International Journal of Business and Management Invention
ISSN (Online): 2319 – 8028, ISSN (Print): 2319 – 801X
www.ijbmi.org Volume 2 Issue 6‖ June. 2013‖ PP.09-20

A Concept to Optimize Internal Material Supply Processes at Volkswagen AG

Caner Cebeci[1], Michael Alsmann[2], Sefika Kozpinar[3]
[1](Department of Business Administration, Faculty of Economic and Administrative Sciences/ Melikşah University, Turkey)
2(Department of Development & Innovation / Volkswagen Kassel, Germany)
[3](Department of Business Administration, Faculty of Economic and Administrative Sciences/ Kassel University,Germany)

ABSTRACT: *The aim of this work is to design "a concept to optimize the supply of materials between cutting systems and the press shop" at Volkswagen Group, which is located in Kassel. For this purpose, the techniques of Business Process Management (BPM) and the tools of Process Improvement will be used. Further, the Volkswagen- Company-System should be taken into consideration by solving the problems. The identified improvements and gaps between the cutting room and press shop are as follows:*

1. *push principle and batch-size production*
2. *high material stock*
3. *a large search effort in the intermediate storage facilities*
4. *lack of transparency between the processes*
5. *long travel path between the intermediate storage facilities.*

Therefore a target concept is created for these problems . Detailed description of the target concept can be found in the following chapters.

This thesis covers the theoretical foundations of Process Management, Volkswagen-Company-System and Process Improvement. Thus, the Value Stream Mapping and the Flow-chart show and give a graphical representation of the relevant processes between the two departments.

KEYWORDS: *Volkswagen Production System, Business Process Management, Process Map, Process Improwement*

I. INTRODUCTION

The "Global competition, changing customer expectation, technological progress and continuously changing markets compel companies to change their business structure." [1]

Through global challenges companies are forced to improve and optimize their work processes and techniques continuously [2]. This requires to focus on company stuctures and processes which should involve value-creating activities [3] and the current customer needs and customer wishes should be considered more and more [4].

The basis for a successful orientation and adaptation forms is the analyzes and implementation of efficient workflows/processes. These efficient workflows are called process management. The development of horizontal organizational structures by introducing a process management leads to the formation of a cross-structure value-chain; here special importance is placed on consideration of customer requirement and customer satisfaction [5]. "The customer expectations […] are the basic yardstick of the corporate activities. [Aim is] to inspire permanently the customer to the company and for their products [6]. To reach this aim, it is necessary to design orders of customers and processes in such a way that they happen in just in time, smoothly and economically priced [7].

Process Management is a measure which helps to design all planning, organizational and controlling topics and priorities. This measure allows objective-oriented management/control of value chain in a company and thereby optimization of process and therefore the fulfillment of the customer requirements [8].

II. AIM OF THIS THESIS

This The goal of this work is to design "a concept to optimize the supply of materials between the cutting room or rather cutting systems and the press shop" at Volkswagen Group, which is located in Kassel. (The Volkswagen manufacturer plant in Kassel is the second largest plant of the Volkswagen Group in Germany. In the production area, with more than 15.000 employees, top components such as gearboxes, cast parts, car panel bodies, substitution-aggregates and exhaust systems are produced. The components which are

produced in the production facility in Kassel are delivered almost to all production facilities of the Volkswagen Group).

For this purpose the techniques of Business Process Management (BPM) or the tools of Process Improvement will be used. Further, the "Volkswagen Production System" should be taken into consideration for solving the challenges.

The first section of this article covers the Volkswagen Production System and Process Improvement. In the same way, the Value Stream Mapping and the Flow-chart shows and gives a graphical representation of the relevant processes between the two departments, the "cutting room" and "press shop".

III. THE VOLKSWAGEN PRODUCTION SYSTEM

The idea of Volkswagen Production System is value chain-oriented and synchronous Company. All practiced activities should be oriented to value chain and contribute to this.The aim is to abolish non-value chained processes (Nine types of waste, 2011). In this context the success is not measured by cost and price; particular significance is attached to the aspect quality. This involves stability of product, process quality and process stability.

The Volkswagen Production System corresponds to the structure of a house. The Basics represent the foundation, which ensures the stability of the four pillars: Tact, Flow, Pull and Perfection.

