Footnote: Szmelter, A., Jidoka jako przykład kaizenowskich technik minimalizacji kosztów logistycznych przedsiębiorstw produkcji masowej, Research Journal of the University of Gdansk. Transport Economics and Logistics 2012, No. 46, p. 149-158 [online: http://ekonom.ug.edu.pl/web/znetl/index.html?lang=pl&ao=numery_archiwalne]

Agnieszka Szmelter

Department of Logistics

University of Gdańsk, Poland

Jidoka as an example of Kaizen techniques of minimizing the logistics costs of mass production companies

1. Introduction

A characteristic feature of logistics processes is that they do not occur if there is no basic process (production process)[1] to support. Logistics process supports each phase of the production process and can be implemented by different organizational units of the company, the elements of the supply chain or third parties through outsourcing. Fig. 1 presents relations between the primary and the logistics processes.

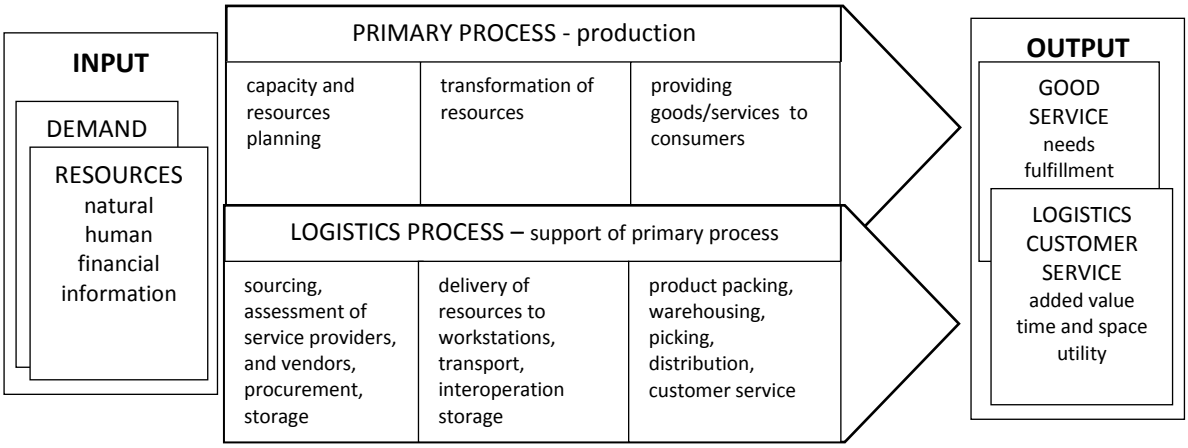

Fig. 1. Operating functions of the logistics process in relation to the tasks and functions of the primary process

Source: M. Chaberek: *Makro – i mikroekonomiczne aspekty wsparcia logistycznego*, Wyd. UG, Gdańsk 2002, s. 24.

The main goal of every activities in logistics support system (LSS) is advantageous purchase of resources, their effective use in order to produce certain goods or services

[1] Production proces of goods or services.

and the effective selling of these products. These efficient use of resources is rational management of these resources to minimize both natural and technical losses.

2. Production logistics

Logistics, which supports all processes in a company, provides all the resources that are necessary to the production of good or service. Main target of logistics processes is to provide:

- right resources,
- in right quantity,
- in right quality,
- to the right place,
- in right time,
- for the right price.

Despite many activities undertaken in a company in order to effective use of resources, wasting resources occurs. There are several areas of inappriopriate use (waste) of resources:

- overproduction, which causes earlier date of production, interferes inventory management through the use of them contrary to the plan, requires separation of extra space for storage,
- too big inventories, especially the costs of their transport, storage and control, and the risk of aging or destruction,
- correction of defects - the elimination or modification of the product already manufactured,
- traffic - the movement of workers which does not add value to the product,
- processing - a two-way: machines overload or not using their potential; also – collecting and processing the information contradictory to the purpose – wasting time and skills of employees
- waiting - due to the existence of bottlenecks in the process and lack of fluent, smooth flow of resources,

- transportation - the cost of damage of goods transported, including time to repair or replace them with other resources[2].

