

LAST 10 YEARS OF LEAN MOVEMENT IN POLAND. CONCLUSIONS AND PROSPECTS FOR THE FUTURE

Tomasz Koch^{1,2}, Tomasz Sobczyk^{1,2}, Remigiusz Horbal¹, Robert Kagan¹, Zofia Mianowska^{1,2}

¹ *Lean Enterprise Institute Polska*

² *Institute of Production Engineering and Automation, Wrocław University of Technology, Poland*

Corresponding author:

Tomasz Koch

Wrocław University of Technology

Institute of Production Engineering and Automation

Lukasiewicza 5, 50-371 Wrocław, Poland

phone: +48 71 3202214

e-mail: tomasz.koch@pwr.wroc.pl

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ABSTRACT

This article is a kind of report presenting the last 10 years of Lean Management development in Poland and forecasts for the future. It contains analyses of the interest in Lean concept in different industries and the results of its implementation over the last 10 years. The emphasis on different aspects of Lean Management in companies in Poland implementing this concept is discussed. The article presents current state of knowledge on effective implementation of lean approach. The importance of developing lean management culture and its components are highlighted. The last section discusses the prospects of further development of this concept and new areas of its applications that will be of greatest interest for industry in the forthcoming years.

KEYWORDS

lean manufacturing, lean management, lean manufacturing implementation.

Lean development in Poland over the last 10 years

Like in other countries, car manufacturers in Poland, for example GM (Opel) or SCANIA, were among the first ones to undertake the implementation of Lean Manufacturing in the nineties of the twentieth century. Simultaneously, the process took place at first-tier suppliers for the automotive business. In the late nineties in Poland, the most mature efforts of Lean manufacturing implementation were undoubtedly made in plants belonging to American corporation Delphi (one of the biggest first-tier suppliers in automotive business), for example in Ostrów Wielkopolski, Krosno or Jeleśnia. It was in Delphi plants that the method of Value Stream Mapping was introduced, probably for the first time, as early as in 1998. A great number of first-tier suppliers in automotive business in Poland started their adventure with Lean in the late twentieth century or early twenty first century, for example Remy, Bosch, Mag-

netti Marelli, TRW, Autoliv, Draexlmaier, Faurecia, Valeo, GKN, Takata Petri, Visteon, TI Automotive and WABCO. It must be mentioned here, however, that not all first-tier suppliers in automotive industry adopted lean as a dominant strategy and even today there are plants, for example those belonging to German corporations, in which Lean has a quite limited application.

Undoubtedly, among the pioneers of Lean implementation in Poland at the turn of century were the plants representing other industries as well, for example Pratt & Whitney in Kalisz or Sauer Danfoss in Wrocław.

The automotive sector was quickly followed by home appliances industry, for example a Polar plant in Wrocław, owned by American Whirlpool, Bosch Siemens Hausgeräte in Łódź or Electrolux plants. Other companies that took great interest in Lean Manufacturing implementation over the last ten years represent electronic and electric industry (for example Sonion, Jabil, Lacroix, Flextronics), FM-

CG (Gillette, Philip Morris, Cussons), food industry (MARS, Cadbury Wedel, Heinz, LU, Danone, Carlsberg, Kompania Piwowarska, Lorenz Bahlsen Snack) or medical industry (Aesculap Chifa, 3M, MacoPharma). Nowadays, it would be difficult to find a manufacturing industry in Poland without at least a few examples of successful Lean Manufacturing implementation. Although Lean implementations take place mainly in companies with foreign capital, most often belonging to global multinational corporations, more and more examples come from private Polish companies, both large ones such as Nowy Styl, or medium-size ones, such as Black Point in Wrocław, Stelweld in Jelcz Laskowice or Lamela in Łowicz.

