

## SMED METHOD ANALYSIS AS A FACTOR SUPPORTING ENTERPRISE MANAGEMENT

Joanna Nowakowska-Grunt, Robert Salek

*Częstochowa University of Technology*

**Abstract:** Methods of supporting production processes have the significant effect to the improvement in the effectiveness of company management systems, which in more and more competitive and globalized environment is aspiring to the excellence of functioning, of guaranteeing the appropriate quality and the cost cutting and the lead time. SMED method, of which with primary task there is a minimization of times of rearming production machines, it is possible to find application also in other environment which undoubtedly beneficial to the development of the company through significant improvement in performance management systems. This paper presents a method SMED as a tool, which application allows improving logistics process by shortening the time affecting the cost reduction and integrated management of both the Warehouse as well as the entire company.

**Keywords:** enterprise management, SMED, warehouses.

### 1. Introduction

Contemporary Logistics, together with areas functioning inside itself, develops and integrates, basing on the high-tech logistic infrastructure, having regard to economic efficiency criteria and the market competitiveness. Organizational efficiency and high economic efficiency of logistics processes is enforced through the business criteria for market competitiveness - in economic terms and technical systems of logistical infrastructure - generally identified as a technician. Market economy and more specifically its open system, recognized the company as a relatively isolated system in the external environment, also has an impact on the economic processes taking place in enterprises.

Logistic of companies, taking into account the model of organizational and functional structure - has task to coordinate the three main subsystems, which include: logistics of procurement, production and distribution as presented in Figure 1. It should also to consider the role of logistics of stocks, which maintains, collects stores and have their own place at the interface between the major subsystems.

Coordination of physical movements in logistics of company is based on the relevant streams of information and decisions which have their origin in the sphere of an economic forecasting. It provides a basis for creating three sequential business plans: of sales, production, purchase. Such scheme allows to create a logistic network of company, whose task is to implement the flows, where is occurring a temporal and spatial transformation of goods [2.].

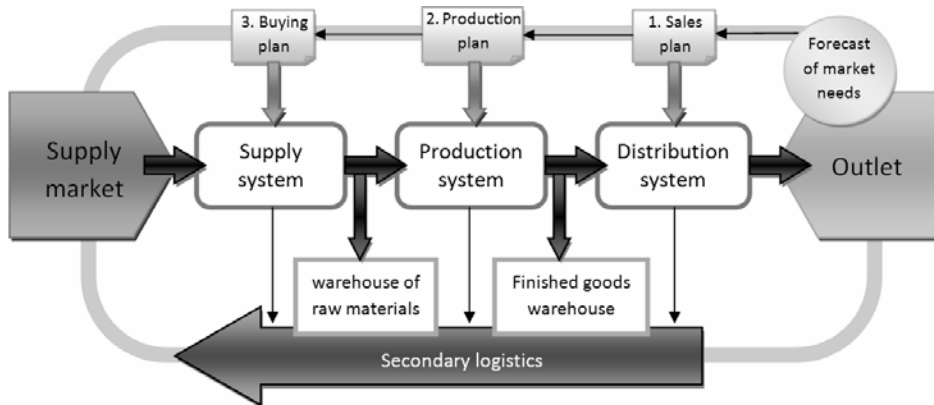


Figure 1. Logistics model of enterprise  
 Source: Own study based on [2.]

Logistics of production (model of production system Figure 2.) in terms of the content of the above is the most important factor for improving the management system across the enterprise, because it's responsible for planning, organizing and controlling the flow of raw materials, components and cooperation during the manufacturing process.

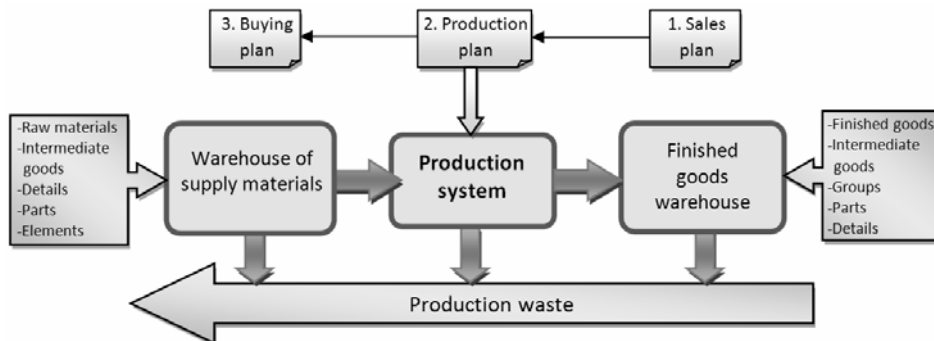


Figure 2. Logistic model of production system  
 Source: Own study based on [2.]