The main task of the logistics in the production phase is quick action to reduce waste of resources or stop the growth of the phenomenon. Therefore, the manufacturing process must be constantly monitored, and information about its components should be provided all the time. First of all, as part of logistical support to the production process, persons responsible for resource management should focus on such activities as internal transportation and reduction of interoperational inventories on production lines, which are connected with eliminating bottlenecks. Minimizing the waste should be a main goal in their activities.

Interoperational inventories can be divided into:

- rotary (maintained in order to synchronize the subsequent operations in the process),
- connected with the transportation (in the process of transport to the workstation or waiting for it),
- compensatory (to compensate incidental abnormalities of labor productivity),
- emergency (held, if the workplace is characterized by high failure rate)[3].

All goods flows in the production process involve simultaneous flow of information. They provide data on the volume of interoperational stocks and material losses, that means - about unnecessary, unfounded logistics costs in the production phase. Logistics information system in the enterprise requires a high degree of integration of various functional areas.This enables to obtain the process control level, in which material delivery schedule to the workstations minimizes the interoperational inventories while ensuring sufficient materials for the realization of previously identified customers' needs.

3. Characteristics of jidoka

The above-mentioned objectives can be achieved through the use of multiple methods. Jidoka is one of them. This is one of the two, next to the Just-in-Time concept, main pillars of the Kaizen philosophy in the Toyota Production System (TPS). As a

[2] J.P. Womack, D.T. Jones: *Odchudzanie firm. Eliminacja marnotrawstwa kluczem do sukcesu*, Centrum Informacji Menedżera, Warszawa 2001, p. 17; A. Hamrol: *Zarządzanie jakością z przykładami*, Wyd. Naukowe PWN, Warszawa 2005, p. 71.
[3] Cz. Skowronek: *Logistyka w przedsiębiorstwie*, PWE, Warszawa 2003, p. 221-222.

major goals to achieve in business processes it makes the highest quality, lowest cost and shortest duration of activities, that is – most efficient use of resources necessary for the production of goods and services. The elements of this management methodology are two areas - immediate problem solution by stopping the production line and separating humans and machines work[4].

The word "jidoka" is derived from the Japanese language and is a composed from three different words: "ji", meaning "oneself, independently, autonomously", "do", describing the transformation, change, and "ka", which is the end of "-ation"[5]. As a result of many translations the word was first adapted to the English language as "autonomation", which is a combination of the words "autonomy" and "automation". Many sources also recall another name for this concept, which is "intelligent automation", that is one that includes the human element, which is the driver of process improvement activities[6].

The essence of jidoka is to embed quality into production by providing adequate resources. First of all, the concept is based on the freedom gave to workers who perform activities that add value to the final product in the production process. This can be achieved by two methods: employee rotation (human resource) within a large number of workstations[7] or entrusting him to handle several machines (multi-process handling) or separating him from the machine[8]. Choosing one of these options depends on the specifics of the process itself. Regardless of the position on the production line, workstations are designed to be handled by people of different height, weight and gender. Another characteristic of jidoka is to build such workstations, which achieve the same productivity, regardless of the person, which handles them. It is therefore clear that the implementation of this concept in the enterprise needs four types of resources: human resources as machine operators (especially their experience), capital resources - the right machines, equipped with alarm systems, information resources - knowledge about handling machines and about Kaizen and jidoka philosophy itself, and finally - money to fund the changes in the process.

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[4] L. Kornicki: *Jidoka – sposób na doskonalenie jakości i produktywności*, „Zarządzanie jakością" 2006, no. 4, p. 62.
[5] M. Ćwikliński, M. Walczak: *Autonomatyzacja (jidoka) – od automatyzacji do humanizacji pracy*, „Zarządzanie Jakością" 2009, no. 2, p. 54.
[6] Z. Martyniak: *Nowe metody i koncepcje zarządzania*, Wyd. AE w Krakowie, Kraków 2002, p. 31.
[7] J. K. Liker: *Droga Toyoty, 14 zasad zarządzania wiodącej firmy produkcyjnej świata*, Wyd. MT Biznes, Warszawa 2005, p. 49.
[8] L. Kornicki: *Jidoka – sposób na…,* op. cit., p. 63.

