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INTEGRATION OF LEAN MANAGEMENT WITH ISO MANAGEMENT SYSTEMS IN ENTERPRISE

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Abstract
Lean manufacturing [LM], quality management system and environmental management system are clear initiatives with a goal of improving effectiveness and efficiencies of organizations. Many organisations tackle lean philosophy, ISO standards individually but this kind of attempt do not focus on the synergy and the advantage from the potential collaboration. This paper aims to present the possibility of integration Lean Management concept with ISO management systems – Quality Management System [QMS] ISO 9001and Environmental Management System [EMS] ISO 14001 already implemented in the enterprises. The integration of these three concepts can be obtain due to improvement of main KPI's defined in the organization. Based on critical research literature and participant observation presented as a case study (one of the author of the paper works as a consultant and is being implemented Lean Manufacturing concept in different organization since ten years) authors defined concept of integration of EMS and QMS (already implemented in the organization) with chosen Lean Management tools. Concept has been developed based on literature analysis and experience of the authors. Results and summary from concept implementation has been described in last chapter of the paper.

Keywords
Lean Manufacturing [LM], Quality Management System ISO 9001, Environment Management System ISO 14001, lean tools, improvement.

Introduction

ISO management systems are widely used which which may be supported by statistical analysis regarding the number of certifications presented in the paper. Their implementation is not only dictated by the desire to meet the requirements of the most important customers but also the ability to organize and improve internal processes in the organization. According to ISO definition ISO management system is understanding as what the organization does to manage its processes, or activities in order that its products or services meet the organization's objective, such as satisfying the customer's quality requirements, complying to regulations, or meeting environmental objectives [1]. In authors opinion the implementation and maintenance of management systems (including their integrated form) does not guarantee the efficient functioning through the organization. An extremely important element of any implemented management system is its improvement [2]. The improvement, if the ISO management system is already implemented, should be understood as the form of changes for the better – it is worth to mention the words of Heraclitus from Ephesus that: "The only constant thing in life is a change". Referring to Heraclitus words only organizations learning by change management are able to gain long-term competitive advantage by continuously improving the efficiency and effectiveness of their processes.

Nowadays one of the common way to improve the efficiency and effectiveness of processes in the enterprises is Lean Management concept. As a result of that, Lean has more and more separate con-

cepts which depends on the area of its application: Lean Healthcare, Lean Logistic, Lean Development, Lean Supply Chain, Lean Customer Service, Lean Accounting, Lean Administration, Lean Office, Lean Distribution. Many areas of application of Lean have inspired the authors of the paper to explore the possibilities of integration the Lean Management with ISO management systems. The paper is based on comparative study of Lean Manufacturing and the ISO management systems using available literature, critical analysis, knowledge and professional experience of the authors and case study presented in the last chapter of the paper. ISO systems were chosen based on statistical analysis of numbers of certificates which is published every year by the International Organization for Standardize [ISO].

ISO management systems – statistics

ISO published statistics including the amount of certifications of different ISO management systems in global and country-by-country formats. In order to compile the information in the survey ISO contacts the accredited certification bodies and request information about the number of valid certificates they have at 31 December 2016. A summary of the 2015 and 2016 results are shown in Table 1. Data for 2017 year haven't been published yet.

Table 1
Number of certification – worldwide review [3].

Standard	Number of certificates in 2016	Number of certificates in 2015	Difference	Difference in %
ISO 9001*	1106356	1034180	72176	7
ISO 14001**	346189	319496	26693	8

* ISO 9001:2008 (=105761) + ISO 9001:2015 (=80596)
** ISO14001:2004(=32023) + ISO 14001:2015 (=23167)

Number of certifications in Poland.

Standard	Number of certificates in 2016	Number of certificates in 2015	Difference	Difference in %
ISO 9001	12152	10681	1471	13.77
ISO 14001	3184	2798	386	13.80

The management systems worldwide are: ISO 9001 Quality Management System, ISO 14001 Environmental Management System, ISO/TS 16949 Particular requirements for the application of ISO 9001 for automotive production and relevant service part organizations and ISO 22000 Food Safety Management System. The highest percentage increase in the number of certifications was noticed for the two ISO systems: ISO 5001 (energy management system) and ISO 20000-1 (IT management system) [2].

