

Lean in Large Enterprises: Study Results

Dorota Stadnicka, Katarzyna Antosz

Abstract—The idea of Lean Manufacturing has been known for 20 years. In Polish enterprises its first implementation took place in the automotive industry in the 90s. Many companies, in order to reduce costs, use lower quality materials or overload employees with work and do not notice other possibilities for improving the company's effectiveness. Enterprises are afraid of the unknown. And that is the problem in many cases with the Lean Manufacturing conception. This article presents the study results conducted in enterprises, the aim of which was to identify waste awareness and the need of lean manufacturing implementation. The authors also wanted to gain information on the most commonly used tools and the way of implementation and the methods of the effects assessment of using the mentioned conception. The study was conducted in large enterprises located on a limited area.

Keywords—Large enterprises, lean manufacturing, tools, wastes elimination.

I. INTRODUCTION

THE term Lean Manufacturing was first used in the book *The Machine That Changed the World* [1]. Its authors explain how enterprises may drastically improve their effectiveness using the approach derived from the Toyota Production System. Positive effects of the lean manufacturing implementation are also presented in other works [2]–[4]. The Toyota System, formed in the 50s of the 20th century and further developed, was adapted to other corporations [5], [6], based on a few main tools such as Just in Time (JIT), Jidoka, Kaizen, Heijunka and other. Lean Manufacturing philosophy is related to using a lot of tools which are, among others, and apart from the abovementioned, the following: TPM, VSM (Value Stream Mapping), Poka-Yoke, SMED [7]–[13].

The beginnings of using the Lean Manufacturing conception in Poland date back to the 90s. Since then, due to using this conception, Polish enterprises have achieved:

- 1) Increase of their capacity of even 66%,
- 2) Increase of the machine exploitation, measured by OEE indicator, up to 59%,
- 3) Reduction of inventory during the production of even 80%,
- 4) Decrease of production area of even 61%,
- 5) Reduction of transition time from a raw material to the finished goods of 70%,
- 6) Reduction of changeovers time of even 96% [14].

More and more Polish enterprises decide to implement Lean philosophy because they recognize the benefits its use may bring.

Dorota Stadnicka and Katarzyna Antosz are with the Faculty of Mechanical Engineering and Aeronautics Rzeszów University of Technology, Al. Powstańców Warszawy 12, 35-959 Rzeszów, Poland (phone: +48 17 865 1452, fax: +48 17 865 1184, e-mail: dorota.stadnicka@prz.edu.pl, katarzyna.antosz@prz.edu.pl).

The conception of lean manufacturing is implemented in different enterprises and in different industries. The implementation examples, the problems appearing and conclusions on the Lean Manufacturing System operation are presented in Poland at the annually organized conferences, that among others are Lean Learning Academy conferences in Rzeszów, Lean Enterprise Institute Polska in Wrocław and at the open Lean Manufacturing Conference in Poznań.

Despite many publications on Lean Manufacturing, which appear in increasing numbers in the Polish language, the Polish enterprises still face many problems, both at the implementation stage as well as at stage of the Lean Manufacturing tools application.

In this article authors seek answers for questions connected to the Lean Manufacturing implementation process and the problems related to that as well as the tools which were or are to be implemented in the future by large companies.

II. THE REVIEW OF THE IMPLEMENTATIONS PERFORMED UNTIL NOW AND THE SURVEYS CARRIED OUT WITHIN LEAN MANUFACTURING IMPLEMENTATION

Although the Lean Manufacturing process implementation is well recognized and there are many principles and suggestions on the introduction of the Lean conception [15]–[17], its implementation still causes many problems. The examples of Lean Manufacturing and the experiences connected to them are often present in the literature and actually indicate the same problems, despite the fact that they occur in different industries [18]–[21].

The literature points to the necessity of determining a strategy of Lean Manufacturing implementation as well as indicators for the implementation assessment [22], [23].