Specific manufacturing processes, are supervised and supported, through the production logistics through engineering design technologies, as well as ensure adequate continuity and intensity of production taking into account material flows, resulting from technological processes. Minimizing WIP inventory is the operational criterion of production logistics, which greatly reduces maintenance costs and minimizing costs of frozen assets. So that the production logistics can efficiently function and have the high effectiveness, you should reach for modern production solutions, such as Kanban and SMED, which aided management systems, will improve the overall efficiency of the entire enterprise [2.].

## 2. SMED as the method of supporting production processes

The SMED method (Single Minute Exchange of Die) was developed in Japan by S. Shingo. The primary objective of this method is time reduction of retooling for machines and equipment. SMED, is also a theory and a group of techniques which enable the exchange of tools and setting equipment, in less than 10 minutes, i.e. the number of the unit less than 10

(single minute). There is no doubt that this method will not reduce retooling times under 10 minutes in all cases, but it is proven that the use of it contributes to the sharp reduction in retooling times in almost every case. Analyzing of this method, consider what it really is the machine rearming. Conversion can be identified with the setting of the machine what means: exchange of tools, jigs and removable handles or setting them in the appropriate positions what is necessary to carry out a certain number of steps or operations in the manufacturing process. Rearming also can be named as a time period, measured from the point of the last proper element manufactured with the old machine settings to produce the first proper element of the new setting for the machine, from which moment is possible to start producing larger quantities of products what is presented in Figure 3.

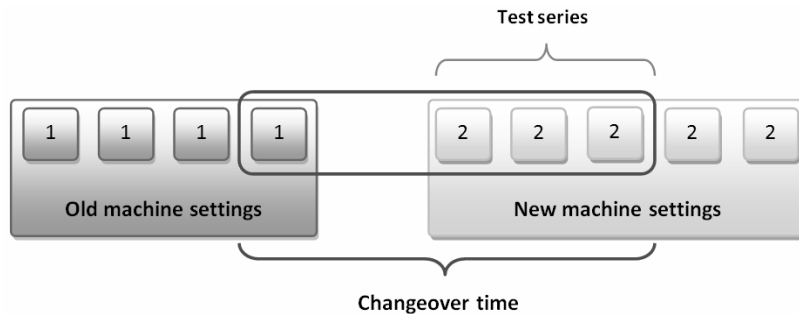


Figure 3. Machine changeover time

*Source: own study based on [4.]*

Although the results of the implementation this system are very satisfactory, resulting in an average of 50% time reduction, the company suspiciously evaluate this method, often fearing the additional improvements costs. However, to function smoothly, and also respond to customer needs, it is necessary to introduce of increasingly shorter series, which is directly associated with a shortening of time at each stage of production. The companies, which are using the flow on time method, i.e. JIT (Just In Time), to the improvements should make use the rapid replacement of tools, because this operation allows for flexible adaptation machine to changing conditions. The main assumption of the method of SMED is to reduce the size of production batches, which increases the possibility of adapting to changing market requirements. The result of this assumption is needed to shorten the time of rearming, because they usually decide about the batch size [1.].

Main project of the SMED method is demarcation activities carried out during rearings of two types: external, that may be performed during operation without interrupting the continuity of production and internal, performed only when the device is shut down. Internal preparatory activities during which it is necessary to disable the machine, greatly lengthening the time series, which is causing the reboot device and prepare it for work, i.e. the implementation of the so-called test series. To be able to analyze this method, it is advisable to first retrain previously observed external actions in such way, that they were made before or after the conversion. Then shorten the time performance of internal operations, and make every effort to convert the greatest amount of internal activities for external activities. Analysis of activities that can be subjected to such transformation in an efficient way helps manufacturing companies in the pursuit of efficient and smoother transition between the production of a diversified range of products. Besides the main objective of characterizing SMED method, i.e. reducing the time, we can distinguish different consequences, which also favorably affect the development of company, and these are:

- reducing long production runs,

- production flexibility increase,
- minimizing stocks,
- time shortening needed to product perform,
- productivity growth in so-called production line bottlenecks,
- reduce of materials consumption associated with rearmings,
- overcoming labor costs during the rearming,
- increase the usability of equipment,
- reduction the number of mistakes committed during the rearming,
- workers safety improvement,
- improve managing of tools-economy,
- reducing of requirements workers skills.