According to the data presented in Table 1 it shows that in Poland the number of certifications increased for all ISO standards. Due to the fact that in Poland, but also in the world, the highest number of certification was noticed among two management systems:

- **ISO 9001** – quality management system [QMS],
- **ISO 14001** – environmental management system [EMS], in the next part of the paper, authors focused on systems mentioned above.

Requirements of process improvement including in ISO 9001 and ISO 14001

Opportunities and requirement for improvement may be desired form any source and any level of organization, many business desired their improvements from three areas: corporate strategic objectives which can be connected with KPI's, customer expectations and industry standard, interests forces [4]. Continuous improvement is defined as making systematic efforts aimed at finalizing an using new ways of conduct to actively and repeatable take initiative to introduce changes [5].

ISO 9000:2005 indicates that "[...] improvement is part of quality management aimed at increasing the ability to meet quality requirements. Requirements may relate to any issue such as effectiveness, efficiency or traceability" [6]. On the other hand, ISO 9004:2009 indicates that "[. . .] improvement becomes part of an organizational culture by providing people with the opportunity to participate in the organization by enhancing their empowerment, establishing a recognition and reward system for improvement" [7]. The rate, extent and timescale of actions that support continual improvements are determined by the organization. Environmental performance can be enhanced by applying the environmental management system as a whole or improving one or more of its elements [8].

The issue of improvement of the quality management system ISO 9001:2015 and environment management system ISO 14001 was included in point 10 of the standards – Improvement – has three subclasses: general, nonconformity and corrective action, continual improvement. New ISO 9001:2015 and ISO 14001:2015 standards requirements encourage organization too not only improve products and services to meet known requirements, but also to predict and address "future" needs and expectations of the customers.

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To better understand the "changes for better" in activities organization can be supported by the kit of main KPI's which should be relevant to mail strategy objectives.

A new requirement is to update the risks and opportunities determined during planning, if necessary. Another new requirement is to make changes to the quality management system, if necessary. The organization must continually improve the suitability, adequacy, and effectiveness of the quality management system.

Due to process of enhancing compatibility in new standards revision of ISO 9001 and ISO 14001, the requirement referring to improvement process has the same content for both standards.

In the ISO 14001 the "continual improvement" concept is aimed at improving on a regular basis the overall environmental management system. ISO 14001 requires to evaluate the organization's interactions/impacts with the environment. Following this evaluation each impact is ranked based upon its significance. The most significant interactions/aspects are then addressed within the frame of the environmental management system. Under the "continual improvement" concept the organization is attempting to continually reduce its interaction/impact upon the environment. The requirements of continual improvement could be fulfilled by the reduction of environment impact which can be visible as changes in main KPI' defined in ISO 14001. New requirement of norm ISO 14001 is risk-based thinking, so it means that preventive action should be converted into risk management systems.

Lean Management – definitions and tools

The Lean concept is derived from the thinking and behavior of the Japanese Toyota company. The foundations of this system were born in Toyota at the turn of the 1940s and 1950s. The precursor of thinking about how lean manufacturing production was the chief engineer of Toyota, T. Ohno.

In Poland, the first compact publication on Lean Management appeared in 2001 (Lean Thinking, Womack and Jones). The most famous Lean interpretation in management is the definition of Womack, Jones, Roos: "Slim production is slim because it uses less of everything, less mass production – half the human effort at the factory, half the production space, half the investment in tools, half the engineering work to develop a new product in a shorter time. It also requires less than half the inventory, leads to fewer errors and produces a larger, constantly growing product range" [9].

In this paper the authors deliberately use the term Lean Manufacturing instead Lean Management due to case study provide in manufacturing enterprise. According to Walentynowicz [10] Lean Management and Lean Manufacturing are two equivalent names for the same idea. The only difference the author sees is the way of interpretation. Lean Manufacturing is perceived as a specific method of managing only a manufacturing company, and Lean Management is recognized as a management concept for different types of businesses.