The literature also indicates that large enterprises are more willing to implement the Lean Manufacturing conception [24], [25]. The fact that in large companies the formalization of the principles of procedure is greater, there are more procedures set and the strategic management must be realized on a higher level causes easier implementation of new management systems. A number of studies and analyses in enterprises have been carried out. Their aim was to identify the problems and benefits related to Lean Manufacturing implementation in the companies of a different size [3], [4], [26], [27], of a different industry [18], [28]–[31], or in different regions of the world [32], [33]. The review of the studies conducted until now and related to Lean Manufacturing has been done, and the analyzed areas were indicated [24], [27], [34]–[42]. Table I presents the review summary.

TABLE I
SUMMARY OF THE LEAN MANUFACTURING SURVEY REVIEW

Survey identification	Survey areas
Shah, R. and Ward, P. T. 2003 [27]	<ul style="list-style-type: none"> Lean manufacturing practices Lean bundles Operational performance Manufacturing equipment and processes
Toni L. Doolen and Maria E. Hacker 2005 [24]	<ul style="list-style-type: none"> Shop-floor management New product development Supplier management Customer relationships Workforce management Associations with Lean Reasons for using lean principles Expectations on using lean principles Specific lean tools organisations are using in order to become a lean enterprise
Thorsten Arens 2006 [34]	<ul style="list-style-type: none"> Functions strategically integrated in the companies' lean Rollouts Relation between Engineering & HR integration and TPS implementation success Critical management factors for successful lean implementation Supplier feedback JIT delivery by suppliers
Rachna Shah, Peter T. Ward 2007 [35]	<ul style="list-style-type: none"> Supplier development Customer involvement Pull, Continuous flow, Just in Time (JIT) Set up time reduction Total productive/preventive maintenance Statistical process control Employee involvement Waste minimization Flow management Quick delivery Unit cost of products Overall productivity Customer satisfaction
Rahman S., Laosirihongthong T., Sohal A. S. 2010 [36]	<ul style="list-style-type: none"> Lean practices implementation Lean tools Lean drivers Benefits, Barriers Lean success Commitment Belief , Communication Work method LM practices and inventory turnover Contingency factors and inventories The role of production systems The role of order type The role of product type The status of lean manufacturing implementation The motivation for lean implementation The frequency of using different lean tools in machine tool industries The general barriers/challenges in lean implementation concepts Self-assessment of waste level Underlying reasons for the Lean adoption The barriers encountered How Lean was tracked internally
NoraniNordin, Baba MdDeros, DzuraidahAbdWahab 2010 [37]	<ul style="list-style-type: none"> Lean success Commitment Belief , Communication Work method LM practices and inventory turnover Contingency factors and inventories The role of production systems The role of order type The role of product type The status of lean manufacturing implementation The motivation for lean implementation The frequency of using different lean tools in machine tool industries The general barriers/challenges in lean implementation concepts Self-assessment of waste level Underlying reasons for the Lean adoption The barriers encountered How Lean was tracked internally
David Losonci n, Krisztina Demeter, Istva'n Jenei 2011 [38]	<ul style="list-style-type: none"> Lean success Commitment Belief , Communication Work method LM practices and inventory turnover Contingency factors and inventories The role of production systems The role of order type The role of product type The status of lean manufacturing implementation The motivation for lean implementation The frequency of using different lean tools in machine tool industries The general barriers/challenges in lean implementation concepts Self-assessment of waste level Underlying reasons for the Lean adoption The barriers encountered How Lean was tracked internally
Krisztina Demeter, ZsoltMatyusz 2011 [39]	<ul style="list-style-type: none"> Lean success Commitment Belief , Communication Work method LM practices and inventory turnover Contingency factors and inventories The role of production systems The role of order type The role of product type The status of lean manufacturing implementation The motivation for lean implementation The frequency of using different lean tools in machine tool industries The general barriers/challenges in lean implementation concepts Self-assessment of waste level Underlying reasons for the Lean adoption The barriers encountered How Lean was tracked internally
M. Eswaramoorthi, G. R. Kathiresan, P. S. S. Prasad, P. V. Mohanram 2011 [40]	<ul style="list-style-type: none"> Lean success Commitment Belief , Communication Work method LM practices and inventory turnover Contingency factors and inventories The role of production systems The role of order type The role of product type The status of lean manufacturing implementation The motivation for lean implementation The frequency of using different lean tools in machine tool industries The general barriers/challenges in lean implementation concepts Self-assessment of waste level Underlying reasons for the Lean adoption The barriers encountered How Lean was tracked internally
Sanjay Bhasin 2012 [41]	<ul style="list-style-type: none"> Lean success Commitment Belief , Communication Work method LM practices and inventory turnover Contingency factors and inventories The role of production systems The role of order type The role of product type The status of lean manufacturing implementation The motivation for lean implementation The frequency of using different lean tools in machine tool industries The general barriers/challenges in lean implementation concepts Self-assessment of waste level Underlying reasons for the Lean adoption The barriers encountered How Lean was tracked internally
Banhan Lila 2012 [42]	<ul style="list-style-type: none"> Attitude, Implementation Problems/barriers

