www.ceejme.eu
www.wsb.pl/wroclaw/ceejme

ISSN electronic version 2353 - 9119
Central and Eastern European Journal of Management and Economics
Vol. 5, No. 4, 117-128, December 2017

CEEJME
Central and Eastern European Journal of Management and Economics

Types of waste analysis in the production departments in one of the companies from the transport industry

Damian OSTROWSKI, Jacek JAGODZIŃSKI
WSB University in Wroclaw, Poland

Abstract:

Aim: The paper is concerned with two issues. The first one involves the identification of waste types existing in Polish production companies – to this end, one large company was examined. The second aspect of the research attempts to answer the question whether there exists a relationship between the company's departments and waste categories.

Design / Research methods: A large company (with over 250 workforce) producing railway rolling stock was analyzed based on a survey. It was substantiated in what context the findings obtained on the basis of the company are reflected in the market evaluation. Statistical tests were used in the evaluation whether relationships were present between the company's individual departments and the type of waste identified.

Findings: In the context of waste identification it was found that the crucial faults include waiting (present in 38,1% of all processes), next defects, 22.5% and unnecessary motion 19%. Statistical tests showed that there was no relationship between the types of waste and individual departments – various aspects of work are associated with the same problems.

Originality: Although there are numerous studies in literature which indicate the main barriers affecting continuous improvement in foreign companies, the number of studies concerned with the situation in the Polish transport industries is very small – the paper seeks to fill in this gap. The information on the types of waste and their characteristics in diverse departments has a critical impact on choosing the suitable method for company management.

Keywords: continuous improvement, barriers, advantages, Kaizen, waste
JEL: D22, L23, L62

E-mail: damian.ostrowski@wsb.wroclaw.pl
http://dx.doi.org/10.29015/ceejme.656

1 . Introduction

In the process of continuous improvement of organizations and processes, the identification and elimination of any type of waste is becoming of key importance. The reason for undertaking the study presented in the paper was to explore the relationship between the type of waste and organizational department. The first section of the paper outlines a theoretical approach to waste which is followed by the survey results. The last section describes an analysis of the relationship using test χ^2 . The paper ends with a brief summary.

According to the research findings in the United Kingdom, nearly 30% of structures manufactured in the industry is reprocessed because of defects, which is then reflected in productivity level at 40-60%, with a 10%-level of waste in materials. For Australian enterprises the costs of rectifying defects in a process amount to 35% of the overall costs of projects (Aziz, Hafez 2013: 682). According to the research on the world's companies, the overall labor effectiveness (OLE) falls within the range between 30% and 90%, with the result at a level of 50% being considered a very good performance, as researchers suggest (Fernandez 2015: 14). In the case of the company under study, it was evaluated at a level of around 19%, thus showing a large potential for improvements (Jagodziski, Ostrowski 2016: 201 – 214).

2. The concept of waste – a theoretical perspective

"Waste means every action which requires work effort and yet fails to create value, with the value being understood as the final value for the consumer." (Łazicki 2014: 8). This implies that the consumer's point of view is seen as overriding and only these actions which bring added value in the production process are not considered to be waste. "Not only does waste increase costs, but it also extends the production time of goods, delaying their delivery to the consumer. Besides, it prevents the organization from using its resources efficiently." (Kubik 2010: 12). It is assumed that waste can account for 90% of activities performed in an organization (Bednarz 2013: an Internet source). The Japanese word for waste is "muda", which denotes a variety of activities failing to add value. According to Kaizen philosophy, in the place where a process is implemented there are only two kinds of actions: those adding value and those failing to do so. The elimination

of waste is a shorthand for introduction of changes that is reasonable and does not require high costs (Imai 2006: 31).

The theory distinguishes eight types of waste:[1] (Kornicki, Kubik 2008: 22-25)

Overproduction – means production of unnecessary products, at a wrong time and in unnecessary quantity. It occurs when goods are produced for which there are no orders.

Inventory – overproduction leads to increased inventory. Inventory includes any kind of goods which have been stored for any length of time in the facility or outside. While combating waste, inventories are considered to be a symptom of a disease. Excessive inventory are symptoms of various much more serious problems that need to be overcome.

Transportation – the more inventories, the longer their transport. Transportation is referred to as any form of moving around or delivering from one place to another raw materials, assembly parts or finished products for any reason.