Martines-Jurado et al. [11] indicate that the successes of lean transformation depends on the application of the tools and techniques and to ensure the sustainable benefit by focusing on the human resources and culture that sustains lean transformation. In this paper Lean Management is defined as a set of tools and techniques helping organizations eliminate non-value added activities through all their processes. In this meaning lean tools are: Value Stream Mapping (VSM), Standard Work, Poka-Yoke, 5S visual management, Kanban system, Total Productive Maintenance (TPM), Single Minute Exchange of Die (SMED) [12–15].

Empirical studies conducted in Poland and abroad relating to Lean Manufacturing, concern mainly: the effects of its implementation and impact on key indicators of productivity, conditions of effectiveness of the implementation, the impact on the financial effects of the organization, possible use in non-profit organizations such as hospitals, schools, offices, the possibility of creating conceptual hybrids such as Lean SixSigma, etc. [16–18]. Classification of the core research areas of the Lean Manufacturing [LM] concept includes: LM structure and areas, LM deployment conditions, LM implementation methods, LM evaluation methods, LM implementation results in organizations, and adoption of concept requirements in various industry sectors [19–21].

The perception of the concept of Lean Manufacturing is subject to significant extension – it relates to methods and tools [22], application areas, organizational forms and levels of management. This paper is another attempt at exploring new areas of application for the Lean Management concept, this time in improving ISO management systems.

ISO management systems juxtapose with Lean Manufacturing

The large number of methods and tools for improving the ISO management systems are de-

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scribed in the literature [23–25] Authors were analyzed literature and has been listed below (Table 2) these publication were elements of Lean Manufacturing were juxtapose with ISO management systems.

In the literature study on integration ISO systems with Lean are not widely provide, therefore authors came across a limited number of publications on the above mentioned subject. There is lack of thorough research carried out in a group of Polish companies. Research concerning integration of environmental management system ISO 14001 with elements of Lean was a subject of paper Wirkus and Chmielarz [33]. Authors presented impact of Lean Manufacturing tools on environment using value added for environment [VAfE] concept. Researches were provided in four big enterprises situated in north of Poland.

Table 2
Methods and tools for improvement of ISO management systems which indicate individual element of Lean Manufacturing concept.

Authors	Lean Management and improvement ISO management systems
T. Borys, P. Rogali (2012) [26]	The authors have identified Lean Manufacturing concepts as a methods and tools for QMS improvement, including: **5S, Just in Time, Poka-Yoke**. Authors as a method of quality improvement have also defined Lean Management, which was characterized as a concept aimed at "leaning" organization, and thus to optimize cost levels and their share in the price of products, improve their ability to adapt to market changes.
A. Chiarini (2011) [27]	He found that in general, lean thinking implementation affects documentation of ISO 9001, such as quality manual, procedures and work instructions. Furthermore, tools and principles such as **value stream mapping**, **lean metrics, 5S and takt time** are the most used inside the 107 companies researched. **Jidoka** and **total productive maintenance** are those that have been more formalized into ISO 9001 documents.
M. Wirkus, A. Chmielarz (2012) [28]	**Value Stream Mapping** has a potential to create value added for environment [VAfE]. This value is creating during analyzing wastes in values stream and can be used during process of improvement of ISO 14001.
W. Urban (2014) [29]	You cannot allow to separate both systems: ISO 9001 and Lean. The separation of both systems must lead to "muda" ("muda" is a key concept in Lean, which means waste). First, it should be noted that both ISO 9001 and Lean systems are complementary to each other. **This observation should be the basis for their integration**. It should be noted that ISO is committed to identifying and strengthening standard business practices, while one of Lean's more difficult tasks is to sustain sustainability improvements at various locations throughout the company. This is the first point of complementarity that can form the framework for integrating the Quality Assurance with Lean.
P. Puvanasvaran, R.K.S. Tian, V. Suresh, M.R. Muhamad (2012) [30]	[...] the highest lean production practices in the ISO 14001 certified company are **Continuous Improvement (Kaizen**). This is followed by **Just-In-Time. 5S'** and **General Visual Management and Standardized Work** . It follows by **Zero Defect**. Other than that respondents have adopted **Total Preventive Maintenance (TPM)** in the companies. It is followed by **Pull Production and Kanban**. Authors found that there was a significant and positive relationship between Lean Principles: value, value stream, flow, pull and perfection with the ISO 14001 requirement.
Amjad Khalili, Md Yusof Ismail, A.N.M. Karim (2015) [31]	There is a positive and significant relationship between the implementation of Lean manufacturing tools and the effectiveness of QMS ISO 90001 in the Malaysian Manufacturing Industries – authors observing and measuring the impact of 11 LM tools on the QMS implementation with eventual contribution to operations management by focusing on hard LM aspects and their interrelationships with QMS in one integrated model. **Lean Manufacturing** can help provide the process improvements that are required by the **ISO 9001**.
S. Gajendran, S. Sampath Kumar (2011) [32]	Integration of Lean Manufacturing and QMS has enabled a Lean compatible quality management system **(LCQMS)** which is built simultaneously thereby avoiding duplication in efforts. Authors propose manual guidelines which include **ISO 9001** requirements listed on one side and the corresponding LMS principles. This will serve as a guide for any new plant that intends to implement QMS and LMS simultaneously.