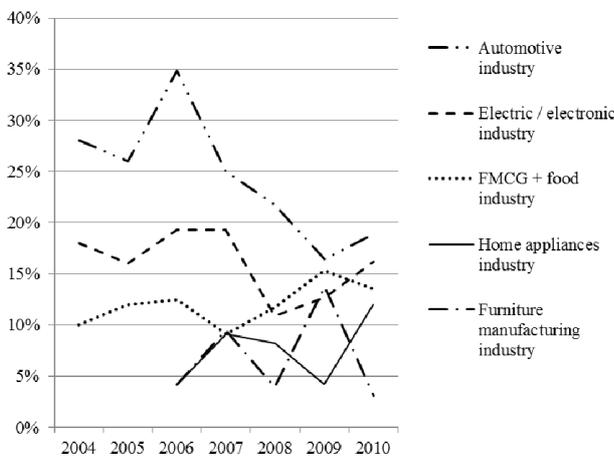


Fig. 1. Percentage share of participants from 5 industrial sectors in subsequent Lean Manufacturing conferences in Poland.

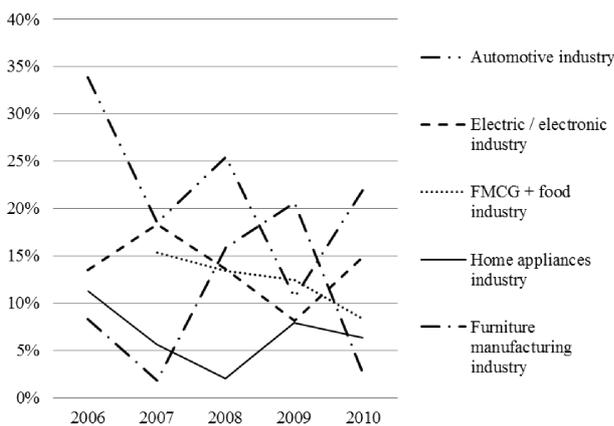


Fig. 2. Percentage share of participants from 5 industrial sectors in subsequent open training sessions organized by Lean Enterprise Institute Polska.

Over the last several years, the interest in Lean has been growing significantly in the furniture industry. One of the most important reasons may be the strategy of IKEA company, which for the last

three years has been promoting Lean among its numerous suppliers in Poland. Such tendencies may be observed while analyzing the percentage share of different industries representatives in subsequent Lean Manufacturing conferences (Fig. 1) or open training sessions (Fig. 2). For example, while the percentage of participants from automotive industry has been declining, the percentage of those from other industries has been increasing.

It is also worth mentioning that the interest in Lean has recently arisen among companies representing heavy industry, packaging and construction industry.

It is difficult to define clearly the way or path of Lean development in Polish companies over the last few years. The way of implementation, the tools and techniques used, the organization structure supporting implementation and, finally, the results achieved were and still are dependent on numerous factors, such as, for example: the goal and motives of changes in the company, type of industry and its specific character, existing culture and management environment, previous experience in process restructuring or the level of management and employees' involvement.

However, even in such a diversified environment, an attempt can be made to make certain generalizations and show how lean implementation projects have evolved in Poland over the last 15 years (Fig. 3). The transformation process presented below is of a general character and it may take a slightly different form for some companies.

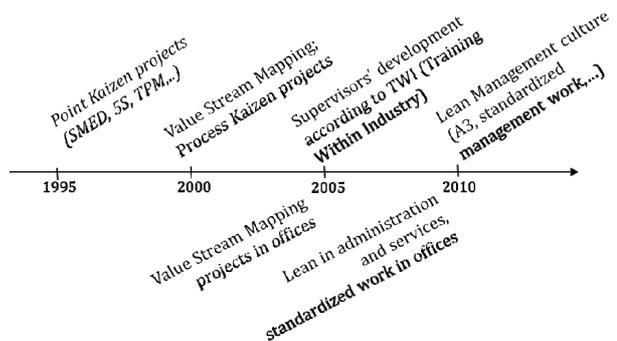


Fig. 3. Emphasis on different aspects of Lean Management in companies implementing this concept over the last 15 years.

Pioneer lean efforts in Poland in the late nineties usually consisted in small, single projects, focused on basic methods and techniques aimed at the improvement of process stability and workplace organization.

The majority of Polish companies started their way towards lean with 5S, TPM, SMED or Kaizen workshops. The motivation to undertake such actions varied, starting with top-down instructions

from foreign-based headquarters, through the willingness to improve processes and, in general, to gain competitive advantage, to some kind of “trend” or interest and curiosity on the part of the management.