During analysis the time rearmings in SMED method, we are finding application for several auxiliary methods and techniques that take account organizational techniques and methods and technical solutions typically aimed directly at the structural changes for rearming machines [4.].

## **2.1. Stages of SMED, preparatory methods and ancillary techniques**

### **Stage 1 - Preparatory Phase**

During preparation for analysis, it's necessary to choose the position or group of devices on which will be carried out time reduction operations. The criterion for selecting the position of the test may include: observation of a bottleneck, the frequency of retooling, the duration of the retooling, the cost of the equipment is shut or other factors previously identified by supervisor. Then it's necessary to draw detailed description of the retooling process test, and registering it on film, in order to gather all kinds of comments, explanations of the process of retooling and possible suggestions for organizational changes. To supplement the previously gathered information, questionnaire is carried out among workers. One of the key elements of this survey is to question employees about their suggestions relating to improvements in the process and the question of the most intrusive, time consuming and laborious details.

### **Stage 2 - Classification of internal and external activities**

While traditionally pursued retooling the vast majority of operations is performed during the equipment is shut down, thereby adversely affecting the implementation of the process. Therefore it's necessary to distinguish those activities to internal and external, in order to carry out effective corrective action. Analysis of the preparatory activities, allows to specify those that may be performed while the machine is working in such a way as to preliminarily and End Time had minimal impact on extending the entire production cycle. In this undertaking may be helpful different types of tools:

- checklist,
- verification board,
- operation control and the necessary repairs,
- improvement of transport,
- Table segmentation of work.

### **Stage 3 - conversion of internal activities on to external**

Converting retooling operations of internal in the external activities is one of the most difficult stages in the analysis by SMED, but this are a necessary steps in order to drastically

shorten the time of rearmings. Based on information from previous phases (preparation and grading activities), it is advisable to search for solutions aimed at:

- simplify the performance of internal operations, thus shortening their duration,
- eliminate the possibility of exposing the internal activities while increasing external.

In most cases, this stage is more dominated by the improvement of a technical nature than organizational. The solutions which are used to improve the process most rely on the development of structural changes for tools or machinery components, using techniques:

- standardization of functions,
- using of middleware instrumentation,
- creating back-end components and assemblies.

#### **Stage 4 - Rationalization of activities in rearming operations**

This is the fourth and final phase of the SMED method, which at the beginning shall be carried out the improvements of internal activities and then external.

Internal activities improvements methods include:

- use of fast-mounting fittings,
- parallel execution of operations,
- elimination of regulation.

External activities improvements methods include:

- optimization the storage of tools, components and materials,
- optimization transport of tools and materials.

It is important to pay attention to the wider aspect of uses the SMED method and its links with other concepts and methods of business management, for example, as a tool to assist systems, Just in Time and Lean Management [10.].

### **3. SMED as the method of streamlining warehouse processes**

Warehouses are one of the more essential elements of the supply chain. In order to improve the efficiency of the processes taking place there, it uses the optimal compilation of software technology and automation equipment in such a way as to create a system with the highest possible performance. Optimal use of space and staff time, it became apparent behavior of entrepreneurs in response to the economic situation and ever increasing storage costs. Reasonable management of storage space, reduce unproductive time, openness to innovative solutions, is one of the main features that characterize suitable storage facilities for proper and safe storage of products. The increasing demands of customers necessitate shortening the cycle of the contract and also leading to a thorough analysis of storage processes and their continuous improvement, automation and optimization. The result of such actions is to facilitate orders picking, logistics costs reducing, and increasing company performance.