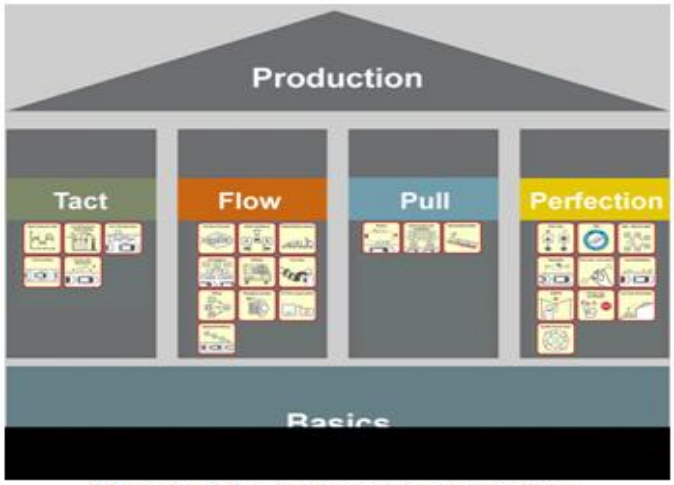


Figure 1: Volkswagen Production System[12]

The Basics include "Nine types of waste". These are: Overproduction, Stock, Waiting time, Movement, Poor ergonomic working, Transport, Unnecessary processes, Insufficient communication and Rework/defects. Everything that does not play a part in value adding is waste.

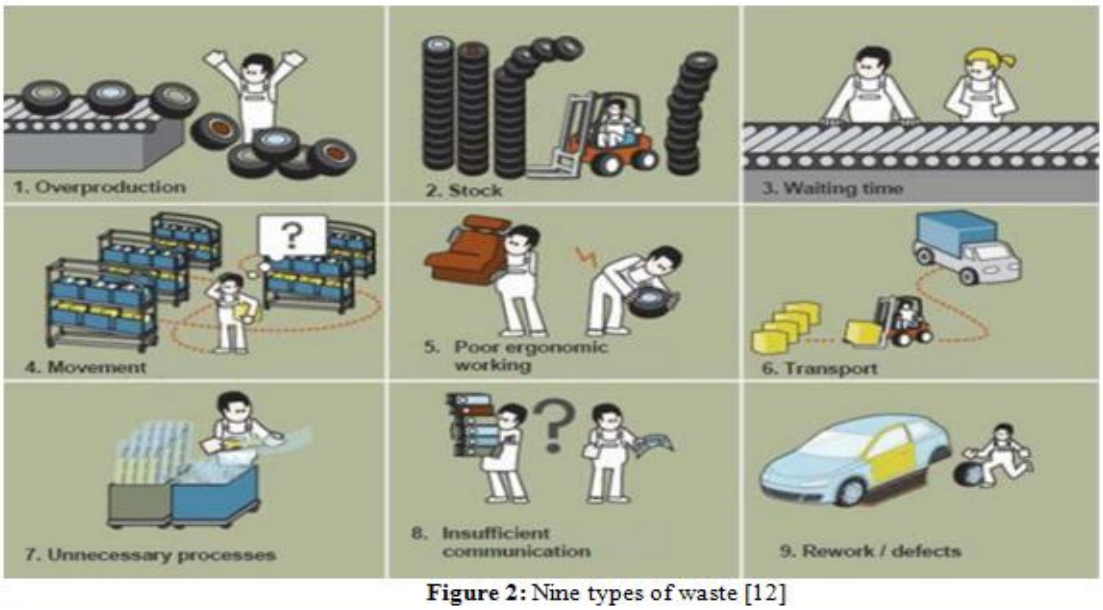


Figure 2: Nine types of waste [12]

Why 9 types of waste? –

Work processes contain a value added element and waste. The 9 types of waste help to recognize and to reduce waste within work processes. It is akin to "Learning to see it". So the reduction of waste supports the reduction of the main driver "lead time".

The question arises:

What is to do? Or which are the methods for detecting, respectively:First you have to do an intensive observation of the process during daily work, in the workshop or through filming observing and capturing the actual situation. i.e. Using a recording sheet for waste, visualizing, walking way-diagram, information flow, taking pictures, filming.

Second you have to identify the different kinds of waste.Elimination of waste through problem-solving and implementation /application of methods building stones.Waste through overproduction means supplying products, services and information faster or in bigger volume than requested by the internal or external customer for this moment in time. Large quantity of material or WIP stock through overproduction, large lot sizes, island optimizations of safety stock cover up various other kinds of waste.

In this context an actual condition-analysis was done in the cutting and press-room at Volkswagen Group, with the help of the 9 types of waste, to identify the non-value added processes (Volkswagen Production System, 2011)

.

IV. DESCRIPTION OF THE PROCEDURE FOR DETERMINATION OF ACTUAL CONDITION-ANALYSIS

The starting point for the actual condition-analysis is the description of the management processes, core processes and support processes. By information-, production- and material processes, the process-inside the pressroom will be described. Via numerous on-site inspections and interviews with the employees the current situation will be shown, analyzed and assessed. The weak points in the process-sequence or in the value-stream (should) have been determined.