It was a common phenomenon that such projects, carried out in parallel on several processes, were often isolated from one another and their objectives might have been in conflict. It was a classical approach to clearly define the project targets on the basis of overheard opinions and benchmarked results of implementation in other companies, while totally disregarding the reality and specific company needs. For example, decisions were made to reduce the change-over time by 50% “because the SMED method certainly makes it possible so we shall benefit from it as well”.

The first years of implementations in our country were characterized by experiments with different styles, methods and techniques of implementation as well as the necessity to break, sometimes exaggerated, prejudice and reluctance to changes. One could observe then a bias against Lean in workforce, a trend that may be colloquially described as “we don’t like it because these are some Japanese methods, good for the Japanese but not Poles”. Another difficulty resulted from incorrect implementation strategy, which assumed the delegation of responsibility for changes in the company to single individuals, such as Lean coordinators or Lean leaders.

It is worth mentioning here that some big companies (for example General Electric, 3M or WABCO), made an effort to progress smoothly from their previous experience in 6 Sigma to Lean, simultaneously preserving their existing structure of implementation project support. In result of this approach, such positions as Lean Green Belt or Lean Master Black Belt still exist.

The method of Value Stream Mapping (VSM) [1] constitutes the next significant stage on the implementation axis (Fig. 3). It has become important insofar that in numerous companies its application constituted the basis of correct implementation of Lean and enabled them to achieve measurable results in terms of the company as a whole, not individual processes. Based on the experience of Lean Enterprise Institute Polska team in this field, which includes hundreds of practical VSM workshops, it needs to be acknowledged that there is a large number of companies in Poland which started their Lean experience with Value Stream Mapping, thus from the very beginning increasing their chance to design correctly the implementation paths and the future state of a value stream. Also, at this point start-

ed the implementation of more advanced tools, on which the optimization of information and material flows is based, both within companies and between them. Continuous flow cells and lines [2], level pull system [3], material deliveries in “milkrun loops” [4] or lean supply chains [5] are just a few examples of numerous methods which have been successfully implemented also in our country.

From today’s perspective the next stage on the axis of Lean development in Poland seems to be one of the most significant ones. It started approximately in 2005, when the implementation of Lean broadened to include staff development and the establishment of appropriate organization structures in companies so that the changes could be more visible and, most importantly, sustainable. It turned out that for many companies the obstacle in the implementation of Lean was constituted by wrong management structure and lack of lean competencies among the mid and low-level management (line leaders, supervisors and foremen), which resulted in poor effects of improvement projects or gradual decline of the results achieved. Hence the rapid development of TWI (Training Within Industry) program in Poland [6, 7], comprising the improvement of foremen and supervisors’ skills and increasing interest in management work standardization program so that there is more focus on change sustainability and day-to-day improvement [8].

Not only manufacturing companies contributed to the development of Lean in Poland. It must be noticed that at the very beginning of implementations, numerous attempts were made to simultaneously introduce some lean techniques and methods in non-productive areas: offices and administration. These techniques and methods included primarily 5S, visual control tools, continuous improvement workshops, pull system in the document and information flows. Initially, such efforts, more or less successful, consisted in copying the solutions from production floor and adapting them to the needs of office environment. Accounting firms, accounting shared service centers or service companies, which started to appear on the Polish map of Lean, prove that the concept of lean manufacturing can help also in this area.

What has been recently happening in Poland in terms of Lean? It is noticeable that lean philosophy is gradually entering new areas, such as: design processes, sales, services, information flow and management. There are also first signs of the interest in Lean concept in healthcare. As regards manufacturing companies, nowadays there is a clear trend comprising the standardization of management work, which includes not only low and mid-level but also top man-

agement. The concept of standardized, lean management started to be implemented. In this way, the lean approach to build process stability has been moved from manufacturing work stations and basic methods of Lean to the top level where company strategies are established and managed. This involves day-to-day improvement process, structured, once-per-shift meetings at area performance boards, determination of KPI indicators motivating to the Lean implementation, application of coaching principles in relations between superiors and subordinates, application of A3 report method [9], which imposes thinking according to PDCA scheme.