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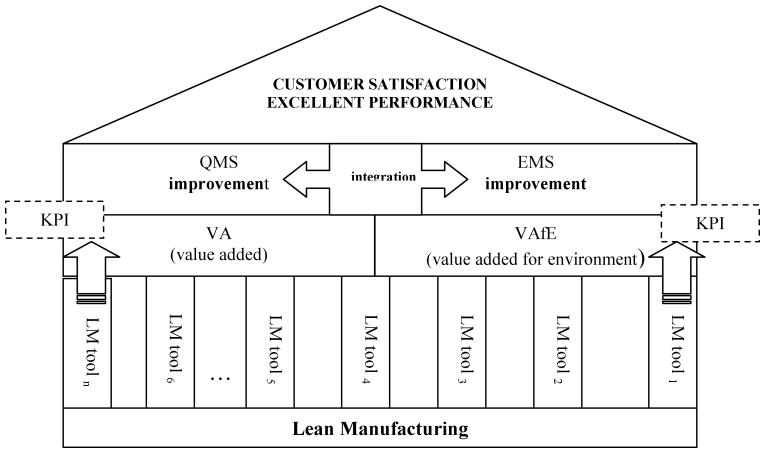

Fig. 1. Concept of integration EMS and QMS system with Lean Manufacturing tools.

Role of Lean Manufacturing in QELM – Quality, Environment and Lean Manufacturing Integrated Systems

Based on the discussed proposition, an integrated concept was developed for QMS (Quality Management System), EMS (Environment Management System) and LMS (Lean Manufacturing System). The concept identifies the possible linkages between three concepts as depicted in Fig. 1.

Main purpose of integration concept of QMS and EMS with Lean Management tools is to get synergy from simultaneous implementation and operations of the three mentioned systems. In this conception (Fig. 1) Lean Manufacturing tools are recognized as these which by implementation might change non-value operations into value added operations in case of QMS and might generate value added for environment presented in next chapter of the paper [27].

In both cases (quality and environment systems) value added is generated during implementation and maintaining tools of Lean Manufacturing – scope of value added depends on proficiency in implementation of Lean tools and managers orientation into continuously increasing the efficiency of organization processes. It can be stated that the improvement of QMS and EMS systems is determined by the ability of generating added value individually by single Lean Manufacturing tool.

Case Study – Improvement of ISO management systems by chosen Lean Manufacturing tools

The case study is based on the implementation of selected Lean Manufacturing tools in one of the world corporations providing product solutions in the field of electrical engineering, electronics, robotics and electrical engineering. The researched enterprise is situated in north of Poland. The company has implemented and certified environmental management system ISO 14001 and quality management system ISO 9001.

