficient use of resources can lead to financial cost savings, in addition to helping to protect and enhance the environment (Web-2). Also, there are many examples where improving environmental performance has improved the company's profit (Porter & Van der Linde, 1995).

There are no doubt that there are a great potential of integrating the lean thinking to environmental sustainability (Womack & Jones, 1996) because lean is creating a new manufacturing paradigm, which includes an environmental sustainability elements - the reduction of materials, wastes and energy that are required by the production (Pampanelli et al., 2011). Therefore, they consider that lean thinking is green once it proposes.

Further, lean production techniques: Kaizen, SMED, Six Sigma, value stream mapping, total productive maintenance (TPM), cellular manufacturing, Just-in-Time production, the five 'S's, pre-production planning (3P) and lean enterprise supplier networks create a culture of continuous improvement, employee empowerment, and waste minimization, which is very compatible with organizational characteristics encouraged under environmental management systems (EMS) and pollution prevention. The lean approach may be applied for deploying an Environmental Management System and a continuous improvement culture (Pampanelli et al., 2011).

Although, lean and EMS have different approaches, they are additional in certain fields:

- Lean production system is a collection of operationally-oriented tactics and practical tools that are designed to achieve an operating environment that is guided by several philosophical pillars.
- Lean is broad in scope, focusing on the elimination of waste (all non-value added activity) throughout an entire organization and aiming to continually improve processes and products.
- Leans drivers are deeply rooted in business competitiveness, capital productivity, and customer satisfaction.
- EMS is more of a strategic management framework than a collection of tactical tools.
- Regarding waste, an EMS takes a narrower focus than lean by targeting only the waste that has environmental implications.
- The drivers for EMS implementation, while often strong, are not typically of the same magnitude with respect to business performance as those behind lean implementation (Web-3).

Lean and EMS have also similarities:

- Lean and EMS have foundations in TQM and rely on a continual improvement philosophy.
- Lean and EMS focus on eliminating waste.
- Lean and EMS seek to foster an organizational culture that emphasizes employee involvement in problem solving (Petrovic & Slovic, 2013).

Also, previous studies emphasize building capabilities in lean to enhance green capability (Petrovic & Slovic, 2013).

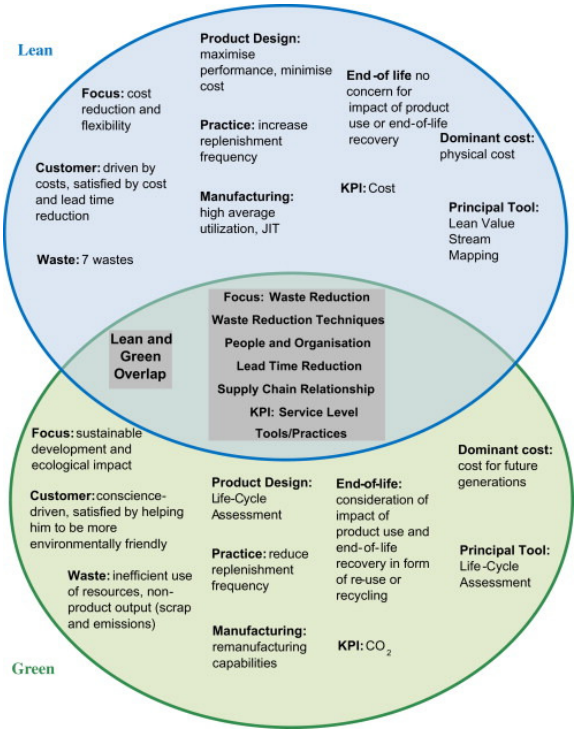

Figure 3: Overlap of Lean and Green Paradigms (Dües et.al., 2013)

The primary waste is targeted by a typical green manufacturing system that includes environmental waste such as: hazardous materials, green house gases, solid wastes, water usage, and energy. The green manufacturing system consequently has the reducing of negative environmental impacts as a result of its activity. Commitment to reducing environmental waste through the implementation of best practices is the essential core of a green manufacturing strategy links it directly to not only the lean philosophy but also the practices of environmental management.

Philosophically speaking, lean and green manufacturing systems may start targeting seemingly different types of waste, but eventually all manufacturing waste affect the objectives of either system. Ultimately, the pursuit to become truly green will require reducing operational waste that typically generates environmental waste as a result of process inefficiency. Likewise, to become truly lean, one must address environmental wastes, which are almost always non-value added (Web-4).

CONCLUSION

Level of environmental degradation that human kind is faced today, demands immediate and effective response. One of potential solutions for achieving sustainable production as a component of sustainable development is definitely LEAN philosophy. Business in the future will have to come with cleaner, better, environmentally more friendly production processes, that are the foundation of LEAN, in order to satisfy increasing consumer environmental awareness.

In vibrant and competitive market environment, companies that are ready to go further in LEAN implementation will be gaining additional market shares. And only by pursuing perfection will be able to satisfy consumer needs. These needs today are more and more in line with the environmental goals and sustainable development. Consumers today demand environmentally friendly products and reward the environmentally friendly companies by giving them their trust.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Communication of Lean and Green Practices Via Web Sites

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ABSTRACT

The purpose of this paper is to provide the review of communication of lean and green practices via web site. Paper analyzes lean and green practices as a part of modern model of responsible behavior towards the environment in order to contribute to the improving overall customer value. As Internet is an important channel of communication with green consumers, this paper analyzes communication via web sites. The research includes content analysis of web sites of leading global fashion companies, and it was concluded that they use web site as a channel for communication of lean and green practices. The topics of communication that the companies use have also been identified.

KEYWORDS: communication, web site, lean and green practices, green customer, fashion companies

INTRODUCTION

Global society has great expectations in terms of participation and contribution of companies. In addition to generating economic growth and competitiveness, companies are expected to contribute to sustainable development of economy, environment and society. Corporate social responsibility (CSR) as a business philosophy aims at achieving long-term benefits for the company and the society in which it operates. Although the concept of CSR has already been accepted in both theory and practice, the goal of this paper is to underline the relevance of environmental initiatives as a CSR dimension, especially the part of lean and green practices. Lean and green practices are analyzed as a part of a modern management approach directed to the improving both business performance and overall customer value.

As manufacturing companies develop capabilities for cleaner production, researches focus on revealing and understanding linkages between operations and environmental performance by supporting the development of environmental practices (Hajmohammad et al, 2013). The continuous effort through lean management to reduce operational waste either from discarded materials, consumption of energy, or water usage translates into lower environmental harm, thus enhancing environmental performance (King and Lenox, 2001). On the other side, in accordance with the philosophy of social responsibility, the company should also make marketing decisions by taking into account the needs and long-term interests of consumers, the requirements of the company's employees and the long-term interests of the community in which it operates (Kotler et al., 2007). This paper analyzes communication of lean and green practices, as a form of social responsible marketing communication. It is analyzed as a voluntary dimension in the theoretical framework of the "dimension of social responsibility" introduced by Carroll (1999). According to this author, the dimensions of social responsibility are: economic, legal, ethical/moral, and voluntary dimension. The "voluntary responsibility" is implemented by process of integration of CSR and marketing communication. In this paper, we analyze the communication of lean and green practices via web site as a channel of communication. The core of the analysis is the apparel industry, as the literature identifies that a new business direction in fashion world is supplying fashion products that meet consumers' green demands (Moon et al., 2013).

COMMUNICATION OF LEAN AND GREEN PRACTICES

Along with increasing public interest and concern for the impact that modern business and production have on the environment, and the wider stance and increasing environmental sensibility of the consumers, the successful business systems are trying to adapt different aspects of their business to new expectations of the public, its stakeholders and its customers. One of the dimensions that has come under strong pressure to change, in order to take more into account the overall impact on the business environment, is marketing. The term "green marketing", and its synonyms or precursors "ecological marketing", "sustainable marketing" and "marketing oriented environment" (environmental marketing) first appear in mid-seventies, when the American Marketing Association (AMA) held the first workshop on "ecological marketing" in 1975, and this was the year they published the book of the same name, which was the first of a kind in the world (Polonsky, 1994). The first definition of green marketing was created at the time, and it reads: "trial of the positive and negative aspects of marketing activities on pollution and resource consumption" (Henion and Kinnear, 1976:1). Polonsky believes that business can't completely eliminate the harmful impact it has on the environment, but can constantly strive to reduce the harmful effects. Same author vividly illustrated his claim by the example that the most accurate version of the statement that often appears in the promotion of products or packaging: "a friend of the environment" (environmentally friendly), should read "less environmentally harmful". Green marketing does not refer only to brand product and services as "green", but it takes into account the operations and overall functioning of the company in relation to the environment.

Accordingly, these are the possible subjects of communication of lean and green practices:

- Business operations sustainability: reduction of water and energy consumption, reduction of pollution, the use of "green" materials and production processes, as well as adequate treatment of waste.
- Green products: designing a product whose use is saving water and/or energy, use of natural, organic or recycled raw materials produced in a sustainable manner, as well as packing products in packaging that can be recycled, broken down and that allows proper waste management.
- Sustainable marketing communication: means that the ecological principles are applied in the selection and design of communication tools. For example, printing promotional materials on 100% recycled paper, using organic inks (such as soy ink), control and reduction of CO2 emission caused by marketing activities, recycling unused posters, billboards and other promotional materials, environmental packaging, etc.
- Supporting institutions or campaigns that promote the protection of the environment: a partnership with non-profit organizations, marketing with social purpose, donations, sponsoring social marketing campaigns, etc.

Generally, the decision to implement green marketing can be the result of external or internal "pressure". According to the authors Polonsky and Rosenberg (2001), drivers of green marketing are following: responding to the needs/expectations/demands of consumers, reacting to the actions of competitors, customer demands when it comes to the supply chain, reducing the cost and adoption of environmental concerns as a business philosophy.