Defects – the waste associated with defects encompasses faulty products, quality control costs, responding to customer complaints and repairing defects. They all increase together with another defect. The most important causes of defects include human errors and differences in machinery set-up during subsequent operations. The size of waste linked to defects can be determined based on the number of customer complaints and also by the growing number of faulty products detected during control. An increased number of defects brings about an increase in the number of controllers, which is to prevent faulty products from getting through to the customer.

Excess processing – excess processing are all those operations and processes whose performance may be unnecessary. An increase in the number of defects could result from incorrect or outdated operations or processes. Excess processing and defects may, in turn, result from working time extension, lack of workforce proper training and work standardization.

Unnecessary motion – motion waste is similar to excessive processing, with the difference that it is more likely to refer to movement of workers. Unnecessary motion is such that is not really needed to perform an operation. It also includes gestures which are too slow, too fast, excessive or clumsy.

[1] The type of waste presented in the paper refers to production processes, as different terminology exists with respect to the management of services; the authors do not present this approach given the nature of the survey which focused on a production company.

Waiting – this type of waste refers to the time length people as well as machines have to wait. There may be a number of reasons for having to wait, such as delays, moving goods in transport, machinery breakdown and too fast (or too slow) work of machine operators.

„**Unused employee creativity** – losing time, ideas, skills, improvements and learning opportunities by not engaging or listening to employees." (Liker, Meier 2011: 63)

Taiichi Ohno, the pioneer of the Toyota production system, emphasizes that the worst type of waste is overproduction. "Overproduction is the main root of all manufacturing evil generating losses in other areas" (Imai 2007: 114). Continuously seeking to eliminate waste has the effect that an organization is becoming "lean", i.e. stripped of actions, things, events, etc. which do not add any value to a specific process. Organizations which set as their objective the process improvement strive to lower costs permanently, to achieve zero errors, zero inventories, etc. To be sure, they will never reach the point at which all types of waste will be 100% eliminated, yet a constant search for finding solutions to eliminate muda generates unexpected results (Womack, Jones et al., 2008: 14). Japanese people are considered to be pioneers of effectively combating waste, trying for 50 years to eliminate any types of muda and create a system which will be capable of manufacturing products, providing services at a perfect level right "at the first time", rightly assuming that this is the only way to a permanent reduction of costs. Edward Deming relates an anecdote which is an apt illustration of the difference in the way perfection and waste management are comprehended by organizations from the USA and Japan, "A certain American producer of computers being unsatisfied with one of his American suppliers decided to try suppliers from Japan. In his order, he wrote that he was expecting on average not more than four faulty products per every 10 000, which was in line with the military norm 105D, applied in the USA in those days. The Japanese accepted the order and sometime later the delivery arrived accompanied by a letter saying: "We, the Japanese, find it somewhat difficult to understand the US American way of doing business. The four faulty parts per 10 000 have been delivered separately. We hope that this would prove to be satisfactory to you (Blikle 2014: 40).

3. Aim and scope of the study

The company under study operates in the transport industry. It has a long tradition in the production of railway vehicles. Since 2001, the company has belonged to an international business

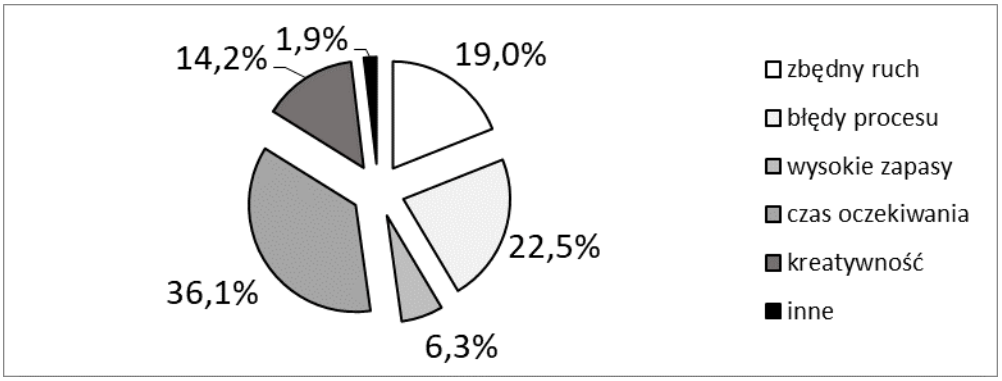
group based in Canada. The users of the products are transport firms from all over the world. The company in question, employs around 700 people, including 200 in administration units and around 500 as manual employees. The company is located in one of the biggest towns in Lower Silesian Province.