1.1. The Press Room At Volkswagen Groups

The press room is organized in six subsections:

- Cutting System
- Step press shop
- Short-grob press shop
- Transfer press shop
- Hot stamping
- Laserpark

With the aid of a process map, an overview of the relevant processes will be created and the possible associations between these factors will be shown. At the top of a process map are the management processes, which include Plant Management, Category Management, Controlling, Strategy Management and Capacity Planning.

Management process includes in particular Plant Management, unit management such as Cost-Center management and subsection management.The Planning, Controlling and Capacity Planning departments contribute for procurement of new plants besides for employment staff as for calculating and fabrication time. Support process involves the units such as human resources department, logistic, quality management and factory technology, shown in figure 3.

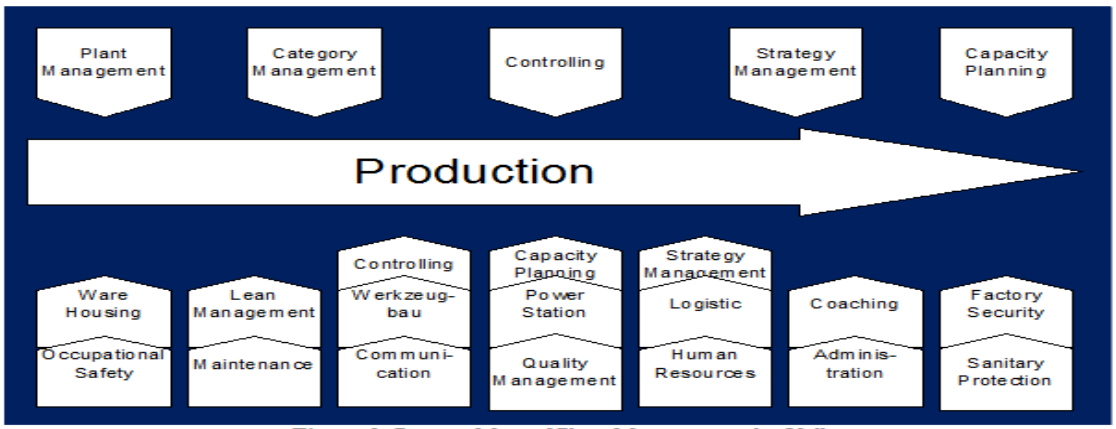


Figure 3: Process Map of Plant Management by Volkswagen.

1.2. Current situation analysis

The current situation analysis will be done in the whole press shop. Consequently, first it will be started with a value-stream, to illustrate which important steps in the production of a finished part are enforced cf. Figure 4.