The expectations of green consumers

A topic that is most common in the academic literature when it comes to green marketing is the profile of "green consumers". Namely, the central theme of this research is to determine: who are the consumers that, when deciding to purchase an item, consider the impact of the product/service to the environment (either during its manufacture, through use of the product or waste management after use), how these consumers are represented on the market in total population, what are their motives, and how their environmental awareness really affects behaviour and willingness to buy green products and/or pay a higher price for such products. Studies often show contradictory results, ranging from the size of the market of "green products", to buying habits and demographic characteristics of "green consumers". It is considered that the market for "green products" is actually already established and growing. An example of this is the

sector of food products, which includes organically produced food that recorded a growth of 20% at the beginning of this decade (Rex and Baumann, 2007). However, according to the same authors, the market share of organic food accounts for only five percent of total food sales in Europe in the same period.

Furthermore, some studies have shown that the typical "green consumers" are women, young people and people with relatively higher level of education, while there are numerous studies that have identified different demographic characteristics of consumers in this segment (Straughan and Roberts, 1999). J. Ottman (2011), author of the book "The New Rules of Green Marketing", which is recognized as a key recent literature in this area, set aside and explained 20 rules, socio-economic developments and facts that have led to the development of green marketing and that significantly determine its development in the future. These are the highlights of the regulations that are relevant to the aspect of communication:

- Sustainability is no longer a basis for positioning in the market, but it is an important consumer need and integral aspect of product quality.
- Sustainability can not be achieved by "cosmetic changes" to the product, but rather by a holistic and fundamentally new business model, which will have much less negative effect on the natural environment.
- "Green consumers" do not expect perfection. They expect the company to set high goals for reducing harmful impact on the natural environment, to go beyond what is required by law, to constantly improve their performance and product performance, and to communicate to consumers about the progress in this regard.

WEB SITE AS A COMMUNICATION CHANNEL OF LEAN AND GREEN PRACTICES

Starting from the internal and external drivers, consumer and society expectations identified in the previous section, and based on previous research (Biloslavo and Trnavcevic, 2009), this paper analyzed web sites as communication channels for lean and green practices. The Internet is an important channel of communication with green consumers (Ottman, 2011), and a company web site is one of the primary means of communication over the Internet. The survey was conducted on a sample of leading global fashion manufacturers, as Moon et al. (2013) identified that a new business direction in fashion world is supplying products that meet consumers' green demands.

For a brief overview of communication of lean and green practices via web sites, this paper selected three global fashion companies, which appeared in the Apparel category of Intebrand's Top 100 Brands 2012 report (http://www.interbrand.com/en/best-global- brands/2012/Best-Global-Brands-2012-Brand-View.aspx): H&M (brand value 16.571 $ m), Zara (brand value $ 9,488 m) and Gap (brand value $ 3,731 m). Selected fashion retailers were comparable according to the criteria of price position and market segment, as they target similar groups of consumers, and are close to the price and position. We analyzed whether companies are using the web site as a channel for communication of lean and green practices, and what is the subject of communication (in accordance with the topics identified in Chapter 2).

H&M

• Sustainability of business operations: Promotion of organic cotton and enhancement of conventional breeding (the biggest user of organic cotton in the world), Sustainable materials: organic linen, recycled wool, polyester, Tencel, Lyocell and hemp, Concern about animal rights and the use of only the skin of animals raised for meat production, The focus on reduced water consumption and energy efficiency, The use of conventional fuels and orientation towards renewable fuels, Focusing on rail and sea transport, in order to increase transport efficiency, Helping suppliers to monitor and reduce their energy use and greenhouse gas emissions, Waste management initiatives, Collecting old clothes of any brand, in any condition any quality in their stores and directing it to the nearest processing plant for recycling, Provides guidance to customers for concinous washing in terms of energy consumption.

- Green product: Products made of 100% organic cotton. Healthy products, safe to use and less harmful to the environment. Quality products - production, transport and sales with care for people and the environment. Recycled plastic used for carrier bags.
- Sustainable Marketing Communication: The label on products made from 100% organic cotton. Archives of the period from 2002 to 2009, which represent the view of business sustainability. It refers to the assistance provided by H&M to improve cotton cultivation, ecological way of transport, reducing the use of chemicals, promoting cleaner production of materials, recycling within the stores and achieving better working conditions. Transparent reporting - Conscious Actions Sustainability Report 2012 is posted on the web site.
- Supporting institutions or campaigns that promote environmental protection: With UNICEF – support the project ment to protect the rights of the poorest children in the world. Teaming up with WWF in a three year global partnership to set new standards for water stewardship in the fashion industry. Worked with Water Aid, in helping build toilets in Asia. Contract with the CEO, the UN Global Compact initiative made up of a set of companies that collaborate to address the issue of water sustainability.

Zara

- Sustainability of business operations: Use of organic fabrics, organic cotton, the difference in the production of PVC-free shoes. Products of animal origin, containing fur and leather, come from animals raised for meat production. Use of biodiesel in the transportation of their products and thus the company achieves the reduction of carbon dioxide emissions by over 500 tons per year.
- Green product: Organic cotton clothes, PVC-free shoes. Environmental management model in the stores, which leads to reduced power consumption. Reduces the production of waste and recycles hangers and theft alarms. Organizes green internal communications campaigns. Fragrances are not tested on the animals.
- Sustainable Marketing Communication: Labels on clothes made from 100% organic cotton.
- Supporting institutions or campaigns that promote environmental protection: No explicit information on the web site.

GAP

- Sustainability of business operations: Accountability in every aspect of business, from the production of clothing, way over to their packaging and transportation, to the planning and editing of point of sale. Certified organic cotton is grown without the use of pesticides and fertilizers that disrupt the environment. Focused on reducing energy use in its stores, offices and distribution centers.
- Green product: Clothing is made from organic cotton. In order to preserve the natural color and quality of the cotton fiber, clothing is not treated with bleach or chemical colors. Reduced the amount of packaging they use, the use of sustainable materials whenever possible. Reduced the use of ruffled cardboard and ensured that wastewater is properly treated before discharge.
- Sustainable Marketing Communication: The label on garments made from organic cotton.
- Supporting institutions or campaigns that promote environmental protection: Since 2005. the company is the member of the Better Cotton Initiative (BCI). Participation in the Sustainable Apparel Coalition, which is aimed at determining standards in such areas as sustainable materials, as well as the working conditions. Supports addressing climate change and the development of cleaner energy sources. Partnerships with environmental groups such as Ceres and the National Resources Defense Council. Since 2003. the company participated in the U.S. Environmental Protection Agency's Climate Leaders program and in the Carbon Disclosure Project, in order to reduce the use of electricity and transmission of greenhouse gases. Report from 2009. states that they have reduced emissions by 20% per square meter in the period from 2003 to 2008.

After analyzing companies' web sites, it was noted that the term "organic clothes" appears in the pages of almost every company. All companies address the issue of safety of certain products to the environment and humans. The term "sustainable development" is mentioned by the company Zara, which it includes in its mission statement, while the term "sustainability" is mentioned by all three analyzed companies, and the term is thoroughly analyzed, by each company, in accordance with the manner in which it is conducted. The organic cotton and its significance are a subject of discussion for all companies. It can be noted that the company with the highest value of the analyzed brands, H&M, has the most intense communication of lean and green practices, in terms of scope and detail of green initiatives that were implemented and communicated via web site.

CONCLUSION

Research of the fashion companies showed that green marketing is more and more involved in their business. It has become an integral part of their corporate culture and it is implemented in all phases of the life cycle of their products, modifying the traditional marketing mix elements and implementing them in the principles of green marketing. The analysis showed that the global fashion manufacturers that, according to the brand value, are placed on the Intebrand's Top Global Brands in 2012, are using a web site as a communication channel of lean and green practices. Regarding the subject of communication and information that can be found on the web sites, the sustainability of business operations and focus on increasing the accountability of companies throughout the supply chain are the main subjects/topics. In addition, the companies communicate information on initiatives, campaigns and cooperation with relevant institutions in the field of social responsibility and the environment. Companies are becoming active in the field of communication of lean and green practices, and they are directed to the same features that green products have, and the ways of their production, sales and promotions.

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LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Environmental Challenges of Tourist-Residential Projects in a Sensitive Emergent Region of Brazil

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ABSTRACT

Tourist activities at a large scale and with systemic effects are relatively new in Brazil and its Regions. The Northern Littoral of the state of Bahia, integrated into the Northeast Region, is a sensitive area from the environmental point of view and has important comparative advantages for tourism. Therefore, internally and externally, it appeared as an attractive pole for such. By the turn of the century, Spanish and Portuguese hotel networks, among other nationalities, significantly invested in the Northern Coast of Bahia. Most of the projects combined tourist and residential purposes. This paper focuses on the environmental challenges faced by these hotel groups in their local endeavors particularly when facing the control and licensing bodies enabled to monitor the implementation of environmental rules. Indeed, meanwhile, Brazil began the process of approving legislation as far as sustainable development is concerned. Due to the variety of players and often contradictory interests (international hotel groups, local population, financial investors, political and bureaucratic agents, and environmental observers) the development of tourist activities became a very complex issue, and has attracted some research. Also, as a sensitive region from the sustainability point of view, it is important to guarantee that tourist residential resorts will not jeopardize the characteristic environment of the Northern Littoral of Bahia. Based on field research and interviews with corporations' executives, it was found that the main obstacles the hotel groups have encountered are bureaucratic procedures, environmental licensing, and the lack of market knowledge. The framework regarding environmental, territorial, and urban public policies appears as the main conflicting motive between Iberian hotel corporations and the control and environmental licensing bodies, particularly as far as concerns its lack of clarity and the long time needed for final decisions. The paper also allows benefiting from the tourism experience of Spain and Portugal when we look at the case of a country and its regions just emerging to tourist and tourist-residential ventures through the hosting of international hotel chains.