• Effectiveness, Level of understanding

The review shows that the main areas of the surveys were Lean Manufacturing practices, Lean Manufacturing tools, benefits from Lean Manufacturing implementation and the problems related to Lean Manufacturing.

III. STUDY SUBJECT AND METHODOLOGY

This article focuses on the implementation of the Lean Manufacturing conception. The way of the Lean Manufacturing system implementation by the companies has been studied. The study concerned the manufacturing companies of different industry types in the area of the podkarpackie voivodeship in Poland. As a detailed subject of the study, the areas of Lean Manufacturing implementation in enterprises, described in Table II, have been analyzed.

TABLE II
AREAS OF LEAN MANUFACTURING IMPLEMENTATION

Area of Lean Manufacturing implementation	Element of Lean Manufacturing implementation being studied
Reasons for Lean Manufacturing implementation	<ul style="list-style-type: none"> Reasons for Lean Manufacturing implementation Main goals of Lean Manufacturing implementation indicated by the studied enterprises
Waste awareness in the company	<ul style="list-style-type: none"> Types of waste present in an enterprise
Strategy of Lean Manufacturing implementation and assessment of the implementation	<ul style="list-style-type: none"> Were the Lean implementation goals in a company determined What do the determined indicators of the Lean implementation assessment concern What are the determined indicators of the Lean implementation assessment
Lean implementation process	<ul style="list-style-type: none"> Means of Lean implementation Difficulties observed in Lean Manufacturing implementation
Lean Manufacturing tools	<ul style="list-style-type: none"> Lean Manufacturing tools implemented Lean Manufacturing tools intended to implement

In the area studied (Poland – podkarpackie voivodeship), in 2010 when the studies began, there were 152 618 enterprises registered, including 202 large ones (data from the Marshal's Office of podkarpackie voivodeship, Department of Strategy and Planning). During the study of the enterprises, the following categories for population identification were adopted: industry and production types. 150 enterprises were invited to take part in the study. Any enterprise, plant or its department that had its own strategy and accounted of its accomplishments could be the object of the study. 46 questionnaires were obtained as a feedback.

The study took the form of interviews. The subjects of the study were the representatives of a medium and top management as well as the employees directly responsible for the process of the technological machines and appliances supervision in a company, as well as the chosen machine operators. The study was conducted in a conjunctive multiple choice format, and included a list of prepared, provided in advance options presented to a respondent with a multiple

response item in which more than one answer might be chosen. Additionally, a respondent could give other answers if they were not among the provided options.

IV. THE STRUCTURE OF THE STUDIED ENTERPRISES

During the study, the enterprises were classified according to the following criteria: industry type, production type, ownership type (type of capital) and technical infrastructure organization. Figs. 1-5 show the structure of the studied enterprises.