Warehouses in logistic systems serve as a node in which the raw materials, intermediates or finished products are stored at different times. From the perspective of logistics, warehouse economy puts special emphasis on:

- possibility for proper storage of products in well equipped storage facilities,
- organizational and decision-making structures related to the external and internal transport,
- optimization actions that define the place of storage and utilization of warehouse space.

The above elements are particularly important in achieving better results for warehouses resource management, which manifests itself in the need to ensure an adequate level of customer service and improving all the logistics processes in an enterprise [8.].

Taking into account the application of SMED method in areas closely related to production and in improving related processes, it is worthwhile to attempt adapt it in warehouses areas which are important and integral part of any enterprise. Because transferring that kind of method isn't a typical solution, it would be on place in some way to distinguish and redefine it again. In this situation, the correct designation for this method seems to be "modified SMED method", because is transferred to areas different than its original purpose, and some of its aspects can be changed by the forced use in the new environment. An objective of this method is the elimination of unnecessary operations performed during the storage, and also transformation and improving warehouse processes, involving different supporting methods. Adaptation of SMED method for the improvement of warehouse processes will be possible when the company [5.]:

- is using warehouses in own activity,
- has a wide range of products,
- has diversified size of distribution goods,
- is transporting many product items at the same time.

Adapting of SMED method in warehouse areas require clarification of exemplary warehouse model and a description of the processes regardless of its size in the enterprise. Warehouse operations are often a bottleneck in the production process, which significantly worsens the quality of services, reducing the company's competitive position. Minimizing the cost of storage is an economic criterion for the proper functioning of warehouses, and modified SMED method creates additional opportunities for development thus leading to warehouse efficiency improvement.

### **3.1. Analysis of warehouse zones**

According to the scheme of the SMED method, first is to refer to processes taking place in warehouse infrastructure, and distinguish the areas where the application of the method is possible. This is the first phase of implementation during which the most important issue is to find objects or operations adversely or not effectively enough affecting on products flow in the processes occurring in the warehouse. Regardless of the type of object, its size or object management, may be distinguished the following zones and operations inside the warehouse [6.]:

- 1) *Acceptance zone*, activities and operations related to the adoption of the goods to the warehouse:
  - unloading from external transport,
  - sorting,
  - identification,
  - quantity and quality control,
  - preparation for storage.
- 2) *Storage zone*, activities related to warehousing and storage of goods within a certain time and place:
  - internal transport and handling operations,
  - storage.
- 3) *Completion Zone*, operations and activities associated with the development of contracts for customers:
  - reformation of goods,

- selection of goods according to orders,
  - transporting goods to releases zone.
- 4) *Releases zone*, operations and activities associated with releasing of goods from the warehouse:
- packing and forming units,
  - preparation of transport documents
  - output control,
  - preparation for dispatch,
  - loading goods on the external transport.

For a more thorough analysis of operations, in each of these zones can also be divided two main structural areas, namely [2.]:

- 1) The area of technical resources, consisting of all devices and technical equipment systems, and technical means of manipulation and transport. When analyzing the area of technical resources is a key issue, drawing attention to the proper functioning of the equipment used in certain operations. Such devices may include:
  - a) all kinds of devices used to move resources within the storage zones and between them, namely:
    - trolleys (manual, electric, diesel),
    - cranes (gantries, hoists),
    - conveyors (belt, roller, articulated);
  - b) infrastructure of IT devices, equipment for the transmission, update and collect all the information necessary for the proper functioning of warehouse:
    - computers,
    - barcode readers,
    - label printers,
    - data collectors (mobile terminals),
    - wide range of warehouse management software, modern voice communication systems, Voice Picking,
    - wireless communication systems: RFID, bluetooth, Wi-Fi;
  - c) storage devices, allowing safe and convenient storage of materials or products:
    - shelving (fixed, mobile, specialized),
    - racks,
    - hangers,
    - primers (pallets),
    - entanglements,
- 2) The area of methodology and organization of work, which includes all performed operations, and organizational methods associated with the movement of resources through warehouse zones.
  - operations of handling transportation and manipulative devices,
  - activities allowing for the rapid information flow,
  - inventory of documentation,
  - methods of storage products
  - rules of safety and health.

After a preliminary hearing with the structures of the object and various operations, it would be to extract the individual activities that constitute the weakest link in the whole process of goods flow, while it's possible to reduce the time of their duration, with help an organizational techniques or additional technical innovation.