The aim of the study was to identify the types of waste present in production departments. The survey was carried out in March 2016. The target group encompassed 464 workers. 207 filled in questionnaires were returned, which made up 44% of all employees classified as production workers. Based on the number of employees thus determined, at a level of confidence assumed at 95%, the conclusion can be drawn at the maximum error being at a level of 5%. In the company, there are five production departments operating: Department Ramy (frames), Department Komponenty (components), Department Pudła (boxes), Department Malarnia (paint shop), Department Narzędzia (equipment).

4. Survey results

In the survey, respondents indicated in total 316 types of waste. With respect to production workers, 114 persons reported waiting time, 71 errors occurring in the process of performing an activity, 60 persons emphasized unnecessary motion, with 45 reporting unused creativity of employees. A detailed outline is presented in percentages in Figure 1.

Figure 1. Types of waste identified at the workplace – production workers

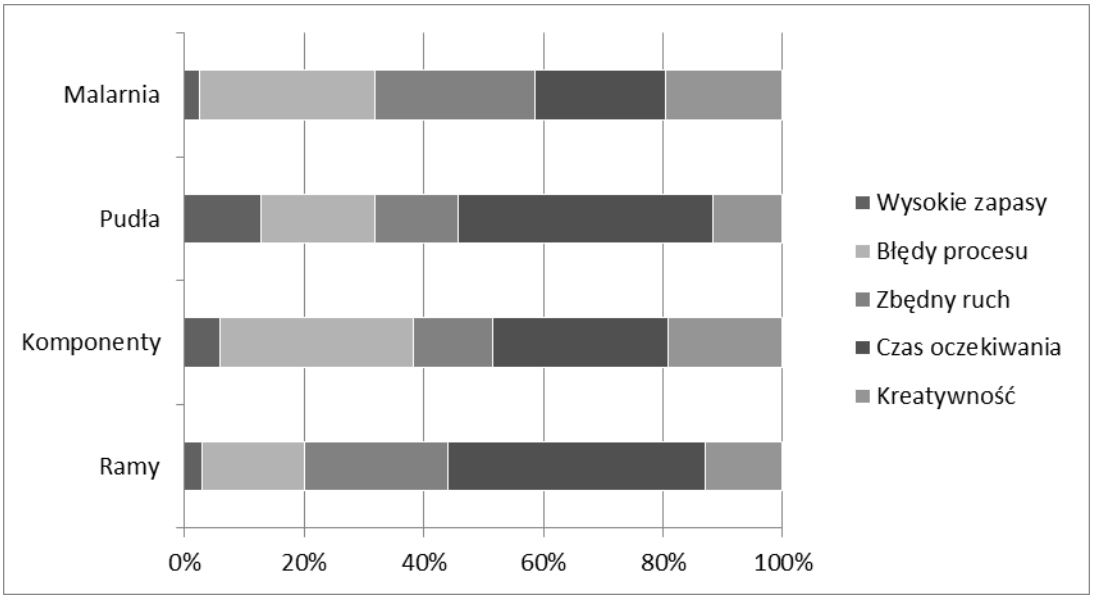


Source: self-reported data based on survey

Further on in the paper, the results of the study on identification of waste by the specific department operating in the company's structure were presented, taking into account shop-floor workers. The data are aggregated in Figure 2; owing to their small number, the following categories

were omitted: “other” and “Department Narzędzia (equipment)”, where only 7 types of waste were reported (the overall list see Table 2)