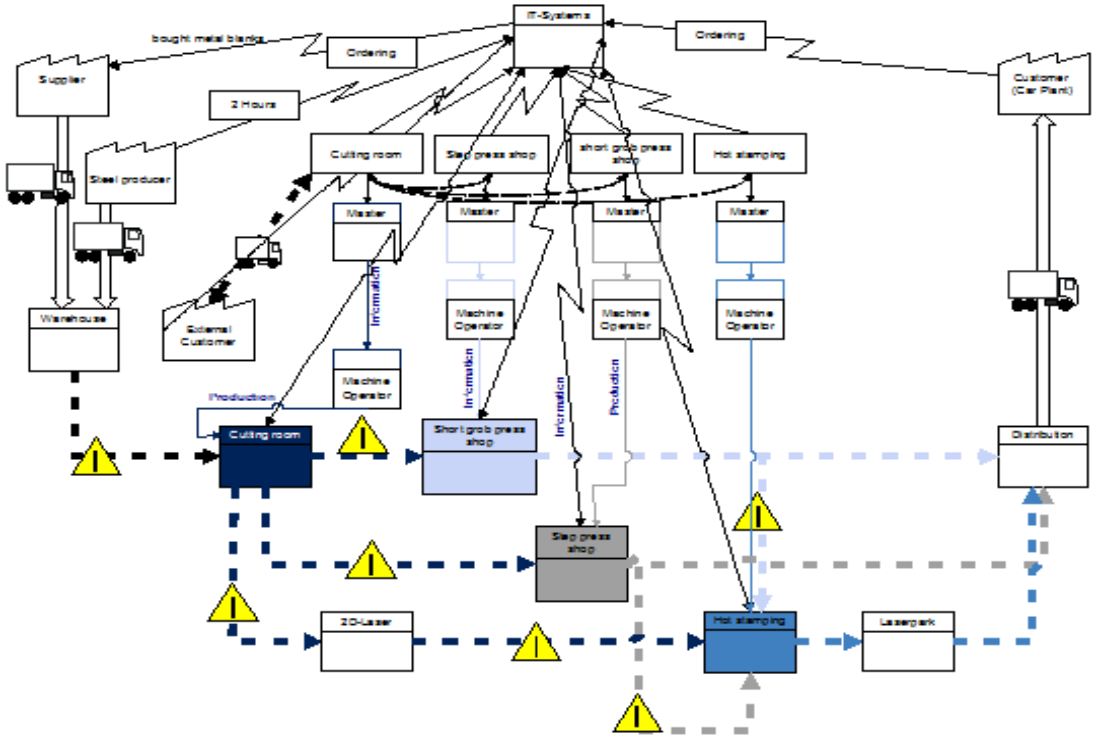


Figure 4: Value Stream Map of Press shop and Cutting room

The value stream starts with an order of automobile, directly at customer. Raw materials for the production of press parts are Coils, which are 4 km long steel sheets. These have a weight of between 0,8 and 30 tons.

In total at the cutting room contains nine cutting systems. Each system has a specific external diameter which has to accord with the internal diameter of the coil.

Within two hours the ordered coils are transported with a truck from supplier / steel producer to the cutting room. Parallel to the transport coils are cut in lot-size and to metal sheets by push principle. Fully processed coils, which had been metal blanks, are stacked on top of each other and bundled by two employees. After these, the bundled metal blanks are transported and placed to intermediate storage.

From intermediate storage these metal blanks are delivered with forklift to the press shop. There they get a final form. Furthermore, metal blanks are ordered by supplies, which cannot be cut after the desired dimension. This bought metal blanks are saved as well at the intermediate storage as well.

The metal blanks which are to bestored,transported by the outgoing goods to the external clients. The external clients use this for their purpose or cut the rectangle metal blanks to B-pillar-shaped metal blanks and then they are transported back to intermediate storage. The whole process (cut, transform etc.) ends with the transport of the press part to warehouse.

1.3. Scope of this work

For illustrative purposes, this analysis particularly concentrates on the press, which is called press-150 and the cutting systems (Coil-cutting system (Coil4), metal blank- cutting system (MBCS) and band cutting system (BCS)) which these press supply.At the press-150 six different volume components are produced :

1 Flor rear
2 Wheel house outer left rears
3 Tailgate back
4 Fenders
5 Engine hood
6 Tunnel enhancements

The non-originating materials are supplied from cutting-coil-system-4 (Coil4), metal blank cutting system (mbcs) and band cutting system (bcs), further so-called "buy blanks" are ordered from external suppliers.For eight weeks observations of the production orders and their processing are documented and recorded. When questions or error reports are received the employees are interviewed in order to find the cause.

Information flow (cf. fig. 5): The production-program for the press-150 is updated on daily basis with four different IT-systems. The necessary dates are taken from different IT-systems (in the whole 8 IT-systems exist).From these IT-Systems, the program planner learns the information on required parts and so he creates the daily program. After that, the data are registered in Excel and published on the intranet.

With the help of this Excel-paper the program planner creates the agenda for the cutting systems. Once the whole daily program is established, at 9.45 am the so called "early circle" takes place. Here, together with Master and the employees the detailed planning of the daily program is conducted. Should interruptions result in any of the programs, measures will be determined. Further, the respective Master of Cost Center will be informed regarding the production plan. These information are passed to the machine operator of the Cutting-systems or press-150, so they can start with the production of metal blanks and press parts.