Automatic stop of the machine can be made in two cases: when appropriate quantity of goods specified in the customer orders has been produced, or in the case of occurrence of an error in the process, that is the fault of the machine or incompleteness of manufactured products, as illustrated in Fig. 2. In the first situation, this action supports the Just-in-Time concept (especially JIT production). This fact makes that company reacts flexibly to unstable demand from their customers, which has undoubtedly a positive impact on its competitiveness in the industry. This frees employees from the need to constantly control the amount of produced goods, which undoubtedly makes it easier to control several devices by one employee at the same time. The result of that is a reduction in employment, and hence - average and total cost of production of goods. Therefore the efficient use of resources is increasing.

If someone will stop the machine as a result of detecting an error, it is beneficial for a company in three ways:

- causes the production of only complete, enough high-quality products (i.e., as mentioned, increasing the flexibility of production)
- immediately indicates an error,
- has impact on the reduction of employment through the inherent error detection (namely the efficient use of resources).

But in the case of immediate error signaling it is also possible to investigate and identify the error causes and initiate corrective actions (for example repairing in relation to the incomplete product or broken device) and the precautions ones that will protect the process from similar accidents in the future and thus minimize waste costs or repairs costs. The human factor is very important here, among others through the aforementioned intelligence and huge experience, and of course – creativity. Thanks to that employee teams are able to develop the necessary technological and technical solutions to improve the process. Stages of jidoka implementation and supporting solutions are presented in the Table. 1.