The company was implementing Lean Manufacturing in 2010–2015, by the implementation the various tools of the Lean concept, beginning with the analysis of internal processes using Value Stream Mapping [VSM].

Value Stream Mapping, in the described case study, at the beginning was prepared for one of the chosen family of product (pilot production process). First, group of workers had to draw the current status map. While the group was created map, they discovered a huge amount of muda. Based on points to be improved, group of workers designed future state map including Lean Manufacturing tools which should be implemented in the near future. They chose – Kanban System, 5S, TPM, SMED. Value Stream Mapping allowed to discovered unnecessary transport (related with the CO2 emission indicator) between production site and warehouse. Additionally semi-products were packed into cardboard although they were used in few days for final products. As a first point, group took a decision to replace cardboard with plastic boxes and keep small stock (kanban stock) in production zone, close to final assembling workstation. Due this fact – number of cardboard was defined as a one of indicator dedicated to environmental aspect, the positive changes was recorded in performance of ISO 14001 system. Value Stream Mapping allowed organization better understand the production process and replace push-system into pull-system based on Kanban supported

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with Heijunka. It allowed to shorter delivery time and improve sOTD (standard OTD) measured as a one of indicators defined in QMS system.

Kanban system which was implemented as a last part of VSM included: production kanban, withdraw kanban and phantom kanban (visual kanban without supporting of ERP system). Implementation of Kanban system allowed to reduce lead time for final products. Shorter lead time meant lower stock of final products. Calculation of number of kanban card in the loop allowed to reduce stock of semi-products and materials. Organization defined new point of customization and therefore reduced stock of semi-products. While Kanban system was implemented it was also time for review contract with the suppliers. It appeared that stock values weren't calculated from long time and didn't include new delivery times from suppliers and actual demand for material (AMD – average monthly demand).

To better managed Kanban system it was necessary to implement **5S** (defined by the authors as a good practice on workstations including Kamishibai board and work standardization). At the beginning of 5S implementation level of wastes was bigger as it was expected. While it was made selection it was appeared that on many workstations operators kept non controlled "old" stock of material and semi-products which in the past had an impact on claim rate and poor quality indicator. Well defined and described places after 5S implementation supported Kanban system – everything is on place and everything has a place. Implementation of 5S reduced number of wastes, improved quality and safety level (from workplaces were removed all unnecessary constructions: as old furniture, racks, trolleys, etc.) One of the biggest mini-project in 5S was dividing production zone for smaller production nests. New zones has their own lighting and fume absorber which allowed reduce energy consumption (defined as one of the environmental aspect in ISO 14001). It was not necessary to keep all device turn on while only few soldering workstation were used during the night shift).

Implementation of 5S was the corner stone for further **TPM** and SMED implementation. As a main target for TPM, it was implementation of autonomous maintenance and reduction of OEE (Overall Equipments Effectiveness). While TPM (at the beginning only pilot machines) was implemented, the level of OEE was improved from average of 63% up to 88%. This results was achieved mainly by increasing the availability (breakdown time reduction and elimination of micro-stops) and reduction of quality level. It was observed lower energy consumption due to fact better efficiency of the machines. Reliability of the machines allowed increase sOTD level almost up to 95%. As a last part of Lean Manufacturing implementation, organization took a decision to reduce standard changeover time for the most critical machines (from the time, quality and cost perspective). Workshops **SMED** were carried out on molding machines as the changeover time was defined as ∼70–80 minutes. This time was not acceptable due the fact Kanban implementation/Heijunka. Heijunka needs to be supported by the flexible production systems where changeover time is reduced. SMED workshops allowed reduce changeover time to 20 minutes for (molding machines). It had impact on sOTD but also on wastes generation during the changeover. As a results of SMED workshops, organization took a decision to change way of molds cleaning replacing solvents into ecological cleaner which is using a closed circuit cleaning agent. New way of molds cleaning helped reduce cleaning time (as one of the operation in changeover time) and has an impact on reducing wastes (defined as environmental aspect in ISO 14001).