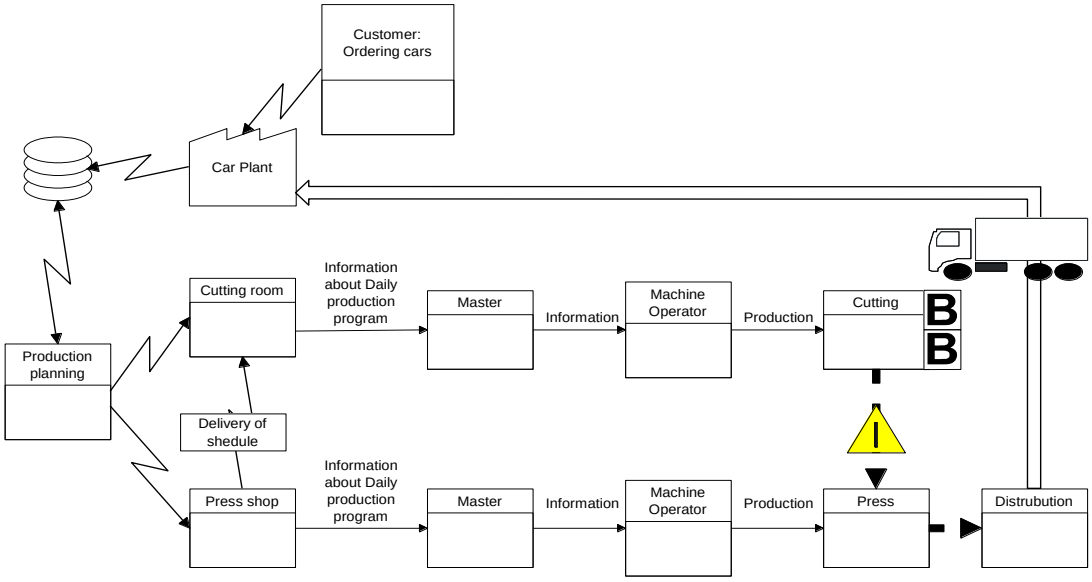


Figure 5: Information flow

Material flow:

For the cutting system three different intermediate storage units exist: one intermediate storage is in front of BCS, the second one is behind the MBCS and the last intermediate storage is in front of press-150. Table 1 shows the area (sq) of the Intermediate storages.

Table1: Area of Intermediate storages

Intermediate storages	
Band cuttingsystem	255 squaremeters
Metal blank cuttingsystem	220,2 sqauremeters
Another intermediate storage	372,6 squaremeters

First step:

stocking of metal blanks: Metal blanks which are cut in Coil4, are intermediate in the storage of MBCS or BCS. From Coil4 until intermediate storage of BCS the transport roadway is 90 meters and until intermediate storage of MBCS is 75 meters. The return journey to BCS 1 minute and 41 seconds, whereas the return journey to MBC Stakes 1 min and 26 seconds, cf. figure 6 and table 2.

Second step:
the transport of metal blanks to press150: Afterwards the intermediated metal blanks are taken from the storage and are transported in front on press-150 before they will be further processed.

Table2: Transporttime between Cutting systems and press-150

Transport-time between the Cutting-systems and Press-150			
Route	**Length in meter**	**Voyage out in seconds**	**Return journey in seconds**
Coil4 → Stock of BCS	90	50,61	50,18
BCS → Stock of BCS	24	19,17	18,74
Coil4 → Stock of MBCS	75	43 ,02	42,59

1.4. Possible optimization potentials at cutting room and press room

***1.Push and pull- principle*:**

According to Volkswagen Production System the production should happen take place after the pull system. This includes pulling process ensure lean procedures and value change orientation. In the pull-principle the downstream process gets only needed materials from the up-stream process. At the same time the up-stream produces only that what the downstream process consumes [12].

Compared with the material control at the press shop follows the push principle. The results show that the upstream process (cutting room) does not always supply the metal blanks to the downstream process, but also the downstream process takes the metal blanks itself. One reason is that the production occurs in lot size. The production in lot size: "influence material stock, lead time and finally flexibility in the company." [9]

According to Volkswagen Production System it is important to avoid the manufacturing after push principle, to reach a high level of process stability and to enable quick reactions. Because the pull principle helps to reduce the material stocks, investments, control effort and so the lead time and costs are minimized. Finally the production at press shop shall happen by the pull principle [12].

2. Transparency:

Target set of Volkswagen Production System is: **"**With Visual Management we can create transparency in all processes. This helps to show all deviations from the standard. One sees at a glance the Production-Volume and if an unforeseen event appeared".

As a result of investigation it was found, that the coordination between up- and downstream should be improved. So the value creating and non-value creating activities are not clear and they show that an interface problem exists [12].

According to the authors Kaschytza and Wotter Control Management by lack of transparency is not efficient enough." Accordingly, Volkswagen Production System should try , to improve transparency with the help of Visual Management [12].

3. Material stocks:

Target for this purpose is the actual production in lot size at press shop leads to high material stocks in the intermediate storage (Nine types of waste). The cause is that the target volume for the cutting-orders cannot be respected because coil is oversized. Hence, a bigger lot size is produced than planned cf. figure 6.