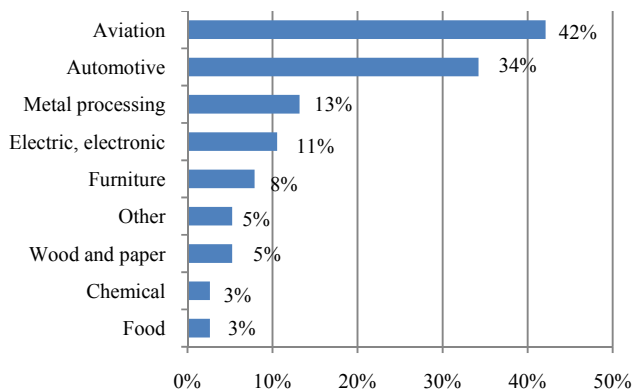


Fig. 1 Industry type of the studied enterprises

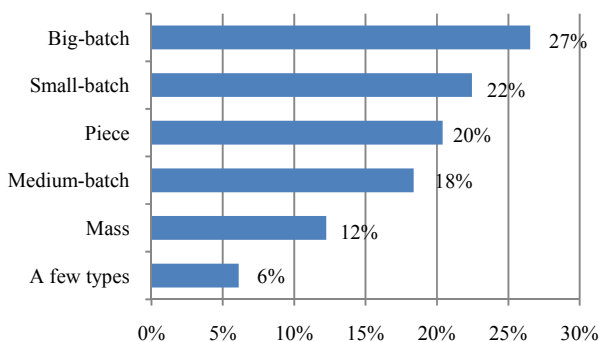


Fig. 2 Production types in the enterprises

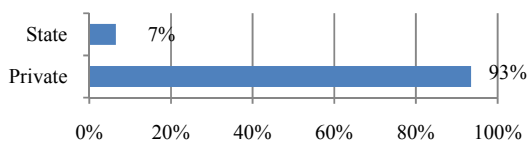


Fig. 3 Ownership types of the enterprises

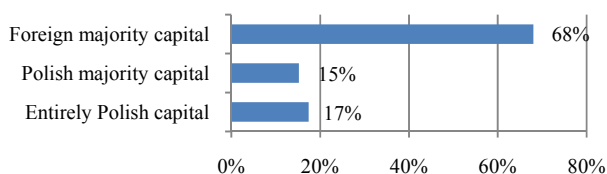


Fig. 4 Type of capital in the enterprises

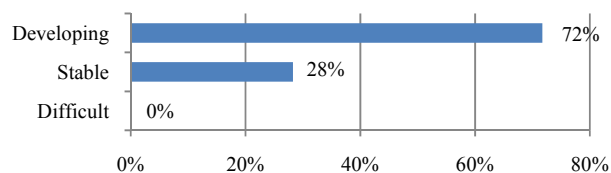


Fig. 5 Self-assessment of the companies' situation

Most of the companies operated in: aviation (42%) and automotive (34%) industries. Most are the companies with a big-batch production type (27%). 91% of the studied companies are privately owned, only 9% is state owned. 68% of the companies possess foreign majority capital. 72% of the companies describe their situation as developing. None of the companies described their situation as difficult.

V. STUDY RESULTS

A. Reasons for Lean Manufacturing Implementation in Companies

Different reasons influence the decision of the companies to implement the Lean Manufacturing conception. In the study, the companies were asked about their reasons for the decision to implement Lean Manufacturing. The most, because as many as 87%, of the studied companies which use the Lean Manufacturing conception, indicated the intention to improve the company's operation as a reason (Fig. 6). For 47% of the companies, it was a desire to gain a competitive advantage. Other reasons for Lean Manufacturing implementation listed by the companies were: reduction of the production costs, this system is in vogue, savings, facilitating the work for employees (11%).

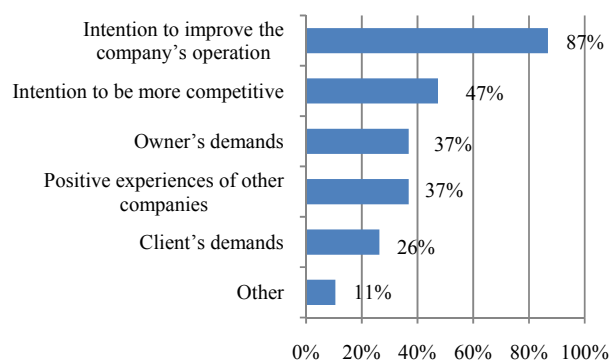


Fig. 6 Reasons for Lean Manufacturing implementation

Next, the authors asked about main goals of the Lean Manufacturing conception implementation. As many as 93% of the companies indicated waste elimination (Fig. 7).