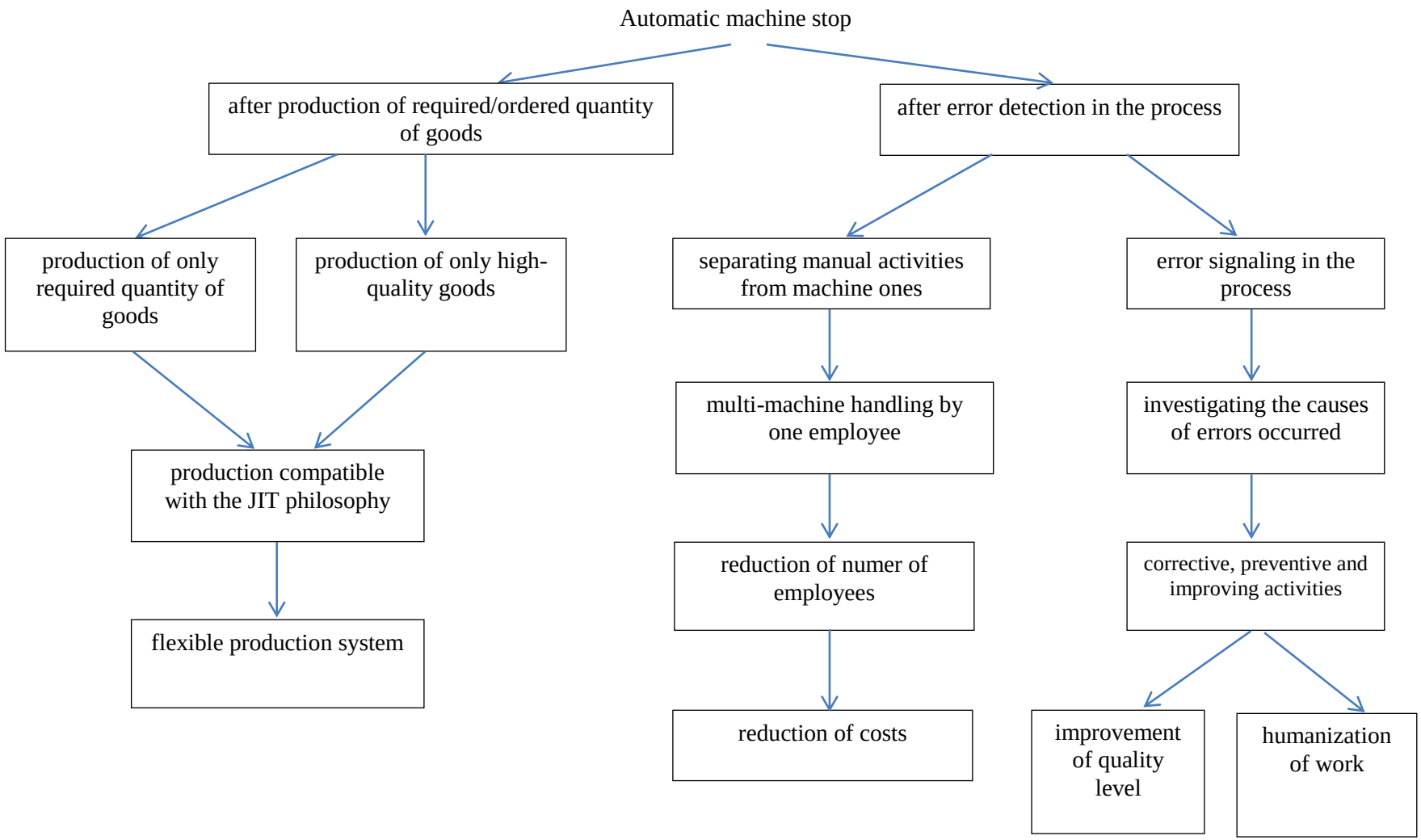

Fig. 2. Effects of jidoka implementation
Source: M. Ćwikliński, M. Walczak: *Autonomatyzacja…*, p. 60.

Table 1

Stages of jidoka implementation and supporting tools

Stage		Tools
1	maszyna wykrywa problem w procesie i to sygnalizuje	autonomous machine stop, andon system
2	stwierdzenie, że sytuacja odbiega od normy	
3	następuje zatrzymanie linii produkcyjnej	
4	osoba odpowiedzialna usuwa przyczynę problemu	5WHY
5	zastosowane usprawnienia są regularnie stosowane (wpisane w standardy pracy)	poka-yoke, 5S

Source: own preparation based on M. Ćwikliński, M. Walczak: *Autonomatyzacja…*, p. 58.

4. Andon system, poka yoke and 5WHY rule

Jidoka as a concept would have no chance for developing an effectiveness of logistics processes without any tools and techniques. Therefore implementing jidoka in a company is mostly connected with implementation of andon system, 5WHY rule and mistake proofing method (*poka yoke*).

The most popular technique used in jidoka is andon system (system of light signaling)[9], automatic alarming about an error in the process. Every time, when something is wrong and not compatible with the norms and standards in the process, an employee is entitled to stop the production line until the error is not identified and corrected. This technique is focused on making a board with every workstation on it and two kinds of lights (mostly yellow and red, but it can be more lights, like green, blue etc.) to each workstation. Yellow light means warning about potential problem or potential source of the problem, for example about date of technical inspection or time of replacing some machine elements with the new ones, what potentially can be a threat for the process, but in particular moment is no factor to prejudge about quality of product or process flow. If the employee will start the red light or it will be started autonomously on the production line, this is an information about essential problem, and then the production line needs to be stopped. In some production facilities additional lights are used in order to identify, in what place and what kind of failure was noticed by employees. An example of such light (lamp) on workstation and andon board.

[9] Andon (jap.) - lantern.

a) b)

Fig. 3. a) workstation signaling element in andon system, b) andon board

Source: http://www.seltec.co.uk/products/productvity-station.html; http://oeejourney.optimumfx.com/the-xl800-system/xl800-and-andon-systems/; 5.10.2012.

Andon system enables immediate reaction to failures in the production process and further – more effective use of materials in the production. As a result, the costs of elimination of defective product (utilization of production waste) are decreasing. Of course, stopping the production line in a certain workstation is connected with the cost of demurrage of another workstations. Therefore today whole production line is split into few segments with buffers. After signaling a failure the line is working until the shift of the defective item to the next workstation. In the meantime team leader has some time for reaction to the problem occurred[10].