KEYWORDS: tourism, residential tourism, socio-environmental conflicts, environmental licensing and regulation, foreign direct investment, hotel groups.

INTRODUCTION

The context of growing global competition and the move towards international expansion due to the saturation of tourist-destination supply in Western Europe is leading the large hotel chains to adopt different strategies in order not only to maintain their position in domestic markets, but also to be increasingly present in the international markets, particularly with great growth potential like those of emergent economies. In their international development, in addition to reduction of costs (Horrillo, 2008), the hotel corporations pursue several objectives, for example they are in search of scale economies, geographical and product diversification, and of responding to new consumers' demand (Williams, 2006). In this process, in order to reduce the seasonal effects of tourism, hotel networks began to serve not only tourism demand but also increasingly residential purposes, especially in places of relative accessibility at a global level, for example not far from airports. Taking into account these trends, in the present study, we will look at the case of

Spanish and Portuguese hotel networks in their internationalization to a sensitive region of Brazil from the ecological point of view: the Northern Littoral of the state of Bahia integrated into the Northeast Region. As far as the tourism-residential projects are concerned, the hotel corporations of both Iberian countries represent by far the large majority of foreign investors in this part of Brazil, still relatively less explored in the sector, and their projects have important local effects from the sustainability perspective. We particularly focus on the institutional framework, legal instruments and policies, the standards hotel corporations have to follow in their local endeavors, and the problems that arise from this process.

As a consequence of the sector's global dynamics, a strong trend towards the internationalization of Spanish and Portuguese hotel groups became clear by the end of 1990s and the beginning of the new century.[1] The saturation of the European market was of course one of the main reasons as was the need for a growing size of these groups to face competition in the domestic and global markets, and more recently the international crisis of 2008 and its aftermath has even exacerbated the importance of these factors. In the 2000s, the highly favorable conditions where the Brazilian economy has evolved, including the economic stability, growth with inflation at low historical levels, the reduction of interest rates, low costs of production in civil construction in relation to those of many parts of the global marketplace, and tax incentives were also quite attractive for these investments. It must be added that government incentives in the countries of origin, and in Brazil, at federal, state, and municipal levels significantly contributed to these investments. The state has performed as a catalyst agent of policies through the lens of territorial planning, marketing, and promotion. Among these policies the guidelines and actions of Brazilian National Plan of Tourism and the PRODETUR/NE ("Plano Nacional de Turismo" for the Northeast) must be highlighted, indeed, their financial resources are essentially devoted to the urban and basic infrastructure (road building, airports, basic sanitation, etc.) aiming at qualifying the coastal areas to the international capital.

A region much favored by Iberian hotel networks for the establishment of their ventures was the Brazilian coast, and particularly its Northeast, which offers vast expanses of land at competitive prices. This process was strengthened through strategic alliances between the sectors of tourism, accommodation, real estate and institutional investment funds for the construction of new projects known as tourist-residential resorts, mainly orientated to second-residence purposes, a relatively recent phenomenon in Brazil. This development meant the appropriation of large parts of the territory in which are included areas of environmental protection (hereafter APAs, in Portuguese "Áreas de Proteção Ambiental"). They are supposedly protected by norms and specific environmental legislation that guide and rule on the use of the soil, as further detailed below. Within this framework, the present study will discuss the main challenges faced by the hotel networks of Spain and Portugal in their undertakings on the Northern Littoral of Bahia, regarding the public environmental policies. Based on an inquiry conducted among representatives of hotel networks of both countries, it became clear that the main obstacles confronting the companies when striving to be established in the region, and begin operations, are the official red tape, the lack of transparency of the environmental licensing, and insufficient knowledge of the market.

The framework of environmental, territorial and urban public policies has been the main conflicting point between the Iberian hotel groups and the bodies of environmental control and licensing. According to the responses we obtained through the inquiries to the corporations, the enterprises fulfill all the requirements demanded by the institutions that supervise the environmental and urban controls. However, they encounter many barriers in the licensing process due to a lack of clarity in the legislation on these areas, which leads to different interpretations on the same matters. The small number of technicians available to respond to the needs and demands of the companies in environmental bodies at the municipal and state levels is one of the factors that most contribute to long delays in the approval of projects, which often lead to significant financial losses by the companies, according to the account given by the corporations' representatives. For example, as far as differences and similarities are concerned between Portugal and Brazil, the Portuguese companies consider that while there are some similarities, in Brazil there is much more jurisdictional vagueness, insofar as the legislation is often not clear enough, creating a margin for different, if not conflicting, interpretations.

[1] Despite specificities, this was also part of a wave of investments of Iberian countries in Latin America, although we will not specifically deal with this issue in the present paper; see for example Silva, 2005, and Toral, 2006.

After this brief introduction, in Section 2, we expose the main features of the theoretical and methodological background of our research. In Section 3, we will describe in detail the characteristics of the tourist-residential model, and the Brazilian environmental legislation, with a focus on the Northern Coast of Bahia, which frame the projects of Spanish and Portuguese hotel networks. Section 4 presents the panorama of actual and planned investments for this region, the main conflicts that have arisen in the interface between the corporations and environmental and licensing bodies, and the existing risks if the process doesn't follow a sustainable path. Section 5 summarizes the main conclusions of the previous study, and some topics for future research are raised.

THEORETICAL AND METHODOLOGICAL BACKGROUND

In this section, we explore the main theoretical and methodological issues related to this paper. First, we look at the theoretical explanations behind tourist and residential-tourist activities, particularly at their initial stages. Secondly, we present the methodological bases that have been used in this research.

The location determinants of tourist activities started to be debated in the first decades of postwar. Indeed, we must recall here the seminal work of Christaller (1955) establishing a relationship between the theory of central places and the spatial location of firms related to tourism's activities, taking into account the distance, and the attractions of the climate and landscape. In his theory, he asserted that differently from other economic traditional activities, for example manufacturing that tends to spatial concentration, tourism follows a distinctive pattern that tends to be decentralized, i.e., these activities tend to be developed in the periphery of central areas and densely populated regions, insofar the tourist aims at knowing not only distant places and but also quite different from its own.

The theory of Christaller (1963) on the trend of tourism to be "peripheral" intended to analyze the spatial organization of tourism in Europe considering that "it is distinctive of tourist places to be located in the periphery", assuming that "tourism is an activity that keeps away from central places and industrial agglomerations". Under this perspective, he argues that "the trend of tourism to be developed in the periphery of densely populated areas is quite often due to the fact that the tourist looks for distant landscapes, idyllic and exotic environments, like mountains, beaches, forests and rural areas". This theory raised several debates, critiques, and applications, as underlined by Assis (2003). One of the first critiques refers to the study of Pearce (1991) showing that in Australia the great metropolitan centers were the main areas for attraction of tourist flows in the whole country. This contradicts Christaller's thesis and allows the conclusion that "tourism as an activity that keeps away from central places is not universally true".

In spite of this, Christaller's theory raised an important point for many less developed regions and countries far from the "central places"; indeed, if favorable conditions for tourism exist, they may catch up in relation to more advanced areas, at least partially, based on these activities. However, as historical experience of the last decades has shown, in Europe and elsewhere, the control and steering of such a process proved to be a fundamental aspect, because in the course of such developments, if precautions do not take place, the openness of new regions to tourism may jeopardize their future insofar they may follow a path leading at too much centralization in these activities and abandoning others that also have potential, sometimes irreversibly damaging the environment, giving free course to a uncontrolled urbanization, and so on. In these circumstances such processes must be closely followed and monitored. But, as is developed below for the case of the Northern Littoral of Bahia, the management of the interface between investing firms, namely foreign firms, political authorities, regulatory bodies, and the interests of local populations is highly complex and conflictive.

Looking at this entire process within a more precise perspective, it is considered that the territorial development is influenced by macroeconomic factors and the growth needs of firms. Natural and cultural resources as comparative advantages are not enough to compose the tourist product and to determine the location of firms. For the constitution of a tourist space, and to attract tourists it is necessary a set of infrastructures as transportation, hotels, airports, skilled personnel, marketing, promotion and trade that allows the movement, stay and consumption in the visited area. This is even more so, regarding residential-tourism projects. Hence, location determinants must be weighed within a wider context, where the firms' rationale is guided by spatial selectivity. For Moreira (2007), spatial selectivity is the process of selection

through which the group begins the construction of its geographical structure. The choice of location is the way through which one selects the best possible spatial establishment for action. According to this author, presently, the selectivity is determined by the logic of the market, adapted to a practice of occupation more and more spatially defined and fragmented of the space, led by and in function of the territorial division of labor in order to reduce the costs and to increase productivity.

In our analysis of the development of tourist-residential projects in Brazil through investments of Spanish and Portuguese hotel networks, and particularly in our case study, the Northern Coast of Bahia, we will also be inspired by the Lean Management approach. This does not mean we will strictly follow lean methodology and indicators. But, even in these industries (relatively new in the context of Brazil) this approach may be highly useful in accordance with sustainability concerns. This makes all the sense if we consider lean management as the search for a better performance in the sector under analysis. Lean may be defined as "linked to the smart organization of production, and thus focus on the entire value chain. From this perspective, it is a philosophy that concentrates on providing added value for customers by eliminating all forms of waste" (Butter, 2012, p. 186). So, we will not specifically deal with the control of costs as such, but if the projects we analyze are in accordance with the sustainability framework and also considering lessons from other experience as regards the consumers' demand and its predictable changes.