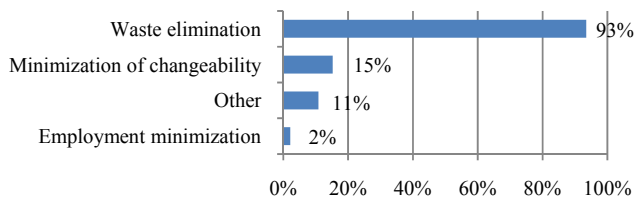


Fig. 7 Main goals of Lean Manufacturing implementation indicated by the studied companies

Among other goals the companies indicated:

- 1) Increasing the company's effectiveness,
- 2) Providing an unchanging pattern, recurrence of the processes/ production,
- 3) Employees' satisfaction,
- 4) Reducing internal stocks,
- 5) Reducing inventory,
- 6) Facilitation of processes, minimization/ optimization of production costs (11%).

B. Awareness of the Waste Present in an Enterprise

The authors also assessed the awareness of the waste present in enterprises. 67% of the companies revealed that their waste is a result of maintaining inventory (Fig. 8). Next, 54% pointed to waiting for material and 52% to unnecessary movements.

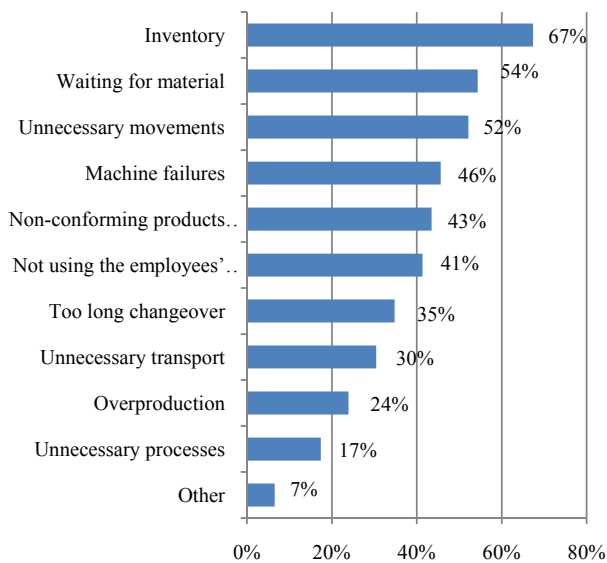


Fig. 8 Types of waste present in an enterprise

Among other kinds of waste the companies listed:

- 1) Unnecessary posters, stickers,
- 2) Sophisticated procedures of business trips,
- 3) Lost possibilities,
- 4) Raw materials waste (7%)

C. Strategy of Lean Manufacturing Implementation and the Implementation Assessment

The companies adopted different strategies of Lean Manufacturing implementation and the assessment of this

implementation. Only 51% of the companies determined general aims of Lean Manufacturing implementation on the level of the whole company (Fig. 9). 10% of the companies didn't determine at all any implementation goals, achievement of which could be later monitored.

17% of the companies which determined the aims didn't establish any assessment indicators of the achievement of these aims (Fig. 10).

93% of the companies pointed to the established indicators concerning costs, and 86% specified the indicators related to capacity (11%). Only 32% of the companies suggested that the indicators pertain to materials, however, as the study shows, 79% of the companies calculate an indicator related to the inventory reduction (Fig. 12).

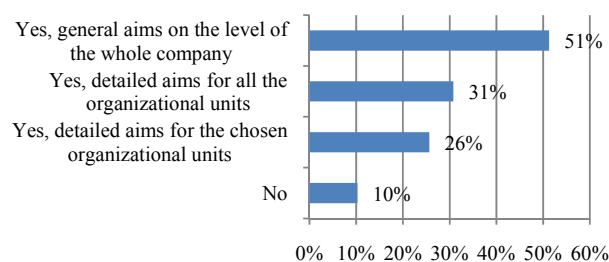


Fig. 9 Were the Lean implementation aims in a company determined?