Signaling of failures is not sufficient to improve effectiveness of use the production resources. Error prevention by eliminating their causes decides about long-term success in process optimization. Identification of causes is possible due to 5WHY rule, which relies on asking the question: "Why the failure occurred?". On the production line the answer is mostly "Because the machine is broken". The next step is asking the next "why" question "Why the machine is broken?" and getting the answer. Using this scheme of acting (asking few or more "why" question until the primary cause/causes is/are identified) is useful in reaching to the main cause of the problem.[11].

Elimination of identified causes is supported by mistake proofing and 5S. The first concept requires such solutions which prevent potential (especially human) errors, for example – wrong assembly of particular elements of product. Usually it relies on mechanical blockade and designing the shape of particular elements in order to make it

[10] J.K. Liker: *Droga Toyoty*…, op. cit., p. 209.
[11] M. Imai: *Gemba kaizen*, Wyd. MT Biznes, Warszawa 2006, p. 26.

impossible to assemble them in the other place than the right one[12]. Poka yoke is a concept which aim lies in preventing the failures in the production process caused by human factor. Mostly these solutions are technical or procedural, their function is to control or warn about an error. The goal of all activities implemented based on poka-yoke concept is to prevent failures. Nevertheless often implementing poka-yoke is cheap, relies on using easy solutions, which will soon bring a significant reduction in cost level. Among them are for example: installing sensors which check air humidity, temperature, physical parameters (height, length) of components or finished products.

5S (see Table 2) is a tool helpful in ordering and organizing elements of workplace and the whole production line. It enables removing of unnecessary, useless elements, which often caused process failures and disturbed in production process flow. According to the fact that poka-yoke and 5S are not activities in the production process (main, primary process), they are element of logistics (secondary) process and logistics support system.

Table 2

5S elements

No.	Rule	Description
1	seiri – select, sort	identification and elimination of useless, unnecessary materials, tools, documents
2	seiton – sistematic arrangement	allocation of space for every object
3	seiso - shine	cleaning the workplace completely
4	seiketsu - standardize	making procedures, rules of functioning in workplaces and in their surroundings
5	shitsuke - sustain	automatic realizing of established rules, self-development, self-improving

Source: J. Czerska: *Zasada 5S*, http://www.zie.pg.gda.pl/~jcz/5S.pdf , 5.10.2012.

5. Summary

According to previous information about jidoka and its role in shaping and transformation of logistic processes can be concluded that the implementation of this concept allows for:

[12] http://artoflean.com/documents/pdfs/Harada_interview_on_Jidoka.pdf, 2.10.2012.

- reduction of poor quality production, and further – elimination of wasted production resources,
- increase in effectiveness of use of production resources (especially human),
- preventing machine breaks by automatic stopping of them, which also leads to saving money spent on repairs,
- increase in production flexibility level, also for use of production pull systems,
- raising the level of quality of manufactured products,
- elimination of human errors, often caused by routine.[13]

To the above arguments, jidoka influences both the primary process (production process) and secondary process (logistics process). In that way it eliminates process elements which do not add value to the product, what has an positive impact on minimizing unnecessary costs in the production of goods and ensuing support process.

[13] B. Mikuła: *Człowiek a organizacja. Humanizm w koncepcjach i metodach organizacji i zarządzania XX wieku*, Wyd. Antykwa, Kraków 2000, p. 21.

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Abstract

This paper aims to present Jidoka (autonomation, intelligent automation, automation with a human touch) as one of the logistics process improvement concepts with reference to processes supporting the production process. Firstly, the author focuses on the connection between the basic process and logistic process in the production phase. Later the author addresses the issue of transportation and work-in-progress store. Then the author analyses the concept of production management, which is Jidoka, and its impact on improving the efficiency in the use of resources in goods manufacturing. After presenting several tools of Jidoka the author evaluates the role of Jidoka in shaping the logistics processes.