Having a ten-year experience in Lean promotion and implementation in Poland and being present in

the main stream of its development in the world, authors of this paper are now certain that Lean Management is not exclusively owned or domain of Toyota. The last few years have been characterized not only by the adaptation of solutions taken from the production floor but also by identification of new areas where this concept may be applied and by development of completely new tools and concepts supporting the principles of Lean Management. Companies representing different industries may be credited with the emergence of these methods and the role of experts collaborating within the framework of Lean Global Network (www.leanglobal.org) should not be underestimated. The examples of such methods are presented in Table 1.

Table 1
Examples of methods and concepts developed in the world over the last 10 years, expanding the set of traditional Lean Manufacturing methods and tools.

Method/ concept	Area of application	Description
Lean Office	Administrative and office areas in service companies and production plants	Dissemination of Lean Manufacturing solutions beyond production floor. A number of methods and tools are successfully adapted to administrative environment (process mapping, 5S, standardization, visual control, problem solving). In addition, the administrative area shows great similarity (and thus also needs) as regards the adaptation of industrial engineering solutions comprised in Lean Management (demand leveling, priority management in workflow, balanced work pace, etc.).
Lean Accounting	Management accounting and cost accounting systems in production companies	An alternative system of efficiency measurement based on process oriented cost accounting focused on value stream combined with the analysis of resources utilization. Lean Accounting supports decision making focused on Lean Manufacturing implementation. It enables the assessment of benefits resulting from future state maps and the evaluation of implementation results of specific Lean Management methods and techniques. It involves efficiency evaluation not only in operational but also financial terms.
Glenday Method (Glenday Sieve)	Analysis of activities in any type of manufacturing enterprises and service organizations	A tool for both product and activities range analysis in any business environment (however, initially developed for a process industry). It assumes identification of about 6% of the most frequently made products (or administrative activities performed in a non-productive environment) which account for 50% of the output (production volume, company turnover, resources etc.). These 6% of products (activities) constitute the so called green stream, whose separation from the rest results in scale effect gains (economy of repetition). Glenday Sieve also makes it possible to prove the uselessness of some part of product range (activities) – usually up to 30% of the least frequently manufactured products (activities performed) account for only 1% of revenues (or output).
TWI in machines' handling and operating processes	Machines' handling and operating in automated production processes	Using TWI methods to standardize and improve work in highly automated plants.
New methods of work standardization	Any production process of relatively repetitive nature	New versions of standardized work for example for tasks with long operation time, in continuous processes, in offices, etc.
Analysis of production flow in process industries	Continuous processes (food industry, chemical industry, FMCG)	Tools based on the technique of standardized work combination table, which make it possible to: model the whole flow in a continuous process, describe product transfers, see the activities performed on parallel installations, define standard times for activities, model optimum production processes in both continuous and multiple-product- range production, etc.
Lean Healthcare	Healthcare	Lean Management concept applied in healthcare. Experience to date show that implementation of Lean Management methods results in better customer satisfaction, more effective utilization of resources, reduction of service lead time, shortening of queues, better patient flow management, etc.

Summing up the information contained in the table, it is worth mentioning here that there is a number of methods that may be applied irrespective of the type of industry, and consequently, adapted in any business organization. These methods include A3 report and A3 process way of thinking, TWI aimed at supervisors' development, 5S technique and visual control, problem solving techniques, Glenday Sieve, etc.

Benefits from lean manufacturing implementation

Specific benefits from Lean Manufacturing implementation have been proved also in Poland. For the purposes of Lean Manufacturing Conferences, 51 case studies from a variety of industry sectors have been published over the last ten years (Fig. 4). Automotive business, which was the first to implement lean approach, accounts for 41% of publications. As regards other industries, the largest number of case studies comes from industrial goods sector (14%), FMCG (14%) and electric and electronic industry (10%). In addition, documented benefits have also been presented for the following industry sectors: home appliances, furniture, medical, aviation, stationery goods and telecommunications.