This work has been elaborated on the basis of the following research sources: bibliographic references, documents and direct enquiries to the corporations' executives involved in the region under analysis, although their investments are at different stages. As we are at the start of a systematic research process over this case, and we need a framework for analysis, all the three sources have been important for this purpose. The last one, however, as we want to investigate concrete dimensions of the interface between the investing firms and local sustainability problems and its regulation, has a key role in the present study. So, the head offices of the hotel corporations with interests in Northern Littoral of Bahia were visited in Portugal (Lisbon and Algarve), and Spain (Palma de Mallorca) as well as their subsidiaries in Brazil, where the interviews with representatives took place in 2009/2010 (Gomes, 2011). Four Spanish groups (Iberostar, Fiesta, Singlehome and Invisa International) and four Portuguese groups (Pestana, Vila Galé, Tivoli Hotels Resorts, and Reta Atlântico Brasil) were directly enquired on the subject. The questionnaires raised several issues, but most particularly they were focused on the following domains: the factors behind their internationalization, the integration into a new environmental, economic and socio-cultural context, the obstacles found in this process particularly as regards the environmental framework and the decisions related with it, and advantages and disadvantages of investing in Brazil. The content analysis was the main approach to the qualitative information provided by the enquiries to firms and their executives. Moreover, the research underlying this work permitted to clarify a few questions related to tourism and residential tourism developments and their sustainability which are sometimes delicate to be directly approached at this level. For example, how far the actual environmental legislation is respected? Which are the agents more favorable to changes in the institutional and legislative frameworks? Are foreign firms accommodating to existing environmental law or actively claim for its change? Are long term considerations present in the licensing and other administrative procedures? Our research permits to start a process leading to more solid and accurate responses to these questions among others, particularly as far as our case study is concerned, opening the door to possible improved policies.

THE FRAMEWORK OF ENVIRONMENTAL SUSTAINABILITY IN BRAZIL FOCUSING ON ITS RELEVANCE FOR HOTEL NETWORKS' PROJECTS ON THE NORTHERN LITTORAL OF BAHIA

General context and features of tourist-residential projects: an overview

The landscape and socio-environmental changes deriving from the construction of tourist and hotel establishments, and the urban intervention have been a permanent concern of different researchers on tourism and environment, for example Boo (1991), Ruschmann (2001), and Gomes (2002). The main issues examined by these researchers respect the application of norms and laws that rule the use of occupation of the soil, and the planning and management of the territory, especially, the commitment and zeal in the application of legal instruments with such purposes by regulatory bodies and involved corporations. The

merchandising of the nature and culture by the economic agents of tourism brought about significant changes in the landscape, the socio-environment, and culture in the regions and urban places located in the coast lines; this is one of the reasons why researchers have been very concerned with medium and long term effects of sustainable development related to tourism (Bramwell & Lane, 2011).

The new rationale of production in the space related to the dynamics of tourism and urban development orientated towards the establishment of tourist-residential resorts is termed by Mullins (1991, p. 331) "tourist urbanization", which is defined as "urbanization based on the sale and consumption of entertainment, i.e., cities and tourist centers specifically constructed for leisure and pleasure". This author argues that the symbols that characterize tourist urbanization are the blend of natural landscape with constructed landscape, including the set formed, on the one hand, by the sea and the natural vegetation, and on the other hand, the implantation of diverse constructions, such as resorts, hotels, marinas, bars and restaurants, shops, sport and leisure centers. Mullins (1991) also considers that the main product to be supplied in the tourist complexes is nature (mainly in tropical countries and regions) through such attributes as the sun, sea and sand, among others, enticing the tourists to feel attracted by the consumption of such amenities. The outcome of this process is the densification of these areas due to tourist-residential mega-establishments all along the maritime rims. Indeed, Brazil is no exception in this respect and in every viable coastal area of the planet, more and more hotels, second residences and closed condominiums are being constructed, the valuations of which are in function of their proximity to the sea.

Beyond the impact on environment, the development of tourism, and in particular of tourist-residential complexes, has major effects not only in the spaces directly managed by the hotel chains and real estate groups but also in the local communities situated outside. As the number of tourists and new residents increases and they in general have a greater purchasing power, even if a large part of their demand is satisfied inside the complexes, local trade related to food, drinks, clothing and footwear as well as the sale of craftsmanship, souvenirs, and typical products are strongly developed. Services' sector, like small retail trade, restaurants, bars, etc., intensely interacts with the economy of tourism, creating jobs and income. Moreover, with the fading of the traditional way of life due to the construction of the complexes, the increase of this trade considerably changes the landscape and activities of neighboring small communities. However, it must be taken into account that much of this impact tends to be unstable, and when the high tourist season finishes, these services become depressed and the employment rate may significantly drop. These negative impacts may only be minimized if the growth of these activities is planned according to local economic and social realities and respects sustainable development concerns, but this is not more often the case, notably in the first stages of the process, and they become hardly reversible.

Indeed, from the economic, environmental and territorial perspectives, the residential tourism presents some characteristic features, summarized by Aledo et al. (2007) as follows:

1) Residential tourist resorts generally present a large spatial and economic size. This model of macro-urbanization demands high investments in land, infrastructures, and services (transports, electric power, and water supply). The infrastructures are the first step for the transformation of land from soil of low value into soil to be readily urbanized, and consequently of high mercantile value, which also favors the speculation over the soil;

2) The residential tourist resorts are constructed as a closed model with maximum security; as this model is exclusive, it separates the newly-urbanized area from the communities located in the surroundings. At the same time, it seeks to satisfy the needs of the residents, supplying multiple services (supermarkets, colleges, leisure and sport centers, etc.), aiming to maximize the spending of the residents on the services provided by the management firm;

3) The tourist-residential sector is characterized by the abilities of relocation and mobility. The transfer to some coastal locations has declined due to the consumption of all the available soil or the reduction of quality of the destination in face of the tourist-residential development. At this stage in the life cycle of the tourist destination, the large corporations that promote and construct these resorts relocate their operations to new, as yet unexploited places and where there is ample availability of cheap land;

4) Urban interventions of residential tourism transform the territory, alter the landscape and local eco-systems, increasing the consumption of natural resources and creating negative externalities (solid urban waste and contamination of soils and waters). Such environmental impacts, besides construction and urbanization, include the effects deriving from the infrastructures of transportation (roads and airports), which facilitate the access and increase international demand, and works of infrastructure (hydraulics and production and distribution of energy) capable of ensuring the high consumption of tourist-residential resorts, as is exemplified by sport and leisure centers (golf courses and marinas, for example).

This logic of the corporations operating in the sector is also marked by their quest for short-term economic gains, by their capacity for mobility/relocation and by their easy access to capital, management capabilities and technology. It is a rationale based on the transfer of negative environmental externalities to local communities that absorb a large part of the negative impacts created by this industry, from which the companies themselves may easily escape through the transfer of their operations to other locations (Aledo, 2008).

Legal framework and policies in Brazil and the case of the Northern Coast of Bahia

After the characterization of the residential-tourist process, it is necessary to present its legislation background in Brazil, particularly as far as environmental protection is concerned. Moreover, under the rhetoric of sustainability, the public authorities at federal, state and municipal levels have also implemented territorial and environmental policies aiming at the orientation, discipline and monitoring of the process of economic and urban development in the Littoral. Indeed, within the realm of Brazilian environmental legislation, several legal instruments are previously required (such as the Study of Environmental Impact – "Estudo de Impacto Ambiental" -, that will be described below), the environmental licensing, and the environmental counterbalance with the objective of minimizing the negative impacts stemming from these activities.

To begin with, it must be stressed that being considered as major reserves of value, APAs have large and diversified eco-systems in a good state of conservation, comprising lagoons, river estuaries, mangrove forests, dunes, wetlands and endemic flora and fauna species. Many of these areas are being threatened by rapid demographic and urban expansion, as well as by the new wave of investments in tourism, hotels, and real estate, as is the case of the Northern Littoral of Brazil, and particularly in our more focused case of the Northern Littoral of Bahia. The growth of tourism in protected areas, associated with intensive urbanization, has produced a number of controversies and divergent standpoints regarding the specific difficulties in integrating public policies of tourism, environmental management and urban planning. In general, these policies conflict with each other, in spite of the fact that, in abstract terms, they aim to reconcile economic interest with sustainability and to overcome contradictions created by the new type of urbanization primarily intended to respond to the demands of tourists, real estate agents and international hotel chains.

The environmental sustainability of relevant areas is framed by the Conservation Units (UCs – "Unidades de Conservação"), which have attracted high public and private investments to these ecologically preserved environments of outstanding scenic beauty and biological interest. This natural and cultural heritage is at risk of being appropriated by economic agents of tourism, being transformed into a mere raw material in the composition of the so-called tourist product. Of course, it is important to note that increasing urbanization and the expansion of tourist activities within a context of economic growth will imply, to some extent, a sacrifice of the environment, bringing, for example, changes in the landscape and intensification in the use of the land. However, it is vital that these processes are harmonious and do not compromise the future of the region, or the benefits of coming generations. In order to prevent the negative spillovers of this transformation, or at least to minimize its risks, the Law nº 9.985/2000 created the National System of Conservation Units (SNUC – "Sistema Nacional de Unidades de Conservação"). According to this legislation, the above-mentioned as APAs are generally large areas, with some degree of human occupation, endowed with a-biotic, biotic, esthetic or cultural attributes, particularly important for the quality of life and well-being of human populations. The SNUC ascribes to the APAs such basic goals as the protection of biological diversity, discipline in the occupation and use of the land and in securing the sustainability of natural resources. APAs are considered by the SNUC as UCs that are capable of sustainable use, thus being

more flexible and appropriate in the use and occupation of the land to the occurrence of economic activities than other types of UCs, which is also valid with respect to the regime of land ownership.