### 3.2. Segregation of internal and external operations

At this stage of the modified SMED method it is necessary to separate the performed operations or activities that occur in the area of reduced efficiency. As is known in classic method, the internal activity is done when equipment is shut down, while the external activity occurs without interfering machine work. Referring to the previous apportionment on storage zones and assuming that each is an individual group of specific operations and each operation is composed of successive activities, we can see the relationship occurring between them, shown in Figure 4.

The first step is to look at the links between storage zones that combine several operations forming the logistics system. Each operation is associated with the two closest, but when they contain it in one zone they are forming internal relationships, while those that are in different zones are characterized by external relations. By analogy to show the links between the various operations that combine sequentially performed activities. Any activity incorporated into the operations, retains in relations to adjacent internal relationships, but outside in relation to activity that contain in to the next operation.

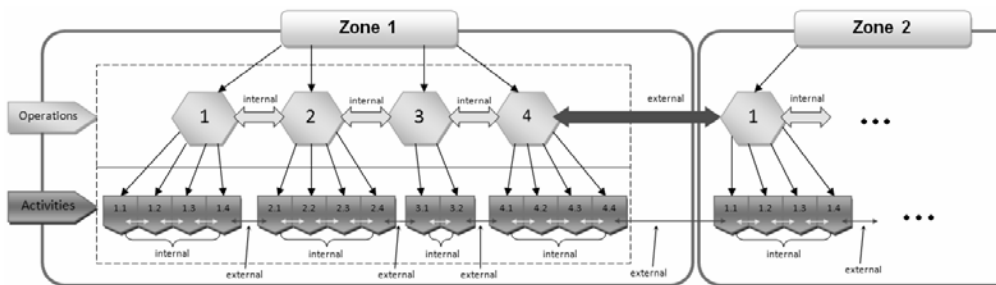


Figure 4. Relationships between operations.

*Source: own study*

These look at the warehouses structure reveals not only the relations occurring there, but also allows the identification of objects or actions which adversely affects the existence of a functioning system of material flow. Application of SMED modified method can also refer to the entire operation as well as to the simplest steps that may seem insignificant across the whole enterprise.

### 3.3. Modifications of warehouse activities and operations

This stage focuses on transforming internal operations to external as well as the simplification of individual activities or complete operation. During the transformation seeks to minimize the occurrence of internal activities, which are replaced on external, with tangible effects of time reduction. There are unlimited opportunities to improve logistics processes, by typical organizational methods or modern technological innovations.

Improving efficiency of the storage processes from the moment of acceptance until the release of the product is possible through the use of modern information systems which are perfectly suited for different sizes of warehouses. Thanks to modern solutions and universal use of the programs in different objects (stores of raw materials, finished goods or returns), becomes more real the increase of enterprise flexibility in storage areas. WMS system (Warehouse Management System) focuses in its area many tools such as card readers and barcode printers, terminals or RFID (Radio Frequency Identification), allowing permanent contact of worker with the information center. WMS producers are paying attention to the



functionality of the system, which greatly facilitates the operations of receipt of goods coupled with the order, and shipping notice, the quantity and quality control or the automated storage place selection. The program creates a virtual map of warehouse, wherein each rack or shelf has assigned a unique coordinates, thanks to this an inventory and picking is easier, also prevents mistakes that can occur. Precise determination of coordinates also relates to forklift trucks, for which the system defines specific tasks in addition to position, knowing the technical capabilities of vehicles, and sets priorities thereby reducing empty mileage and tasks crossing [9].

One of the systems which are increasingly common in Poland is an identification system using radio frequency (RFID), which is ideal for warehouse logistics processes. With this solution, it's possible to control the availability of equipment, tools, and facilities, identify the goods or to monitor the working time of employees. The RFID system is based on the wireless exchange of information between the transmitter called transponder, and receiver (antenna). Pre-programmed transponders are placed in the RFID cards and include all necessary information about a particular product. Cards are read by means of a read-program devices and do not require charging, because the power draws of a bundle of electromagnetic wave emitted by the reader, are very resistant to any kind of mechanical damage, chemicals, light and dust, which greatly increases their lifespan and thus improves the efficiency information transmission through virtually zero defect. The most significant advantage of transponder is the possibility of non-contact control, are recognized without any physical contact with the reader, which allows faster data transfer. Have the possibility of multiple recording and modify the information contained therein, which is obviously much more advantageous way to deal with such as bar codes. The RFID system works well during the course of a many of logistics processes, including the admission of the goods, or inventory of its completion. Searching for new ways to effectively managing the flow in the logistics chain is made possible by innovations in new technologies [7].