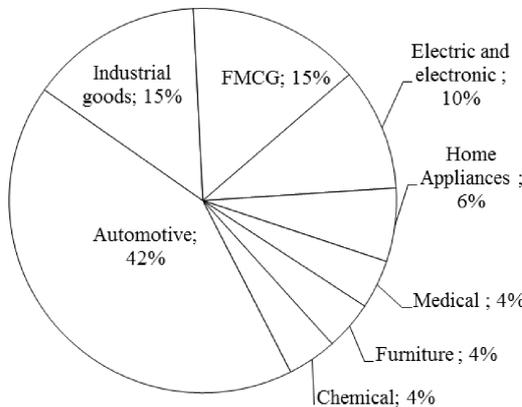


Fig. 4. Distribution of 51 Lean Manufacturing implementation case studies from industry in Poland analyzed in the years 2000-2010 by industry sectors.

The most often improved indicators in 51 analyzed companies implementing Lean Manufacturing are as follows (Fig. 5):

- productivity (growth by 5% to 66%),
- overall equipment effectiveness – OEE (growth by 8% to 59%),
- work in progress – WIP (reduction by 30% to 80%),
- space (reduction by 15% to 50%),

- lead time (reduction by 9% to 92%),
- changeover time (reduction by 30% to 96%).

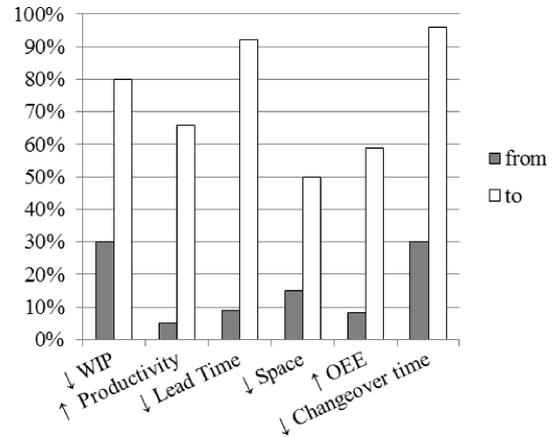


Fig. 5. Improvement of selected indicators in companies in Poland resulting from Lean Manufacturing implementation (based on 51 case studies published for Lean Manufacturing Conferences in the years 2000 – 2010).

In addition, some companies add other benefits, such as:

- significant quality improvement,
- reduction of complaints claims,
- increase in the number of improvement suggestions made by employees (2 to 10 times more),
- better communication,
- scrap reduction.

Lean culture key to elimination of typical mistakes in company transformation

Despite greater knowledge, awareness and experience enterprises have been still making many mistakes (often very fundamental ones) while entering the lean path. Below a list of selected problems, compiled on the basis of Lean Enterprise Institute Polska experience in a number of industry sectors over the last 10 years is presented. The most important mistakes are as follows:

1. Delegation of accountability for Lean implementation to Lean Manager/Coordinator, who has neither formal authority nor proper tools, which results in taking off responsibility from those who shall be held accountable, i.e. executive management, department managers.
2. Lack of interest and time devoted by managers managing those areas where changes are to be introduced. Lack of management commitment.
3. Lack of knowledge (often even fundamental) among individuals participating in implementation.

4. Low awareness of the necessity to perform concrete activities in order to make changes sustainable, and in consequence, poor interest in once-per-shift standardized work auditing process.

5. Absence of team leader structures which are key to a problem solving process (fear of excessive increase in overhead costs being the most common excuse for this).

6. No link between specific implementation project objectives and corporate strategic goals.

7. Inability to define actual problems (we know how but very often we don't know what for). The desire to quickly implement the tool (for example pull system) without understanding a true nature of the problem.

8. Operational assessment system, which necessitates focus on short-term success at the expense of long-term improvement.

9. No focus on the so called basic process stability. The implementation of more advanced management tools in Lean Manufacturing environment is impossible without the basic stability.

10. Incorrect efficiency evaluation of both company and its departments on the basis of results provided by traditional cost accounting (which includes concentration on unit cost).

11. Changing objectives.

12. Absence of incentive and bonus system for employees.

13. No separation of standard products (activities) from non-standard ones, which results in constant fire-fighting (interruptions in the main stream caused by small-volume products and/or activities performed rarely and irregularly).

14. Absence of activities making up a lean culture (focus on tools without emphasis on the importance of developing management skills and problem solving abilities). Management without learning and education.