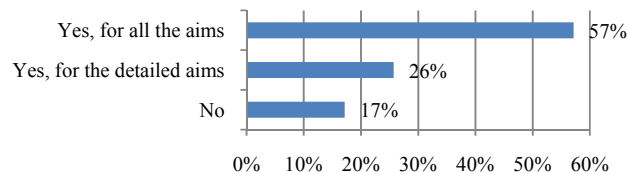


Fig. 10 Were the indicators for the Lean implementation aims established?

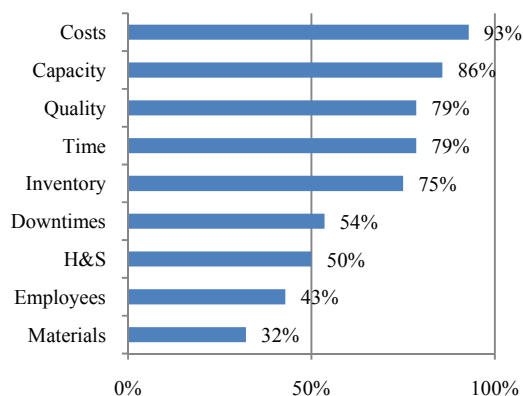


Fig. 11 What do the set indicators of the Lean implementation assessment concern?

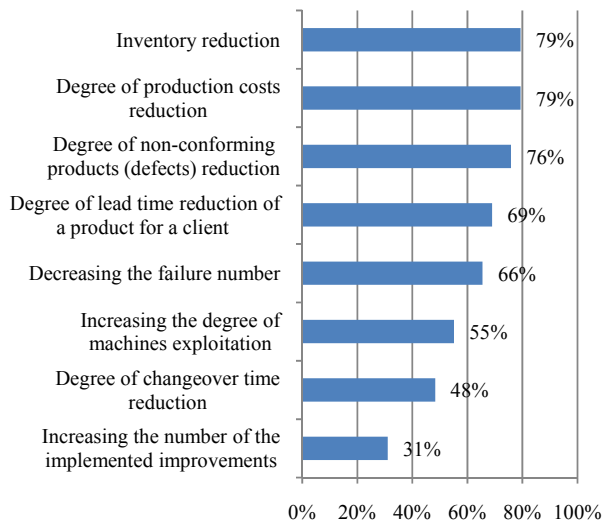


Fig. 12 The indicators of Lean implementation assessment established

79% of the companies monitor the degree of production costs reduction as well. It is worth emphasizing that 31% of the companies monitor the increase of the number of the implemented improvements.

D. The process of Lean Manufacturing Implementation

Among 46% of the enterprises which took part in the study, 11% didn't implement the Lean Manufacturing conception, and 4% are just planning the implementation (Fig. 13). Most of the studied companies, because 39%, have already owned the Lean Manufacturing system for 5 years.

The companies implemented the Lean Manufacturing conception on their own (39%), with the assistance of a consultant (39%) or employing a Lean specialist (33%) (Fig. 14). 11% of the companies employed a Lean specialist and, at the same time, benefited from the external consultant aid.

In the study, the companies also indicated difficulties which occurred during the implementation of the Lean Manufacturing conception (Fig. 15). 76% of the enterprises pointed to the excess of the current work as a main problem.