The next step toward improving warehouse operations is the use of voice systems and Wi-Fi (Voice Picking) which, being a complement to other electronic tools in warehouses such as RFID, barcode, or terminal, is aimed at freeing the hands of employees to handle other devices, as well as increasing storage capacity and the preparation quality. The implementation of voice technology in warehouses has a view to allow quick and easy communication between the employee and systems such as WMS or ERP (Enterprise Resource Planning). The person using the system, through the headset becomes aware of the location and type of goods directly from the main storage unit. Informations are sent to the so-called talkman operating normally over a dozen languages, which is usually attached to a worker belt. The great advantage of these systems is the high flexibility and the ability to adapt to innovative mobile technologies offered by various manufacturers. Thanks to the Voice Picking is possible to minimize production errors, improve information flow and reduce administrative costs throughout the whole supply chain, and experience has shown that the implementation of these technologies can increase the efficiency of warehouse by up to 25 percent [3., 9].

#### **4. Summary**

The SMED method introduced in this article is one of many tools for improving productivity in production processes, as well as logistics. Using of that kind of tools is clear from the continued need for improvement of processes, whose correct functioning has a fundamental impact on the healthy development of the company. Many of them after the implementation of SMED to production processes have seen a significant increase in operating performance, improving the competitiveness and flexibility, resulting an improving response to customers'

needs. Successful implementation of new methods requires solid and permanent solutions, and the key to viability is its standardization.

Through the application of SMED, which previously was present primarily in the production areas, to warehouse areas, it is possible to thoroughly examine the entire logistics process, and what's more analysis of the basic steps, which are the smallest cell in the process flow of goods. With a new look at the application of SMED, new opportunities open up for entrepreneurs, and through this method they can effectively control the flow of goods and information in all stages of the supply process. Introducing innovative technologies and unconventional solutions can accelerate this movement, which ultimately translates into increased customer satisfaction and improve efficiency across the enterprise.

## References

- [1.] CAKMAKCI M.: **Process improvement: performance analysis of the setup time reduction-SMED in the automobile industry.** – Elsevier, Int J Adv Manuf Technol (2009) 41:168–179
- [2.] FICOŃ K.: **Logistyka techniczna. Infrastruktura logistyczna** - BEL Studio, Warszawa 2009, p. 19-20, 27-29, 119-136.
- [3.] ID LOGISTICS POLSKA: **Wolne ręce w magazynie** – EuroLogistics 1/2010, p. 53.
- [4.] MACIAK J.: **Redukcja czasu przebrojenia maszyny przy użyciu techniki SMED** - Konferencja KZZ Zakopane 2010. p. 188-195.
- [5.] MROŻEK-DUDA A., WÓJCIK M. H.: **SMED jako metoda usprawniania logistyki.** – Gospodarka materiałowa i logistyka, nr. 3/2004. p. 19-22.
- [6.] NIEMCZYK A.: **Podstawy logistyki, praca zbiorowa.** – Biblioteka Logistyka, Poznań 2006. p. 139-142.
- [7.] NOWAKOWSKA A.: **Efficiency of Application of RFID in Supply Chain Management** - Annales Universitatis Apulensis, Series Oeconomica Vol. II nr 10, 2009. p. 749-753.
- [8.] NOWAKOWSKA-GRUNT J., WIŚNIEWSKA A.: **Application of the Systems of Electronic Warehouse Management Support.** - Enterprise, Logistics and Innovations in Knowledge Based Economy. Ed.by Maria Nowicka-Skowron & Ralph Lescroart, Blaise Pascal, Arlon, 2008. p.173-181.
- [9.] OZGA P.: **Magazyn zdalnie sterowany.** – EuroLogistics 1/2010, p. 48-51.
- [10.] WALCZAK M.: **Techniki organizatorskie w strukturze metody SMED.** – Zeszyty Naukowe nr. 713, AE. Kraków 2006. p. 123-136.