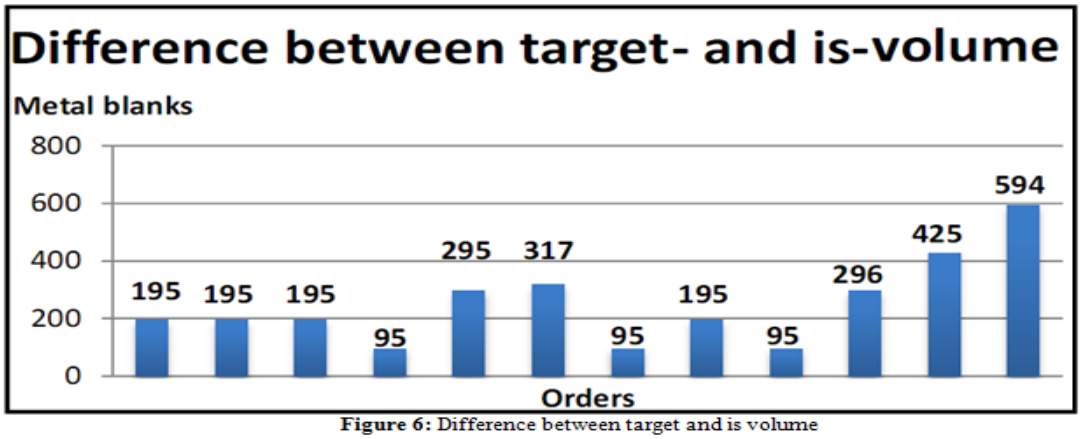


Figure 6: Difference between target and is volume

This requires that the employees have to search for the required metal blanks to continue working. This prevents the removal of metal blanks in fifo(first in first out).Furthermore, the number of metal blanks which exist at Intermediate storage does not match with the number of metal blanks in the IT-Systems. So there are residues of metal blanks at intermediate storage, cf. Figure 7.

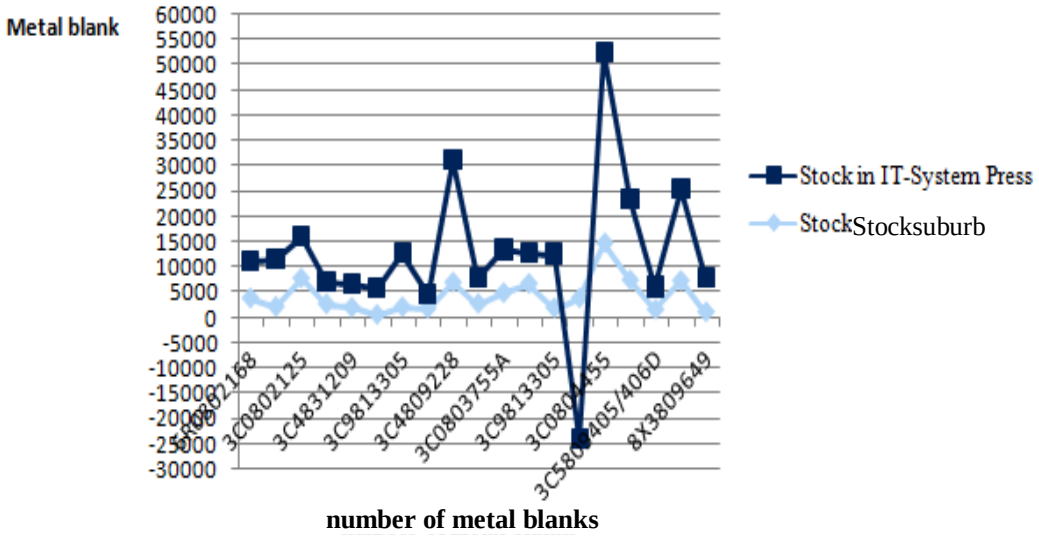


Figure 7: Stock in It-system press and stock suburb

The consequence of material stock shows the analysis of Wildemann: "In the meantime it is widely understood that safety merely increases the capital commitment in liquid assets. As well leads to additional capacity and not contribute to value chain." [10]. Kletti and Schumacher note in this regard that the aim of stocks are: "Ensurance of material flow at each stage of Supply Chain." [9]. According to Volkswagen Production System the material stock should be avoided in the production. This can be reached by a tight customer cycle or by a Kanban-control [12].

***4. Fifo principle and repacking processes*:**

The task of Flow-principle: "The flow- principle states that the material- and information flow should stream by customer-time. This means that we have to organize all processes and operations according the production stream and distribute them in compliance with customer-time, on each working place. By working after Single-Piece-flow, supported by Visual Management and direct distribution at the downstream process we can detect quality problems and track their prompt disconnection." [12].

As a result of the investigations it was concluded that the metal blanks cannot further processing with the Fifo-principle. In this way the problem is that the steel can be influenced by environmental conditions e.g. pollution or obsolescence for example Corrosion can occurs. And thus have to be scrapped.

Furthermore, the employee has to repack the metal blanks to get on the essential blanks. The problem here is that the employee does not have a direct entrance to the intermediate storage, because the storage is full with blanks and mismatching blanks are stacked on top of each other.