Figure 2. Types of waste identified in the workplace – by individual departments

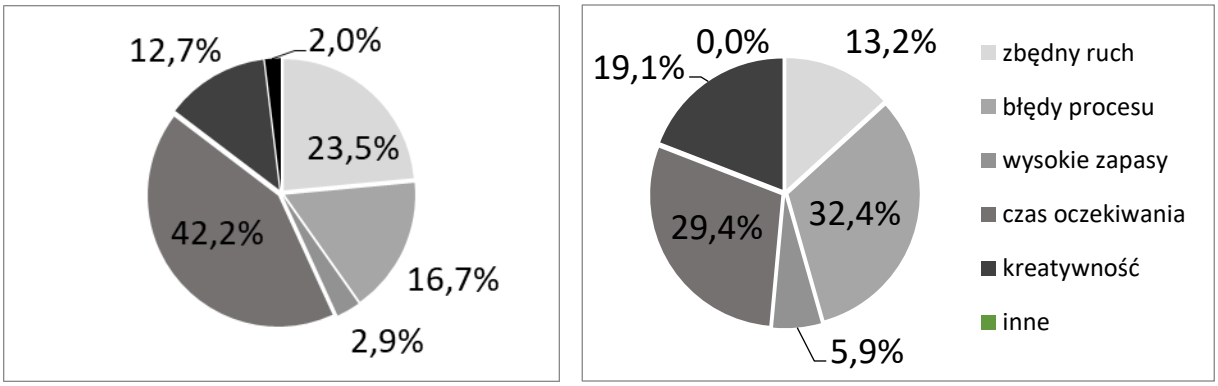


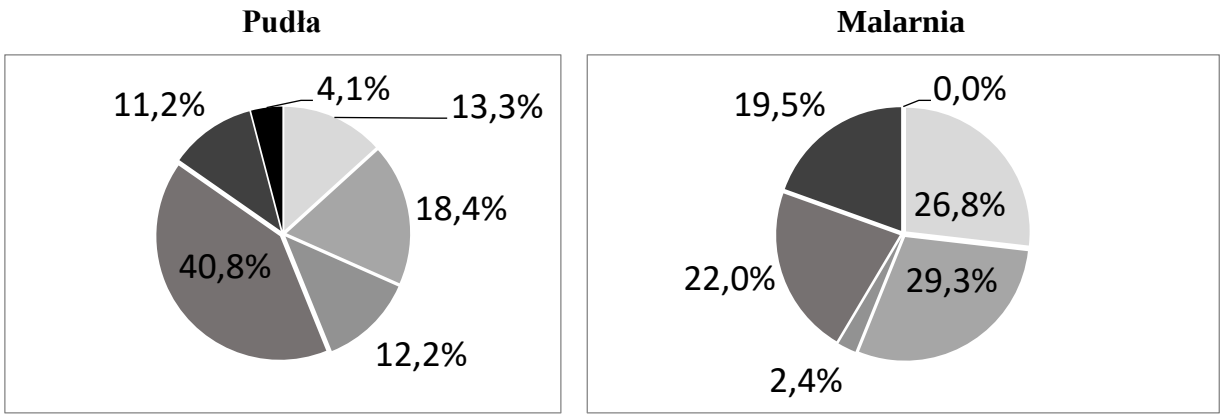
Source: self-reported data based on survey

The type of waste to be most likely identified was waiting time – in Department Ramy at 42.2% and Pudła at 40,8%. Moreover, in the two other departments, Malarnia and Komponenty, errors in the processes dominated (29.3% and 32.4%, respectively).

Figure 3. Types of waste identified by employees of individual departments

Ramy **Komponenty**





Source: self-reported data based on survey

The list of the percentage distribution of the types of waste for individual departments is given in Figure 3. It is worth noting that virtually in each department process errors and waiting made up about 60% of ineffective use of resources. For a better illustration of the types of waste in the organization surveyed, a matrix comparison is presented below. In addition, the reference to the types of waste presented in Section 1 of this paper was illustrated, too. In Table 1 the type of waste and its place from 1 to 6 is also showed, taking into account the frequency of occurrence, according to respondents' reports. This comparison clearly showed that waiting time (twice in the first place and three times in the second) was the type of waste to be most likely identified in the production departments. Process errors were reported in the second place, with unnecessary motion ranking third. The incidence of unused creativity was a fact worth highlighting (ranked 4).

Table 1. Matrix perspective of the types of waste together with their assignment to departments.

Reference to the types of waste	**2**	**4**	**6**	**7**	**8**	**-**
Waste	Excess inventories	Process errors	Unnecessary motion	Waiting time	Unused employee creativity	Other
Ramy	5	3	2	1	4	6
Komponenty	5	1	4	2	3	6
Pudła	4	2	3	1	5	6
Malarnia	5	1	3	2	4	6
Narzędzia	-	2	1	2	-	-

Source: self-reported data based on survey

5. Analysis of relationships between waste and the company's departments

Table 2 presents the results of the survey conducted in the company's individual departments. Respondents were asked to specify types of waste occurring within the area of their work, the muda indicated encompassed: unnecessary motion, process errors, excessive inventories, waiting time, creativity. The remainder of the categories, owing to their small number, was recorded as "Other".