The National Policy of Environment ("Política Nacional de Meio Ambiente") was created by the Federal Law 6.938/81 and provides a set of instruments aiming at the reduction of negative impacts of the human action over the environment. With respect to the development of tourist, hotel, and real estate activities, the instruments required are the Study of Environmental Impact (EIA), Environmental Licensing, and the Environmental Countervailing Tax ("Compensação Ambiental") which are closely related. EIA is a previous study of the likely impacts arising from the establishment of big ventures, and is a pre-requisite for the licensing of activities with a great potential of pollution, and that may considerably harm the environment like factories and other industrial buildings, the construction of roads, projects of urbanization, tourist and leisure complexes, ports, airports, among other possible ventures above 100 hectares or in areas of relevant ecological interest. EIA is an instrument of environmental management for the identification, prevention and balance of the changes induced by ventures or actions with significant environmental impact. Considered as a polemical instrument as far as its coming into effect is concerned, EIA and related environmental licensing are the main points of collision and conflicts of interest between corporations, licensing bodies and the civil society.

The Environmental Licensing is described by the Resolution CONAMA 237/1997 as the "administrative procedure through which the competent environmental body licenses the location, installation, enlargement, and functioning of establishments and activities that use environmental resources effectively and potentially considered as polluters or of those that under any form, may cause environmental damage, taking into account the legal and regulatory provisions, and the technical norms applicable". The environmental licensing is thus the instrument of the public power for controlling the installation and functioning of the economic activities potentially polluters targeting to balance the development with the environmental conservation.

The Environmental Compensatory Tax may only be raised after the licensing process is concluded, and, once in vigor, it creates many apparent conflicts, often associated with the slowdown of the licensing process, being a major point of disagreement between environmental bodies and the involved corporations. Indeed, it is at this stage that the countervailing measures are objectively defined, by the competent environmental body; as referred to above they will counter the effects of the establishment of the project; it is ruled that the tax will represent at least 0.5% of the total amount of the investment.

In the case of the Northern Littoral of Bahia, the legal instruments for these policies are the "Zoneamento Ecológico-Económico" (ZEE – the establishment of zones according to ecological and economic criteria) and the "Plano de Manejo" (PM – "Direction or Administration Plan"), a technical document that, based on the general objectives of the Conservation Unit, establishes the use and the adequate workability of natural resources, also targeting the control and regulation of occupation and use of the land, as well as the economic activities in urban centers inside the protected areas. In these conditions, APAs are an attractive location for many of the planned investments in the region we are analyzing, which were most of them under environmental licensing procedures in 2011. Figure 1 shows the location of a lot of these projects in the southern part of the Northern Littoral of Bahia (municipalities of Mata de São João and Entre Rios).[2]

[2] The Northern Littoral of Bahia is known as "Costa dos Coqueiros", and has around 190km, starting from north of Salvador, capital of the state of Bahia, to the limit with the state of Sergipe, both belonging to the Northeast Region of Brazil. The importance of "Costa dos Coqueiros" for tourism purposes may be confirmed by news provided by *Correio da Bahia* (a daily of Salvador), 22nd July, 2012, under the title: "Northern Littoral attracts R$4 billion in tourism ventures", and continues as follows: "For whom who knows Praia do Forte, Imbassaí and surrounding areas, it is not hard to conceive why Northern Littoral is preferred to by tourism investors. In the coming eight years R$5.7 billion (2.28 billion € according to the exchange rate prevailing in the end of July 2012) will be invested in Bahia, and a large part of this amount has a precise destination: the paradise regions that compose the denominated Costa dos Coqueiros … the Northern Littoral is today the main pole of Bahia's tourism due to its infrastructure". After other considerations, reproducing the point of view of political authorities, the article of *Correio da Bahia* finishes enumerating 17 new tourist ventures in the region, and the corresponding foreseeable amounts of investment.

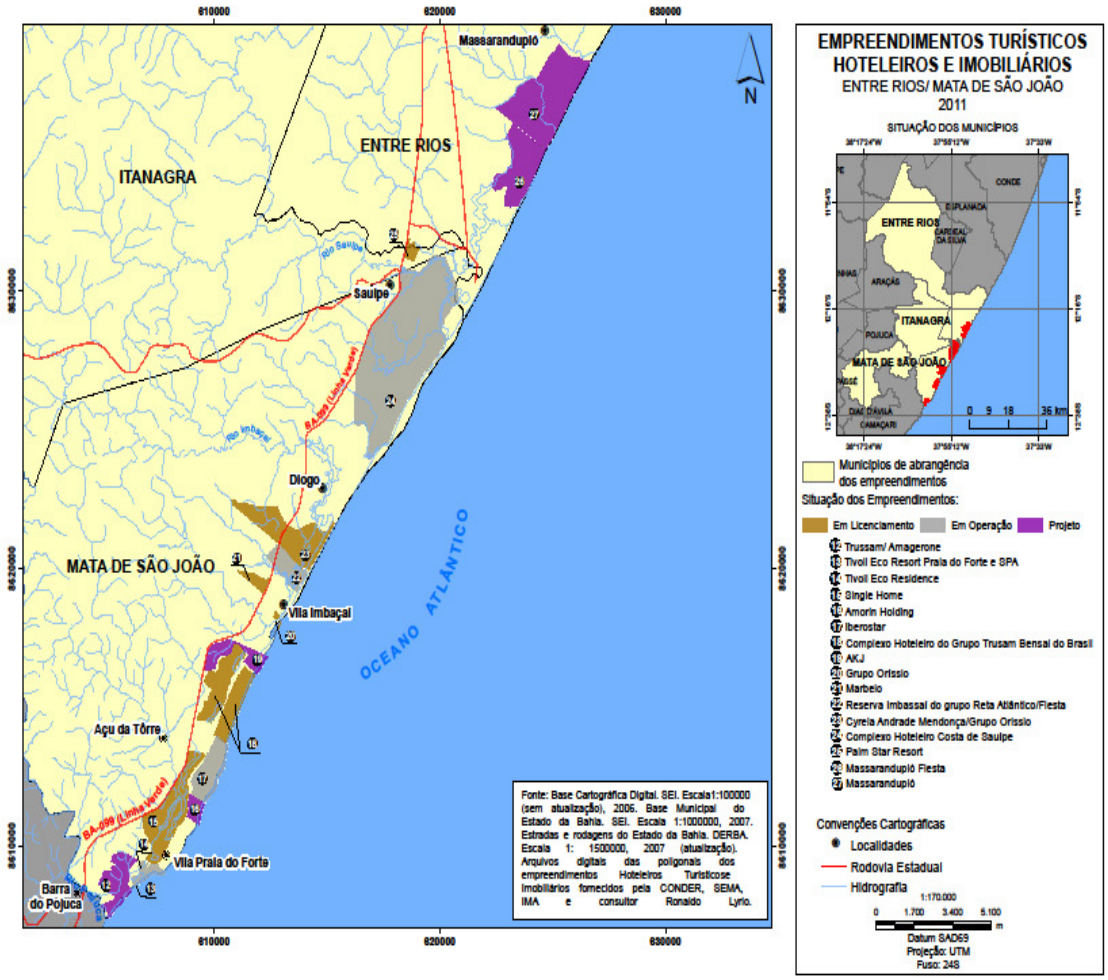

Figure 1: Tourist and residential-tourist projects in the Southern part of Northern Littoral of Bahia

Also, at the state level, the Environment Law Nº 10.431/2006, through the Decree No 12.353 of 25/08/2010, defined the typology and size of the establishments that must be submitted to licensing, permission and terms of reference of environmental responsibility. With respect to the urban, tourist and hotel complexes, the requirements stipulated by this legislation occur in function of the size of the projects that are ordered in hectares as follows: micro $\geq 1 < 5$, small $\geq 5 < 10$, medium $10 < 50$, large $\geq 50 < 100$, and exceptional size ≥ 100. In accordance with the same decree, the urban, hotel, and tourist establishments that compulsorily must elaborate the EIA/RIMA and are submitted to environmental licensing are those above 100 hectares, i.e., those considered to be of exceptional size.

The "Plano de Manejo" of the APA of the Northern Littoral of Bahia and its respective ZEE were approved by the Resolution No. 1.040 (21/02/1995) of the State Environment Council (CEPRAM – "Conselho Estadual do Meio Ambiente") and they establish the uses and parameters of occupation compatible with the fragility of local eco-systems. In spite of these instruments of territorial planning, the APA of the Northern Littoral is being pressed to change the uses and parameters of occupation, in order to satisfy the interests of investors. In practice, what has been observed in the application of these instruments, and particularly in the case of the APA of the Northern Littoral of Bahia, is that the state has played a dubious role in relation to the control of the use and occupation of the land in this area. The state, in addition to performing the role of supervisory and regulatory agent, is responsible for environmental planning and the management of the APA, yet acts at the same time on another level that is contradictory to the previously mentioned role, i.e., it is the promoter of the establishment of hotel and real estate complexes, not only

providing basic infrastructures, but also altering the parameters of occupation that were envisaged in the ZEE.