Volkswagen Production System should be the ideal further processing take after the Flow-principle . On the one hand this makes a just-in-time supply possible and on the other hand problems with regard to quality can be avoid [12].

5. Searching efforts and travel paths:

As already mentioned, employees have to search the essential metal blanks. This means a high cost of time and money. According to TaiichiOhno "The movements of employees have to be related with value chain movements because to move oneself means not always to work. To work means to move the process towards this means to bring the works complete."[11]**.** Long transport paths are also the result of lack of transparency, material stock and the searching effort. In the context of researching the blank, the employees have to travel between the different warehouses.

The consequence of wasteful processes and transport can be taken from nine types of waste. The elimination of this waste can be realized by using standard workflows, Pull-principle or by prevention of overproduction [12].

1.5. Root cause analysis

The following chapter examines the factors which could account for the weaknesses of the analysis. First the IT-systems that are used will be discussed. On this occasion the production planning and control is extremely important because it is connected with the IT-system, via the employee using the IT systems.

Particular emphasis is placed on following points:

1. Vague data transmission and interface problems
2. With obstacles met metal blanks by further processing
3. No match between the size of a lot with coil size
4. Remains of metal blanks in intermediate storage
5. Production planning and control by experience

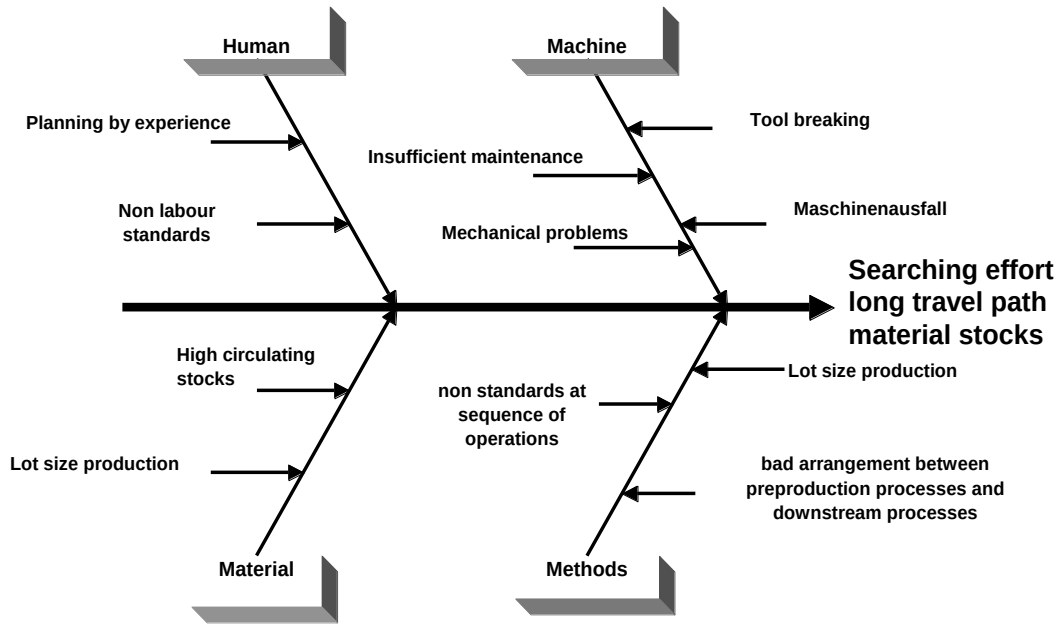
There are eight IT-Systems in total with different content, which the information flow for the planning gallot/permit exist. The employees have access rights to various IT-Systems. After assort they are obligated/forced to show each system because the number of orders varies and may be changed. This means a lot of eff-ort e.g. time to look up an planning.

The investigation showed that between the involved department and the IT systems an interface problem exists. Analyses and data showed that the number of finished part which exists at the car plant does not match with the number of finished part. The IT-systems comparison between the metal blanks in the hall with the blanks in IT systems shows that the metal blanks do not exist, have a negative number or have a high number. This means that production planning and control have to set at all times of new order, short time repeat order of finished part. Finally the whole program plan have to set on the demands of car plants and the cutting systems have to convert on new tool kits to meet the short-time demand of the car plants.

The analyses show the program planner is responsible for the high material stock. The interviews and the recorded observations indicate that 750000 metal blanks are produced within a week. This complies a stock of 150000 metal blanks per day and a circulating stock of 550000 metal blanks. The difficulty is that the cut metal blank averaged wait three days for the treatment although they should wait 1,5 shift before they get in treatment. An additional problem is that the ordered coils for the production are too high from weight and diameter. This leads to leftovers of metal blanks because the cut metal blanks cannot all at once be process.