Table 2. Identification of particular wastes in the company's departments

Department	Excessive inventories	Process errors	Unnecessary motion	Waiting time	Creativity	Other
Ramy	3	17	24	43	13	2
Komponenty	4	22	9	20	13	0
Pudła	12	18	13	40	11	4
Malarnia	1	12	11	9	8	0
Narzędzia	0	2	3	2	0	0

Source: self-reported data based on survey

Within the framework of the analysis, it was explored whether there existed a relationship between the types of waste and the company's individual departments. To this end, test χ^2 was used in which the starting hypothesis was that such relationship did not exist. The problem presented included a table with 5 rows and 6 columns, and thus it had 20 degrees of freedom; in which case the critical value of test χ^2 read from the tables, with the significance level assumed arbitrarily at $\alpha = 0{,}05$, was equal to $31{,}41$. Given the small number of responses, test χ^2 with Yates's correction was used, with the result at 25,58. This determined that there were no grounds for rejecting null hypothesis. In the case demonstrated, one can talk about relationships between variables only at a level of error at 18%. The result suggests that there is rather a uniform tendency for various types of waste to occur.

At this point it should be stressed that on the whole while examining different areas of the company it was rather a surprising finding, since it is hardly to be expected that all the company's departments would struggle with the same kinds of problems. In addition, one needs to bear in mind that muda types may be interpreted differently among a variety of activity areas. For example, excessive inventories in a production department may refer to raw materials as well as to products manufactured, while in a HR department it would be rather an excessive number of resources

representing an entry to the process (e.g. office supplies), as it would be difficult to talk at this point about overproduction of contracts, documents.

However, in the case of the company in question those production cells were explored which represented a similar class in terms of the company's operations. The result obtained suggests that there are certain general tendencies when it comes to the categorization of muda, with various types of process activity being associated with similar problems. Unfortunately it is this case where test χ^2 does not provide a clear answer to the hypothesis advanced. Given the lack of the overall relationship between departments, it was therefore decided to explore whether there existed relationships between pairs of departments. Showing that such synergy of certain areas of the company existed would require that diverse Kaizen methods be applied depending on the individual performers of the processes.

The results of the analysis are tabulated in Table 3. It presents, as before, the results of test χ^2 with Yates's correction and value α_{gr}, indicating the significance level which would allow the hypothesis on non-relationship to be rejected. Given the small number of responses, waste from the category "other" was not included in the test. The issue presented described the problem with 4 degrees of freedom, at a -5% -error threshold, the test critical value for this case was $\chi^2 = 9{,}488$.

Table 3. Results of test χ^2 between individual departments

Departments	**Ramy**	**Komponenty**	**Pudła**	**Malarnia**	**Narzędzia**
Ramy	x	α_{gr} = 9.606%	α_{gr} = 13.898%	α_{gr} = 27.525%	α_{gr} = 89.236%
Komponenty	χ^2 = 7.880	x	α_{gr} = 19.478%	α_{gr} = 67.237%	α_{gr} = 64.003%
Pudła	χ^2 = 6.942	χ^2 = 6.059	x	α_{gr} = 7.044%	α_{gr} = 70.149%
Malarnia	χ^2 = 5.120	χ^2 = 2.346	χ^2 = 8.651	x	α_{gr} = 79.039%
Narzędzia	χ^2 = 1.112	χ^2 = 2.526	χ^2 = 2.187	χ^2 = 1.702%	x

Source: self-reported data based on survey

The highest results of test χ^2 worth noting occurred for the comparison between the departments Malarnia –Pudła χ^2 = 8,651, and Komponenty-Ramy χ^2 = 7,880. Yet, the values were not sufficient for asserting the presence of a relationship at the error level assumed at 5%. In these two cases, however, α_{gr} was small enough to be able to conclude that there was a relationship at a 10%-error level, and that is why the influence measure was tested using Yule's coefficient φ. The

influence for Komponenty-Ramy was only 0.22, and for Malarnia-Pudła 0.25, thus implying that the correlations virtually did not occur.

The analysis conducted suggests that the distribution of muda in the departments of the company under study does not depend on the activities performed. It is, therefore, possible to consider the company as a general case. That is why it is to be expected that in any department waste distribution will be uniform and similar to the global outline of the company presented in Figure 1.