ACTUAL AND PLANNED TOURIST RESIDENTIAL INVESTMENTS ON THE NORTHERN LITTORAL OF BAHIA IN LIGHT OF LEGAL INSTRUMENTS OF ENVIRONMENTAL AND TERRITORIAL PLANNING AND MANAGEMENT: MAIN FINDINGS AND DISCUSSION

Enterprises of different nationalities have invested in the region under analysis. However, according to figures provided by the Secretary for Tourism of the State of Bahia (SETUR, 2012), the Spanish hotel networks are responsible for 70% of the total already invested up to 2011, and 82% of the planned investments up to 2014. Portuguese groups have a much smaller share, with 8.8% and 6.7% respectively of the total. Domestic Brazilian companies represent 12.2% of the total. Other European countries with companies making relatively minor investments in this domain are Italy with 4.7% and Belgium with 0.8%. Thus, Spanish and Portuguese enterprises are the main foreign hotel groups investing in the region. As far as their modes of entry are concerned, Iberian groups have also differed in their local strategies: Portuguese hotel networks have been more inclined to acquisitions and management and rental contracts, whilst the Spanish groups have mainly opted for greenfield investments (Gomes, 2011).

In the course of our research, and with regard to Spanish hotel networks, we observed that Iberostar and Fiesta have already been operating in the region since 2005 and 2010 respectively, whilst others, such as Trusan/Bensal/Brasil, Sol Meliá, Singlehome, Prima Inova and Invisa International are still in the licensing or planning stage. Furthermore, the Portuguese hotel groups Vila Galé SA and Tivoli Hotels and Resorts have been operational since 2005 and 2008 respectively, in the municipalities of Mata de São João and Camaçari, both in the southern part of the Northern Littoral of Bahia. Another Portuguese group, Pestana, has concentrated its investments in the city of Salvador, prioritizing the urban segment, orientated toward business and historical-cultural tourism. In the Northern Littoral of Bahia, the Pestana group also managed the hotels ("pousadas") of the "Costa do Sauípe" Complex in 2008/2009, but then proceeded to transfer this management to the ultimate owner, PREVI (pension fund of the employees of the Banco do Brasil). In 2010, reinforcing its urban orientation in the region, the same group inaugurated the first tourist-residential complex in Salvador (the state capital), the *Pestana Bahia Lodge Residence,* in the quarter of Rio Vermelho (center of the city and close to the beaches).

The fact that Brazil is to be the host nation of both the FIFA Soccer World Cup in 2014 (Salvador will be one of cities to stage matches) and the Rio de Janeiro Olympic Games in 2016 has necessitated immense public and private investments in transportation infrastructures (particularly in airports and ports), security, construction or enlargement of stadiums and accommodation, in addition to the assembly and training of a professional workforce. The awarding of these mega-events has created high expectations among entrepreneurs and in the society as a whole (Table 1). Moreover, related to these events, the Brazilian government's plan of investments in infrastructures has attracted the attention of many foreign investors, as has been noted by international media and institutions in the following terms:

> *"The two mega-events represent a unique opportunity for the largest economy in Latin America to show that it is capable of realizing projects of the greatest magnitude. The Brazilian government has drawn up ambitious investment plans, in the order of 373 billion euros, to provide new roads, ports, airports and electric power stations, with the participation of foreign investors (…). 'In Brazil, whenever we speak to an investor, the first and foremost problem that comes up in the conversation is the infrastructures', points out David Beker of the Bank of America Merrill Lynch (…). 'Foreign investors are alert'. Patrice Etlin, of the firm Private Equity Advent, adds 'We will closely follow all the initiatives of the government regarding port and airport infrastructures. There are many foreign investors interested in this kind of assets". (Lehay, 2012)*

All of this process has its effects on the hotel and tourist industry. According to the executives of the Iberian companies interviewed during our research, the benefits of investing in Brazil, and particularly in the "Costa dos Coqueiros" will be increased by the World's two greatest international sport events coming to Brazil in the near future. In the context of these investments, it must be pointed out that incentives are being

offered by the Brazilian government, at the federal level, through specific credits provided by the development banks: Banco do Nordeste and the BNDES ("Banco Nacional de Desenvolvimento Económico e Social)". At the state and municipal levels, there are tax breaks, such as those of the IPTU (tax on the urban patrimony) and the ISS (tax on services) for a period of ten years. In spite of the need for a relatively rapid advance in the building of the venues and infrastructures, the executives consider that a clear disadvantage continues to be the numerous bureaucratic and administrative obstacles that create delays in the processes of environmental licensing, as well as the high operational costs due to labor charges and the tax system. As in similar previous cases throughout the world, the most serious problems may come later, i.e., after the mega-events have taken place. As recently highlighted by the president of the Bahia Hotel Industry Association ("Associação Baiana da Indústria de Hotéis"), the tourism market in Brazil and Bahia does not have sufficient demand to sustain the projected size of the sector, post-2016, arguing that: "At present, we have 60% occupation of the hotels' capacity. The market is not growing, it is stagnant. Possibly, demand will increase with the World Cup, but afterwards, there will not be enough guests for all of the establishments that are being created in the region." (*Correio da Bahia*, 2012).

Table 1 Planned investments for the Northern Littoral of Bahia (Source: SETUR, 2012)

Project	Origin	Estimated investment (thousand US$)	UHs (Rooms)
The Reserve Paradisus Hotel	Spain/Sol Mélia	60,000	225
The Guarajuba Beach Resort	Spain/Sol Mélia	700,000	1000
Costa de Imbassaí Resort & Residence	Brazil/Cyrella Brazil Reality	450,000	2,714
Grand Palladium Imbassaí Resort SPA	Spain/Fiesta	90,000	210
Orissio Sul: I	Italy/Orissio Investimentos	14,500	533
Double Tree / Les Terrasses	Brazil/Doubletree by Hilton	30,000	110
Bahia dos Coqueiros	Portugal/Grupo Lena e Liz Construções	220,000	770
Iberostate (3ª etapa):	Spain/Iberostar	50,000	240
Complexo Turístico em Praia do Forte - Norte	Spain/Grupo Trusam	500,000	1,200
Complexo Turístico em Praia do Forte - Sul	Spain/Grupo Trusam	700,000	2,500
Plano Baixio	Spain/Grupo Ed. Prima	398,000	60
Busca Vida Bangalô Resort	Portugal/ Grupo Lena e Liz Construções	40,000	45
Costa Azul Bahia Golf Resort & Condomínio	Spain/Grupo Invisa	312,500	2,250
Fazenda Onça	Belgium/Inka Lodge	18,750	300
Naurigas	Spain/Naurigás	175,000	1,500
Quintas de Arempebe	Portugal/Design Resorts	150,000	400
Total		3,908,750	13,327

Until the stage of operation, the functioning of tourist-residential establishments implies significant changes in the socio-economic and cultural patterns of the local population. There are changes in the local way of life, an increase in basic services of support and infrastructure available to the population, an increase in tax receipts and in the number of jobs on offer, either permanent or temporary. One of the most important changes is at the level of local trade, with the multiplication of shops partly based on local products and souvenirs; although this is seasonal, the process has a deep impact on the communities that surround the tourist-residential resorts, notably as referred to above in terms of jobs and local production of some goods and services. Spatially and environmentally, the social effects on the landscape are quite visible, with different types of occupation and use of the soil, which also signify social differentiation, as is well illustrated in the Figure 2.

Figure 2: Territorial dynamics in the APA of the Northern Littoral of Bahia: Imbassaí Resorts and surroundings (Source: SEMA (2010))

The changes in the territorial dynamics, deriving from the setting up and operation of tourist and residential hotels and resorts, are of a diverse nature, such as socio-spatial segregation, rather different occupation and use of the land, concentration of the property of land and restriction or even termination of the right of free circulation in the areas in which the establishments are erected. This type of land occupation makes the access to, and the use of, natural resources much more difficult for local populations that previously used these areas for extractive purposes, fishing and leisure. The real estate valuation of coastal areas, deriving from the presence of hotel establishments and infrastructures, induces the local inhabitants to sell their homes located in the small coastal communities and to migrate to inner regions that often are of far less value and without infrastructures. This implies the irrevocable loss of neighborhood ties and common cultural activities and values. After the installation and launching of the hotels and resorts, the right of passage is changed, due to the construction of buildings and infrastructures that most frequently imposes

limits on the free access to beaches, rivers and lagoons, meaning a real loss for the traditional resident population.

Impacts are however of diverse nature, intensity and magnitude as well as there are often substantial difficulties in their measurement by objective criteria, given the complexity of procedures, mainly as regards the socio-cultural environment. There are diverse methodologies that allow to quantify and to qualify the socio-environmental impacts arising from the economic activities that aim, among other objectives, to define the inherent costs due to the application of the polluter pays principle. Such initiatives face difficulties so serious as the identification and quantitative evaluation of socio-environmental impacts that create conflicts between different actors that often lead to judiciary procedures. The dimension of these conflicts between corporations and the bodies of environmental control, particularly the difficulties faced by hotel networks in the setting up of their establishments, is made quite clear in information provided by the Brazilian media:

> *"In the list of tourist establishments envisaged for Bahia, announced by the State Secretary for Tourism (SETUR – Secretaria Estadual de Turismo), almost all suffered delays to their projected delivery dates. Among other motives referred to by SETUR and the entrepreneurs, the delays are due to readjustments in the projects caused by the crisis in Europe (the majority of the entrepreneurs are Europeans), and to ensuring that the documentation complies fully with the legal requirements. However, another reason clearly predominates: the slowness in the granting of environmental licenses. This is the case of Costa Azul Bahia Golf, in Jandaíra [situated in the northern part of the coast under analysis, near the border with the state of Sergipe], which was projected to be operational in January 2014, but had its schedule modified, postponing its opening until December 2015. 'The process of approval by the environmental bodies is extremely slow. Initially, we thought the hotel would be ready before the FIFA Soccer World Cup (in the middle of 2014), but obviously this will not be possible. This causes financial damage, as all investments need to obtain returns. We have already obtained the first license, and now the problem is with the license for the setting up', claims the project's General Coordinator, César Barreto de Araújo. However, he is not the only one to complain. 'This is a process that takes too much time, it is too complicated', agrees Javier Trinidad, from Iberostar. The Institute of the Environment and Water Resources (INEMA – "Instituto do Meio Ambiente e Recursos Hídricos") stated that the process takes a long time because is very complex and involves not only technicians of the institute and the company (which must provide a study into the possible environmental impact), but also the population that resides in the location, since the project must be approved by a public audience."*[3] *(Correio da Bahia, 2012).*

All along the coastal strip of the Northern Littoral of Bahia, we find small and medium-sized tourist establishments, as well as large units. The former are classified as guesthouses ("pousadas") and small hotels, generally belonging to local and national entrepreneurs, whilst the latter, i.e., the large-scale developments, belong mainly to international hotel networks, although they are often associated with national and local partners, in particular from the real estate and construction sectors, in order to make their investments more viable. One of the most attractive advantages to foreign investors interested in the construction of tourist and hotel mega-establishments in the Northern Littoral of Bahia is the price of land, which can be acquired in large parcels of hectares as rural soil, then later transformed into urban soil through municipal decision, regardless of the creation of infrastructures. This transformation of rural soil into urban soil offers more possibilities for use and division into smaller lots, with urban indicators that are more advantageous for hotel and real estate establishments, since it generates greater profitability for the investors.