The majority of company managers perceive the implementation of Lean concept as the implementation of particular methods and techniques of waste elimination aimed at productivity improvement. In result, they focus on technical aspects of a supermarket for the pull system, reduction of changeover times, increase in OEE for a particular machine, etc. However, they frequently realize that the changes are implemented slowly and reluctantly and even if the change is implemented, it is difficult to sustain as the new practices are not followed and after some time a step backwards is observed. Obviously, there is no chance of further improvement. Most often, this situation results from the fact that there is no focus on creating a corporate culture typical of Lean Management. While developing competencies in technical

aspects of various lean methods, managers should also systematically develop their competencies in the so called lean management culture. It comprises particular methods and tools which enable managers to replace classical management by indicators and resulting fire fighting with management by processes and continuous improvement. All managers want to see measurable results. These are, however, the effects of processes and reflect their effectiveness in the past. Isn't it better to build, align and change processes in such a way so as to be able to control and manage them to achieve proper results? Work organization according to Lean Management principles requires knowledge of such methods as visual control at the level of workstation, area and department, problem escalation system, support chain for rapid response to problems, one-per-shift audits and gemba walk. All these components, supplemented by standardized management work make it possible to create an efficient, lean management system, from supervisors to directors.

It is essential for Lean culture that the manager becomes the coach of their subordinates. Change processes, resulting from transformation into lean enterprise, make it necessary to cascade responsibility down through the organization. What is the best attitude of those delegating responsibility? It turns out that the best results are achieved by mastering coaching skills, thanks to which the superior becomes a teacher (sensei) focused on developing and improving their subordinates' skills. A3 report [9], commonly used in Toyota, is a powerful tool aiding this process. However, A3 report is not merely a tool that supports coaching. It is a management system in the organization, way of supervising and managing changes and projects, suggestion presentation and teamwork, platform for consultation within the company, way of visualizing implementation projects and any change planning. A3 reflects a PD-CA cycle report on one sheet of paper enforcing the synthesis and selection of only such actions that have the greatest impact on achieving the goal. A3 report is also viewed as a tool comprising the principles of structured thinking, oriented towards goal achievement and continuous improvement.

At this point TWI methodology needs to be discussed. It involves developing in low-level managers, especially supervisors and foremen, key skills in instructing employees, improving methods and establishing good relations with subordinates [6, 7]. This is of paramount importance for lean management culture as low-level management seems to have the greatest impact on the largest number of front-line workers.