6. Summary

According to GUS data, in 2016 there were approximately 3.5 thousand companies in Poland employing over 249 people, of which 29.4% operates in industry (GUS – Central Statistical Office, Economic entities by types and place of business in 2016). Against this background, the company under study is one among approximately thousand others, while in Lower Silesia it can be seen as a representative of a set comprising around a hundred enterprises of this type. Moreover, attention should be drawn to the fact that the majority of companies operating on the Polish market are merely sub-contractors. For example, Bosh which employs about 5000 people in the country does not have R&D units in Poland (Bosh website). In this context the company examined has such units and generates the final product. In addition, it is one of the railway vehicles producers of which there are only few and as such exemplifies the state of the national development in terms of economic activity.

The analysis carried out was that of the relationships between production departments and types of waste occurring in the company. Test χ^2 did not show that there were relationships between variables. Thus, each department should be discussed individually in terms of the muda identified. Still, there are certain tendencies in the company indicating which types of waste are dominant (Figure 1). The most significant type of waste is waiting time (36.1%), followed by process errors (22.5%), unnecessary motion (19%) and unused creativity (14.2%). In each of the departments discussed the company should in the first place seek to solve these problems.

There are numerous studies on waste in literature. The research findings of Arunagiri and Gnanavelbabu pertaining to companies in automobile industries rank muda types as follows (starting with the most crucial ones): transportation, waiting, unnecessary motion, inventories, overprocessing, overproduction, with defects being ranked at the bottom (Arunagiria,

Gnanavelbabu 2014: 2174). In the analysis discussed the authors do not take into consideration unused employee creativity. One can detect similarities in the case of waiting and unnecessary motion. In well-organized enterprises defects (process errors) are the least important muda, and therefore, the company examined requires substantial work effort in order to improve the processes.

Bibliography

Arunagiria P., Gnanavelbabu A., (2014) Identification of Major Lean Production Waste in Automobile Industries using Weighted Average Method, 12th GLOBAL CONGRESS ON MANUFACTURING AND MANAGEMENT (GCMM), Procedia Engineering Vol. 97.

Aziz R. F., Hafez S. M., (2013) Applying lean thinking in construction and performance improvement, Alexandria Engineering Journal, Vol. 52.

Bednarz K., Siedem marnotrawstw, (2013), źródło internetowe http://www.leancenter.pl/bazawiedzy/siedem-marnotrawstw-eliminacja, data dostępu: 25.11.2016

Blikle A. J, (2014) Doktryna Jakości, rzecz o skutecznym zarządzaniu, Helion, Gliwice.

Fernandez Q., (2015) Performance indicator design and implementation on semi-automated production lines, Overall Equipment Effectiveness (OEE) philosophy adaptation, Master of Science Thesis, Production Engineering and Management, KTH Royal Institute of Technology School of Industrial Engineering and Management, Stockholm.

GUS – Główny Urząd Statystyczny, Podmioty gospodarcze według rodzajów i miejsc prowadzenia działalności w 2016 r. Warszawa, opracowanie 06.11.2017

Imai M, Gemba Kaizen, (2006) MT Biznes, Warszawa.

Imai M., Kaizen, (2007) Klucz do konkurencyjnego sukcesu Japonii, MT Biznes, Warszawa.

Jagodziński J., Ostrowski D., (2016) Optymalizacja wybranego procesu produkcyjnego w oparciu o zasadę ciągłego doskonalenia na przykładzie przedsiębiorstwa X, Zeszyty Naukowe Politechniki Częstochowskiej Zarządzanie nr 24, t. 2 2016, ss. 201–214.

Kornicki L, Kubik S., (2010) Identyfikacja marnotrawstwa na hali produkcyjnej, ProdPress.com, Wrocław 2008
Kubik S., Just in Timie dla operatorów, ProdPublishing, Wrocław.

Łazicki A., (2014) Systemy zarządzania przedsiębiorstwem – techniki Lean Management i Kaizen, Wydawnictwo Wiedza i Praktyka sp. z o.o., Warszawa.

Liker J. K, Meier D. P., (2011) Droga Toyoty, MTBiznes, Warszawa.

Womack J. P, Jones D. T., Roos D., (2008) Maszyna, która zmieniła świat, ProdPress, Wrocław.