In practical terms what has been observed is the application of these instruments with a view to ensure the principles of environmental, economic and social sustainability in the area under analysis, particularly in the APA of the Northern Littoral of Bahia is one of the main conflicting points between institutions of environmental control and surveillance and the corporations of the tourist, hotel and real estate sector.

[3] Translated into English by the authors of this paper.

According to the Spanish and Portuguese executives, the firms that respect the requirements of the institutions related with urban and environmental issues face many obstacles in the licensing process due to the lack of clarity of the urban and environmental legislation, leading to different interpretations of the same subjects. Within this context, some firms have faced judiciary procedures by allegedly did not respect the norms and regulations deriving from EIA and from the environmental licensing process.

However, as underlined before, the state due to its ambivalent position, has also often acted according to the wants of the hotel corporations and other groups (i.e., owners of the lands), like imposing changes in the parameters of occupation as established in the "Zoneamento". A good example of this was provided by the rearrangement of the uses that were previously established for the "Zona de Proteção Visual" (ZPV) through the Law 11.476, dated from 01/07/09, determined by the state's government, with the objective of giving flexibility to the "Zoneamento", and to adequate it to ventures of corporations, and thus, allowing the occupation of the ZPV with the construction of huge tourist complexes in the thin littoral strip of the dunes and among coconut trees with "vista mar". It must be pointed out that the shift in the urban parameters in 2009 transformed the "Zona de Proteção Rigorosa" (ZPR – Zone of Rigorous Protection) into a ZPV, what occurred under strong lobbying of corporations and politicians in order to adequate the legislation to the interests of firms that had, since a long time, their projects in stand by waiting for licensing.

CONCLUDING REMARKS

The conformity with environmental sustainability on the part of the hotel networks' projects in Brazil, particularly in the Northeast and the North Littoral of the State of Bahia, must be evaluated from a broader perspective. It is necessary to take into account that the experience of the corporations that we have analyzed has been acquired in the Iberian Peninsula, since most of them have their headquarters and primary investments in this European region. In their Brazilian experience, the administrative aspects, particularly when linked to environmental regulation and the lack of knowledge of the local market, are the main obstacles confronting their implantation in the country, and specifically in the area we have studied. To this must be added the difficulties arising from the lack of organized, clear information and other aspects, such as cultural differences. Even in the case of Portugal, despite the linguistic proximity, the corporations' representatives recognize the difficulties that impede their entry into the Brazilian market, which does not have the same characteristics as their domestic market.

The corporations' executives claim that one of the main obstacles they found in the implementation of their ventures, in Brazil and particularly in the Northern Littoral of Bahia, is the much reduced number of technicians in the environmental bodies at the state and municipal levels able to respond to the firms' demand. In our interviews, this fact is one of the reasons that contributes to the rather slow path in the approbation process of the projects, often leading to heavy financial losses; indeed, many licensing cases have taken around five years. In addition, firms that are in the long licensing processes consider that actual investments are below expectations, due to the "breakdown" of their projects at this stage. Comparing the process of setting up a venture in the tourist, hotel and real estate sector with what happens in Spain and Portugal, in the Northern Littoral of Bahia, under the local framework of environmental, territorial and urban policies, the corporations' executives consider that "the rules of the game are clear in the European countries" whilst in "Brazil/Bahia the rules are not clear" and may change according to particular interests and governmental bodies. This does not necessarily mean they want environmental violations, and it must be recalled that international hotel networks are increasingly concerned with environmental protection (see for the Hilton group, Bohdanowicz et. al., 2011).

With regard to the model of tourist-residential complexes, researchers such as Aledo et al. (2007) argue that its development on the Spanish coast demonstrates the immense process of increasing artificiality and densification of the littoral and the disappearance of local activities and cultures, substituted by undifferentiated, cosmopolitan global culture and patterns. Among other socio-environmental impacts, they underline the modification of the landscape as a result of the establishment of infrastructures for the expansion of the sector, the suppression of vegetation, the contamination of the soil and water due to the

inadequate treatment of residual waters and solid wastes, deriving from the over-exploitation of some tourist destinations and the massive activities, the deficit of qualified services and infrastructures and insecurity. We believe that these negative impacts should be prevented or at least minimized in the Northern Littoral of Brazil, and in particular on the Northern coast of state of Bahia; indeed, even the environmental and economic sustainability of the investments would be threatened if the same model of development of the tourist-residential resorts found in the countries of origin were to be simply reproduced in this rather different area of the world. Similarly to what occurred on the Mediterranean coast, the Iberian hotel networks promise great economic benefits to the Northern Littoral and the north of Bahia, like more jobs, increased tax receipts and the improvement and enlargement of the infrastructures. Moreover, as mentioned before, in the long run, beyond other negative impacts, the result of these projects may entail a significant deterioration of the environment and the quality of life, sometimes irreversibly.

Up to a few years ago, the determinant factors for investments of Spanish and Portuguese hotel networks in their quest for international diversification were, in the case of Brazil, the potential for growth of the local market, and the favorable conditions existing in the Brazilian economy, such as economic stability, including lesser exchange volatility, and increasing tourist demand. More recently, great investment opportunities appeared with Brazil's successful bidding to host such vast global sporting events as the FIFA Soccer World Cup in 2014 and the Rio de Janeiro Olympic Games in 2016. The social movements in the biggest Brazilian cities in June-July 2013, parallel to games of the FIFA Confederation Cup, reflect somehow the concerns about this process if it advances without restrictions, and gave them a wide expression. As a consequence of all this, the problems raised in this paper regarding the investments of hotel corporations in regions like the Northern Littoral of Bahia became much more pressing than might usually be the case.

Finally, the present crisis of the Iberian tourist-residential model must lead to a reflection on the possible risks of the "real estate bubble" in the sector, since there is no equilibrium between supply and demand. We must also consider the territorial, environmental and economic sustainability of this industry in the region: the realization of all of the planned projects implies an extreme specialization in the use of the soil and the strongly increasing demand for basic services such as water, energy and sanitation, the supply of which has so far been quite unsatisfactory to the local populations. It must be pointed out that the scarcity of the soil and the development of more restrictive environmental regulation in European countries led many firms in the tourist-residential industry to transfer their investments to regions where soils are cheaper and have natural attractions, as is the case of the Northeast Littoral of Brazil, where "Costa dos Coqueiros" is a good example. Under the present context, however, this premise must be reassessed insofar the effects of the international economic crisis have strongly hit the real estate markets in Europe, creating an excessive supply leading to a devaluation of real estate assets, and the Brazilian market is certainly not immune to such an outcome in the future.

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20-19 Conversion Kit on Packer Focke 350

Slobodan Galašev, Dragan Perunović, Tibor Tomin

20-19 conversion kit on packer Focke 350

Contiuous Improvement Conference 2013
JTI Senta, Serbia
quality commitment innovation synergy
RG-PDCA

Team members

Galešev Slobodan

Maintenance Planner

8 years with company

Perunović Dragan

Packer mechanic

7 years with company

Tomin Tibor

M&P Supervisor

8 years with company

General Information on Senta factory

Capabilities

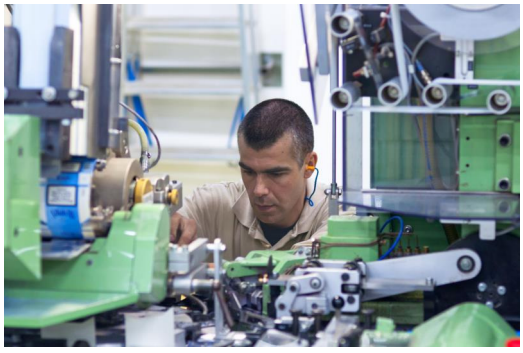
• Green Leaf Threshing:	up to 3.500 t	Tobacco/year
• Primary:	up to 11 Bn.	Cigarettes/year
• Cigarette M&P:	up to 6 Bn.	Cigarettes/year
• Filter Rod:	up to 6 Bn.	Cigarettes/year

Situation before improvement

***R**G-PDCA*

General description:

- Packer types:
  - 84mm SFP
  - 84mm RET
  - 84mm ROC
  - 100mm ROC
- 84mm packers equipped by supplier for 20/19 cigarettes per pack



Target setting

*R**G**-PDCA*

Market Request:

- Introduce LD 100mm in Macedonia Market with 19 cigarettes in pack in order to accelerate GFB volume growth
- Start-up time maximum 2 months
- Cost as low as possible

Project setting

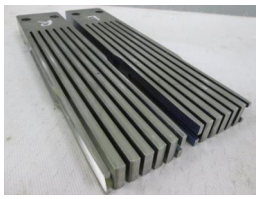
*RG-**P**DCA*

Proposed solution:

- **Supplier** – Focke
- **Investment** – 75M EUR
- **Delivery time** – 10 months

Not accepted due to:

1. Payback >5 years
2. Long delivery time



New set up / Design

*RG-**P**DCA*

Try to find alternative in-house solution:

Make Pack mechanics asked for support and finding a local feasible solution.