In the case study authors explored the added value and added value for the environment created during the implementation of Lean Manufacturing tools. The added value was expressed in the form of positive changes in the main indicators of organization's effectiveness – Key Performance Indicators [KPI]. The most important indicators of QMS [in acc. with ISO 9001] were defined as:

- KPI_1 – timely deliveries of orders to the customer – OTD [%],
- KPI_2 – stock value in the form of material, semi-products and final goods [EUR],
- KPI_3 – number of external complaints [number of events].

The implementation of individual Lean Manufacturing tools in the long term has increased the effectiveness of the organization's processes, what has been reflected in the changes of main KPI's assign to quality management system – Table 3. Information included in Table 3 and 4 was defined as a result of participant observation – one of author of the paper has been working in researched company for eight years (2008–2016). As a manager of engineering department was responsible for implementation Lean Manufacturing and as an internal auditors was auditing quality and environmental management systems.

The value added for environment [VAfE] created by particular tool (were presented in Table 3) as a positive change of an indicator assigned to environmental aspect defined in the researched enterprises.

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The most important indicators of EMS [in acc. with ISO 14001] were defined as:

- KPI_4 – number of usage of media, including energy, water and gas/volume of production [kWh/pcs],
- KPI_5 – number of generated waste by codes [t],
- KPI_6 – number of used cardboard packages [t],
- KPI_7 – number of dangerous situation recorded [number of accidents].

Common indicator for both systems ISO 9001 and ISO 14001:

- KPI_8 – cost of poor quality (as scrap from processes) – COPQ [EUR].

Table 3
Impact of implementation of Lean Manufacturing tools on main indicators defined in quality management systems.

Lean Manufacturing Tools	ISO 9001
Value Stream Mapping	$\uparrow KPI_1$ $\downarrow KPI_2$
System Kanban	$\uparrow KPI_1$ $\downarrow KPI_2$
5S (including standard work and Poka-Yoke)	$\downarrow KPI_2$
Total Productive Maintenance	$\downarrow KPI_1$
Single Minute of Die	$\uparrow KPI_1$

Table 4
Impact of implementation of Lean Manufacturing tools on main indicators defined in environmental management systems.

Lean Manufacturing Tools	ISO 14001
Value Stream Mapping	$\downarrow KPI_6$ $\downarrow KPI_5$
System Kanban	$\downarrow KPI_6$
5S (including standard work and Poka-Yoke)	$\downarrow KPI_8$ $\downarrow KPI_7$ $\downarrow KPI_4$
Total Productive Maintenance	$\downarrow KPI_4$
Single Minute of Die	$\downarrow KPI_4$

The implementation of the individual Lean Management tools contributed to positive changes in the organization and its processes, as a results in the positive changes in the key indicators of the quality management system and environmental management system – table 3 and 4. The observed changes in KPI's may be a prerequisite to the hypothesis that selected elements of Lean Manufacturing might be integrated with quality management system ISO 9001 and environmental management system ISO 14001 to get effect of synergy.

Conclusions and discussion

In the paper the authors tried to demonstrate that the concept of Lean Manufacturing can be successfully used to get synergy effect, and while improving operations, can support ISO management systems (QMS and EMS with the fulfillment of improvement requirements) already implemented in enterprise. Statistics presented in the first part of the paper indicate that these two systems are enjoying a great popularity both in Poland and in worldwide. After their implementation and certification, one of the most important requirement of ISO management systems is their improvement. Main indicators defined in the organization certified with ISO support organization with the knowledge of current improvement. Improvement of management system ISO 14001 and ISO 9001 is oriented to improve performance (business indicators) as a results of QMS and EMS [1, 35]. To obtain targets and be more effective, organizations can use Lean Manufacturing tools to improve performance (quality and environment). This improvement can be achieved by removing from organization non value added operations and by generating value added for environment.

Presented case study can be premise to provide common research among group of enterprises which have already implemented three systems: QMS, EMS and LM. The next research issue will be focused on integration of Lean and ISO management systems into a coherent, not conflicting, management system.

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