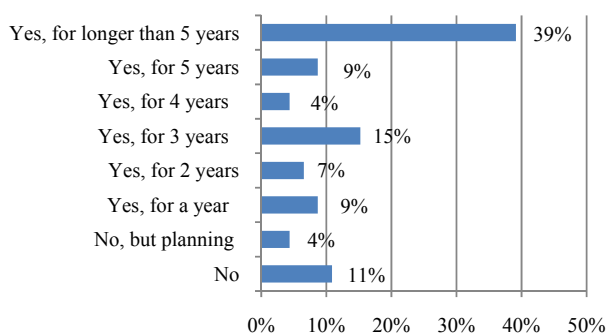


Fig. 13 Use of the Lean Manufacturing conception

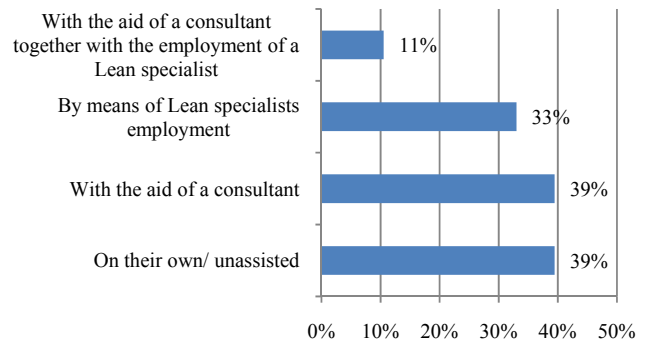


Fig. 14 Means of Lean implementation

Furthermore, the following were present: employees' reluctance (57%) and a lack of employees' engagement (51%) what generally signifies a lack of understanding of the Lean Manufacturing conception by a company's employees, and what may indicate the necessity of motivating employees better. As the study conducted shows, the companies (46%) complain about the lack of incentives which they can use to motivate employees.

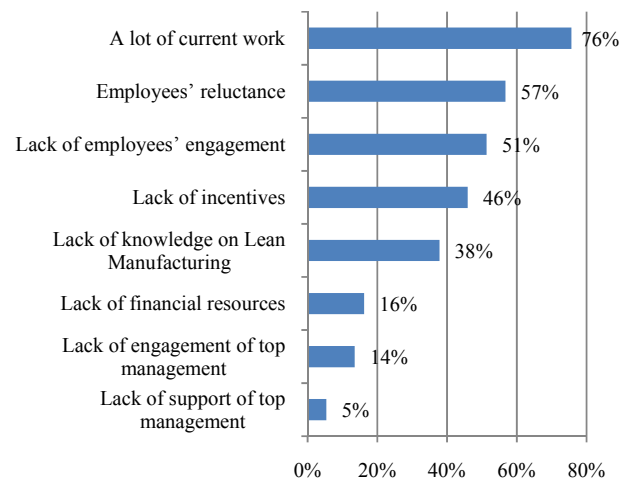


Fig. 15 Difficulties in Lean Manufacturing implementation

E. Lean Manufacturing Tools

In the study conducted the authors asked also about the Lean Manufacturing tools applied in the companies and about the tools the companies intend to implement in the future. The results are presented in Table II.

Most of the studied companies, because as many as 97%, possess 5S system implemented. Furthermore, the most commonly applied tools are: FIFO (82%), 5xWhy?, Work standardization and Poka Yoke (79%). 13% of the companies intend to implement additionally: OEE and A3 problem solving. Other tools are implemented to a lesser extent.

Table III presents the percentage of the companies which implemented certain tools distinguished by the operation time of the Lean Manufacturing system in the company.

Based on the data presented in Table IV, it can be concluded that some tools are more popular than other, and they are applied regardless of how long the Lean

Manufacturing conception is used in the company. Such tools include: 5S, work standardization, Poka Yoke, FIFO, 5xWhy?, and also team work, Kanban system and RCA. It can be noticed that these tools are applied only in the companies which have possessed the Lean Manufacturing system for longer than 5 years.