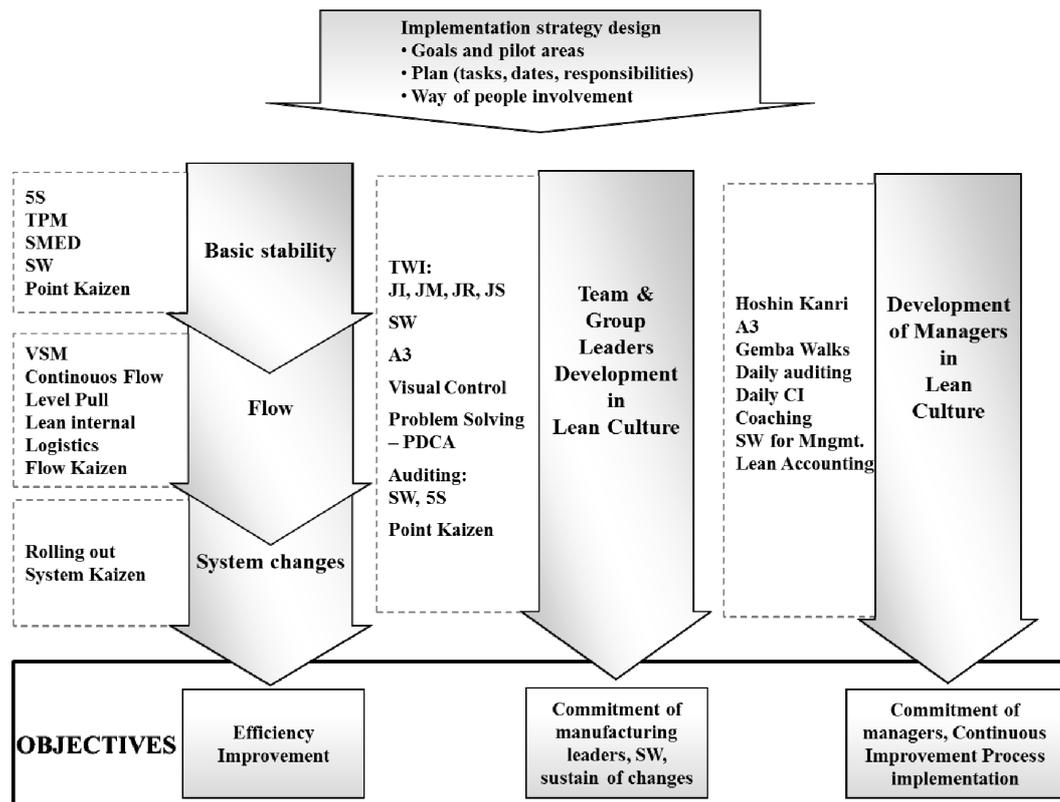


Fig. 6. Components of lean management culture as an integral part of Lean Management implementation projects.

Summing up, lean transformation shall focus simultaneously on technical changes aimed at the achievement of process stability, implementation of uninterrupted value flow and technical enhancement or improvement of processes and the development of Lean Management culture within the company (Fig. 6). It is important to create an organizational culture where all employees will show problem solving and work improvement initiatives and collaborate to provide value to customers and ensure the company's success.

Conclusions and prospects for future

What shall happen in the nearest future, what shall "Polish way towards lean" look like, where shall it lead? Now, it is clearly visible, especially in the context of the desired division of implementation areas into three parallel streams as presented in Fig. 6, that some companies in Poland still have a long way to go.

It is easy to distinguish a number of companies (especially in the automotive and related industries) which are highly advanced in applying Lean techniques and tools. Their impressive results and efficient, standardized processes look good even in comparison with the best industrial practices. At the

same time, these companies still have a lot to do in terms of line leaders and executives development, especially as regards the abilities to create lean management culture. On many occasions, authors of this paper observe lack of such aspects as: a wide-range strategy, company organization structure supporting subsequent lean changes, well established culture of change auditing and effective corrective action implementation. These aspects will be certainly subjects of improvement in such companies. Therefore, a great potential seems to be here for the TWI methods, which application is a sort of return to the roots of lean initiative. TWI methods focus on the development of supervisors' basic skills, without which successful Lean implementation is hardly possible. In opinion of authors of this paper it is the TWI methods, whose renaissance can be now witnessed, that will constitute a powerful weapon against reverting back to old ways and prevent failed implementations.

It is optimistic that more and more companies in Poland are turning to A3 reports and their underlying way of thinking. Authors of this paper based on their experience, predict further, dynamic increase in A3 method usage in Poland, not only as a tool of reporting or project presentation but also as a dominant method of change management. It is apparent that also in our country A3 reports are more

and more widely practiced for example in corporate strategy development, which is done by creating the so called cascade structure of A3 reports (reports are prepared at different levels of company organization and tied together by objectives and tasks).

Most likely, in companies at medium level of Lean implementation not only TWI and A3 method will be popular but also standardized work in many areas (shop floor, line management, executive management, offices and administration) as well as advanced Lean techniques. We forecast significant growth of dedicated tools, adapted to the needs of specific industry sectors (for example Glenday Sieve and other tools for process industry, Lean in job shop type of production, tools adapted to the needs of highly automated processes).

It is also optimistic that the number of Lean implementations is significantly growing in such industries as furniture manufacturing, medical and pharmaceutical (despite serious limitations resulting from rigorous GMP principles). In addition, food industry in Poland is showing strong interest in Lean as well. At present, construction sector with its specific nature and limitations and heavy industry may be labeled as beginners in Lean.

In the forthcoming years, we predict a significant growth of Lean in offices and administration, standardization and improvement of processes related to information handling and any documentation creation [10]. Banks, accounting shared service centers and accounting firms will make use of lean management good practices to a larger extent than ever before. In addition, we observe the first results of Lean implementation in product design and development as well as dissemination of lean methods in services.