Team of mechanics proposed to:

- Modify and combine:
  - 84mm packer 20/19 conversion kit
  - Surplus parts from cigarette circumference reduction project

Delivery time: 2 weeks

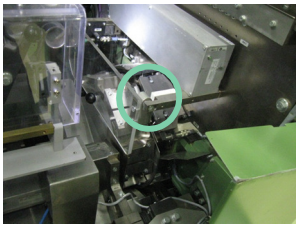
Cost: 50 EUR

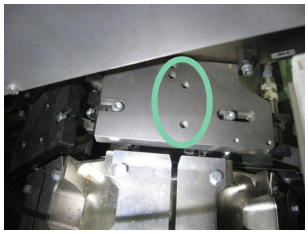
Safety: Same as with OEM supplier

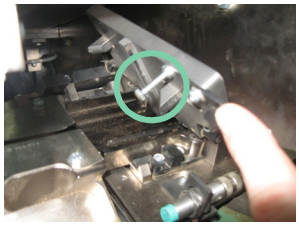
New set up / Design

*RG-P**D**CA*

Holes on hinge for pin



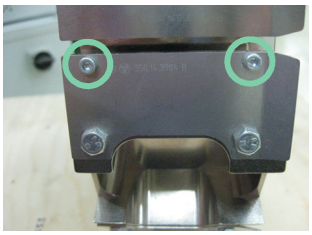


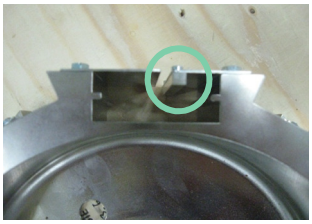


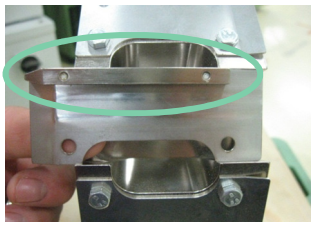
New set up / Design

*RG-P**D**CA*

Holes on pocket cover plate for guide



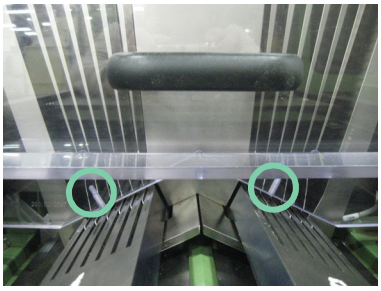


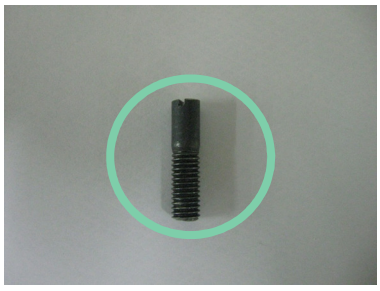


New set up / Design

*RG-P**D**CA*

Pins for doors





Benefits

*RG-PD**C**A*

Solution	Investment (M EUR)	Financial benefits Market OCC (M EUR)	Additional Volume (MM cigarettes)	Delivery time (months)	Other benefits
Focke –OEM	75	0	0	10	
Senta Mechanics	0	20	19	0.2	1. Speed to Market – product launched in 2 months 2. Employee motivation, development and empowering

Conclusion / Further challenge

*RG-PDC**A***

Next steps:

- Promote example how to achive significant savings by using own creations skills.
- Share the solution with Global Engineering and JTI factories equipped with Focke 350 packer.

Enterprising
Open
Challenging

Milk Run Concept

Aleksandra Milešević, Brigita Biro

“MILK RUN” concept

Lean thinking practice: MS dpt
Project: April, 2012

How it started…

Research: total annual freight cost and cost for specific relations / destinations

Goal: Reduce actual freight cost and planned cost in product standard

Plan: analyze all existing transportation routes and find optimal (short time, minimal cost) concept of routes and transportation mode

Do: implement “milk run” concept where possible

Check: constantly analyze cost for other options (DDU, full truck loading..)

Action: implement the best options in practice

In figures…

Research: total annual freight cost: 1.227 M USD

Goal: Reduce actual freight for 5 %: 61 M USD

Plan: 15 different transportation routes decrease to 10 routes through milk run concept

Do: new implemented transportation routes are:

- Russia & Poland,
- Russia & Russia,
- Netherland & Germany & Austria

Check:

Spain	Solo truck	Milk run
Freight cost (USD)	2.700	3.600
# of pallets	14	28
USD per pallet	190	130

Action: full truck loading implemented in Russia, Spain, Germany, Belgium

"Milk run" - concept

- Senta factory is controlling transportation of 98% of all NTMs (EXW-ExWorks or FCA-Free Carrier Incoterm)

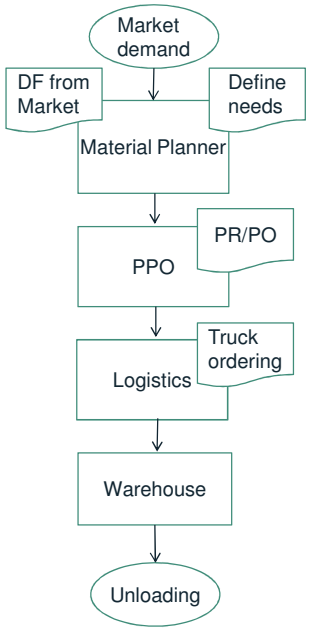
- NTMs are delivered with:
  - FTL (Full truck load) – One loading / One unloading place
  - LTL (Less than truck load) – More loading / More unloading places (various receiving companies)

- Senta factory negotiated LTL load in the way:

more loading => 1 unloading place: Factory

“Milk run” - process

- Material Planner: Defines quantities of various NTMs needed to be delivered at Factory in different timing (APO PRs)
- PPO: Consolidates Orders (PR/PO) together with Material planner and performs PO adjustments in order to align:
  - Arrival time of various materials to the Factory
  - Quantities for Full truck loading at various suppliers
- Logistics: Orders the truck and follows loading and documentation flow with Forwarding agent until truck arrives at Factory
- WH: Unloading of various materials (in one truck) at one point of time (more efficient process)



Some figures

Annual number of trucks organized by JTI:

- Before “milk run” concept: 330 ea
- After “milk run” concept: 259 ea
- Improvement: - 71 ea (-22%)
- Annual saving: **61 M USD (5%)**

Average saving:

Freight cost	**-5%**
Timing for Unloading activities	-10%
Timing for Customs process	-10%

“Milk run” – various benefits

- JTI controls:
  - the process/flow (from loading, over all border crossing until unloading and customs process)
  - the timing
- Eliminated potential risks of:
  - Wrong documentation of other receiving companies
  - Mixing improper goods of other receiving companies in the truck
  - Issues at unloading points of other receiving companies
- Optimized freight cost, that gives opportunity for more frequent loadings
- Optimized quantities for loading that lead to optimized inventory levels

“Milk run” – various benefits (continued)

- Better work time organization/utilization:
  - For transport and documentation arrangements
  - For unloading
  - For customs clearance procedure
- Shorter transit (transportation) time
- Simplified customs procedure
- More efficient WH space organization

Routes already improved via “milk run”

- Belgium:
  - Route I. :Lanaken & Merelbeke
- Spain:
  - Route I.: Rubi & Barcelona
- Russia:
  - Route I.: Novgorod & St.Petersburg
  - Route II.: Yelets & St.Petersburg
- Various Europe counties:
  - Route I.: Netherland & Germany & Austria
  - Route II.: Germany & Austria
- Russia and Poland:
  - Route I.: St. Petersburg & Lodz

Routes already improved via “milk run”

Enterprising
Open
Challenging

LeanTech'13
2nd International Scientific Conference on Lean Technologies
Belgrade, Serbia, 5th-6th September 2013

Succesfully SMED Expirience in Press Change in the Automotive Sector

Manuel González Domínguez, Susana Ortiz Marcos

SUCCESFULLY SMED EXPERIENCE IN PRESS CHANGE IN THE AUTOMOTIVE SECTOR

Manuel González Domínguez
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PURPOSE

- The fact of identifying some of the key factors for the successfully implantation of a Lean Project in a company will help others to bet on the change towards the lean way designing a clear strategy from the beginning and being centered in the factors that will cause that the wished objectives are fulfilled. This case will show how accomplishing drastic cuts in presses setup times by single-minute exchange of die (SMED) procedures, from 16 hours to 2 hours, a company can raise much better results (the OEE increases to 65%).

METHODOLOGY

- In this case the SMED (Single minute exchange of die) methodology is one of the tools proposed by the Lean Manufacturing.
- Changes proposed by the workers were videotaped in order to account the synchronized task list
- It's a real case implemented in an automotive sector' company.

CONTENT

- Target definition
- List the reference exchange operations
- Analyzing and improving the operations:
  - Eliminating
  - Reducing
  - Outsourcing
- Make improvements
- Synchronizing each task (diagram)
- Writting operation standards (iterative procedure)
- Applying the operation mode and continuing with the baseline exchange times
- Lessons learned

Key words

- Lean methodology
- Key factors
- Lean implementation
- Automotive Sector
- SMED
- Overall equipment effectiveness (OEE)