TABLE III
LEAN MANUFACTURING TOOLS IMPLEMENTED IN THE ENTERPRISES AND INTENDED TO IMPLEMENT

Lean Manufacturing tool	Percentage of the enterprises where the tool was implemented	Percentage of the enterprises intending to implement the tool
5S	97%	0%
FIFO	82%	5%
5xWhy?	79%	0%
Work standardization	79%	8%
Poka Yoke	79%	3%
Team Work	76%	0%
Kanban System	71%	11%
TPM	71%	11%
Kaizen	68%	11%
Visual management	63%	5%
Value Stream Mapping	58%	8%
RCA (Root Cause Analysis)	53%	3%
Just in Time	47%	5%
Taktu Time	45%	3%
SMED	45%	11%
One piece flow	42%	8%
3P (Production Preparation Process)	39%	3%
U-shape line	34%	3%
Gemba walk	32%	5%
Andon	26%	3%
OEE	24%	13%
TQM	24%	8%
Milkman course	16%	8%
Global 8D	16%	3%
ChakuChaku	16%	3%
Gemba/Gembutsu/Gengitsu	13%	5%
7 Mudaidentification	11%	11%
Hejunka Box	8%	3%
Jidoka	8%	0%
A3 problem solving	5%	13%
HoshinKanri/Policy deployment	3%	3%
Kaikaku/Reengineering	3%	3%
Jishuken	0%	3%

VI. CONCLUSION

Based on the study conducted, the following conclusions can be drawn. The companies are willing to implement Lean Manufacturing because they want to improve the enterprise's operation and are aware of the necessity of waste elimination. The main problem of the companies is constant inventory, and that is why the most common indicator of the Lean Manufacturing system assessment is the inventory reduction.

Still, a high percentage of the companies do not have the Lean Manufacturing system implemented, and those which implemented this system use tools such as 5S and work standardization.

Many of the companies have implemented the Lean Manufacturing system unassisted (39%) and that could be the reason for the employees' lack of engagement.

It is worth emphasizing that only 14% of the companies pointed to the lack of top management engagement in Lean Manufacturing implementation, even though such a situation shouldn't happen at all. Nevertheless, the basic obstacle revealed in the process of implementation was the excess of current work.

TABLE IV
LEAN MANUFACTURING TOOLS IMPLEMENTED IN THE ENTERPRISES WITH ACCOUNT TO THE OPERATION TIME OF THE LEAN MANUFACTURING SYSTEM IN THE COMPANIES

Operating time of the Lean Manufacturing system in the company	Longer than 5 years	For 5 years	For 4 years	For 3 years	For 2 years	For 1 year
5S	94%	100%	100%	100%	100%	100%
Workstandardization	94%	75%	100%	57%	33%	75%
Poka Yoke	89%	100%	100%	57%	67%	50%
TPM	89%	75%	100%	71%	33%	0%
FIFO	89%	75%	100%	86%	33%	75%
5xWhy?	83%	100%	100%	86%	33%	50%
Kaizen	83%	100%	100%	57%	0%	25%
Team work	83%	75%	100%	71%	33%	75%
VSM	78%	75%	100%	29%	33%	0%
Visual management	78%	50%	100%	71%	0%	25%
Kanban system	72%	100%	100%	71%	33%	50%
RCA (Root Cause Analysis)	61%	100%	50%	29%	33%	25%
3P (Production Preparation Process)	56%	100%	50%	0%	0%	0%
Takt Time	56%	75%	50%	43%	0%	0%
One piece flow	56%	50%	50%	29%	33%	0%
SMED	44%	50%	100%	43%	67%	0%
Andon	39%	50%	50%	0%	0%	0%
Just in Time	39%	50%	50%	57%	67%	50%
U-shape line	39%	25%	50%	43%	0%	25%
Gemba walk	33%	50%	100%	29%	0%	0%
ChakuChaku	17%	0%	0%	43%	0%	0%
OEE	17%	0%	50%	57%	0%	25%
Global 8D	11%	0%	0%	29%	33%	25%
7 Muda	6%	25%	50%	14%	0%	0%
Hejunka Box	6%	0%	50%	0%	0%	25%
A3 problem solving	6%	0%	50%	0%	0%	0%
TQM	11%	50%	50%	29%	0%	50%
Milkman course	11%	25%	0%	43%	0%	0%
Gemba/Gembutsu/Gengitsu	6%	50%	100%	0%	0%	0%
Kaikaku/Reengineering	6%	0%	0%	0%	0%	0%
HoshinKanri/Policy deployment	6%	0%	0%	0%	0%	0%

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