The last decade has shown how Lean Manufacturing may help increase operational efficiency made up of production process efficiency, support process efficiency and office process efficiency. However, even the most efficient company has no guarantee of surviving on the market. To be successful the company needs to:

- offer products that really meet customers' expectations;
- rapidly modify corporate strategy in response to technological, legal and market changes;
- implement efficient delivery and distribution chains.

The key issue is whether the company offers products or services that customers expect. For example Japanese car manufacturers (such as Mazda or Subaru) offering high reliability SUV vehicles in Europe do not have on offer powerful yet economical diesel

engine cars. Many European customers, due to either economic reasons or fashion, simply do not accept high fuel consumption in large petrol engines. Thus, the key to success is to focus on the first lean principle, that is defining value for customers. This principle is not fully put into practice even by companies well advanced in lean approach implementation.

Another critical issue is a good strategic management. It is the corporate strategy that determines a long-term success. Yet, in many companies strategic planning is ineffective and often neglected. In the course of research done by Lean Enterprise Institute Polska in collaboration with 12 European research centers within the framework of FutureSME project [11], problems with strategic management have been identified as the main obstacle in the development of medium-size European manufacturers. The problem lies in the fact that nowadays strategy planning needs to be different from what it used to be. Changes in economic and technological environment occur so rapidly that to keep up pace with them changes in corporate strategy need to be introduced sometimes even several times a year, in between yearly strategic plan establishment/ modification sessions. To make it possible, an efficient environment scanning process is needed to immediately identify the changes in customers' expectations or legal regulations as well as the emergence of new technologies. However, it is not enough. Identified changes which have a considerable impact on the company need to be incorporated in the strategy as fast as possible and translated into operational processes. This requires a very efficient process of change management and continuous improvement. Such more frequent and faster strategy modification cycles will be possible only thanks to appropriate organization and improvement of strategic management process. It is this area that, along with market needs analysis, will in our opinion be the main field of research into new applications of Lean Management approach.

The third area which will be gaining importance in subsequent years is supply chain remodeling. Nowadays, supply chains are "stretched out" and in some industries key suppliers to domestic plants are located in China, which practically renders impossible a flexible response to demand changes without increasing costs of logistics. Over the last year there have been more and more signals from big manufacturers that they are likely to transfer their supplier or manufacturing base back to Europe, which will be beneficial mainly to Central-East Europe. On the other hand, supply chains have a great improvement potential, in terms of both better integration with suppliers and implementation of lean approach

in distribution and sales (including sales leveling or better orientation on the service process that meets customers' real needs rather than on the product itself).

References

- [1] Rother M., Shook J., *Learning to see. Value stream mapping to create value and eliminate muda*, Lean Enterprise Institute, Cambridge, MA, USA 2003.
- [2] Rother M., Harris R., *Creating continuous flow. An action guide for managers, engineers and production associates*, Lean Enterprise Institute, Cambridge, MA, USA 2001.
- [3] Smalley A., *Creating Level Pull. A lean production-system improvement guide for production-control, operations, and engineering professionals*, Lean Enterprise Institute, Cambridge, MA, USA 2004
- [4] Harris R., Harris Ch., Wilson E., *Making materials flow: a lean material-handling guide for operations, production-control, and engineering professionals*, Lean Enterprise Institute, Cambridge, MA, USA 2003.
- [5] Jones D., Womack J., *Seeing the whole: mapping the extended value stream*, Lean Enterprise Institute, Cambridge, MA, USA 2003.
- [6] Horbal R., Misiurek B., *On-job training. TWI method – Training Within Industry*, Magazyn Przemysłowy, 8–9, 2009.
- [7] Wrona B., Graupp P., *The TWI Workbook. Essential Skills for Supervisors*, Productivity Press, New York, NY, USA 2006.
- [8] Koch T. et al., *Lean beyond production, Proceedings form 8th International Lean Management Conference*, Lean Enterprise Institute Polska, Wrocław 2008.
- [9] Shook J., *Managing to learn*, Lean Enterprise Institute, Cambridge, MA, USA 2009.
- [10] Grycuk A., *Lean government – lean management concept at public administration*, Analysis of The Bureau of Research at Chancellery of the Sejm, No. 3 (47), February 4th, 2011.
- [11] <http://www.futuresme.eu>