The surveys showed that there are not operating instructions and target for the planning. This means that each planner plans by experience and act with safety consciousness to avoid production shutdowns. This accrues from pps, a high material stock and with this closely associated storage by Fifo-principle. It follows a lack of transport, high effort by searching after metal blanks, complex repacking process and unstruct process.

The following ishikawa-diagram (fig. 8) pictures summaries which cause leads to the problem. Mainly the problem of high material stock is shown. It is obvious that the lack of working standards leads to the problems.



Figur e 8: Ishikawa-Diagram

1.6. Target concept

In accordance with the working objectives, in this section the following points will be discussed.

1. Elimination of waste
2. Optimized and standardized transport routes
3. Pull process and visualization
4. Cost reduction
5. Quality enhancement

As already mentioned. it is the aim of this thesis/paper to work out the possible optimization potentials in consideration of the objectives and methods of Volkswagen Production System.The method "Nine types of waste" has already shown which activities cause waste. So, long travel paths or research on material represent non value creating activities.Accordingly Volkswagen PS shall different possible optimization potentials works out and a concept for a better and more efficient supply to production shall developed.

The results of the cause analyses showed that a high potential for optimizing the production planning and control exists. In this part, according to that, target-concept for a sustainable production-program will be prepared.

First of all the production of irregular/uneven week lot shall happen in a continuously week lot. By the use of a continuously week lot the production will be consequently and this has a positive effect on material stocks. Furthermore, the production-program shall be reorganized for the street 150, (this shall follow in the future for the other cutting systems), implemented by one person compare fig. 8.

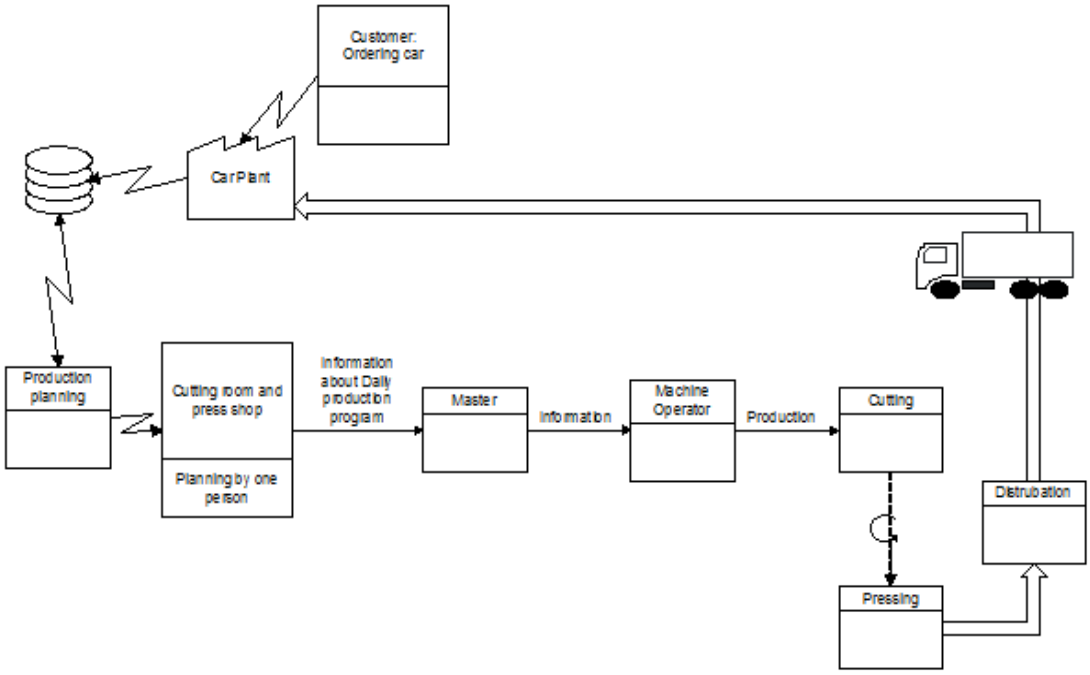


Figure 9: New Information flow.

This means that the planning of production of metal blanks (cutting room) and the forming of metal blanks (press shop) shall be planned by one person. As a result the interface problem can be optimized and the lack of information is prevented, so a better communication can exist.

With the help of this production-program-planning many positive solutions can be transferred on other areas and levels. This optimization-idea ensures that the material stock is low and is according to the demand.

4.6.1 Ideas for improvement: a clocked route-transport

According to Volkswagen Production System at Press-150 the discovered waste, such as material stocks, transport etc. shall be eliminated and standardized. The weaknesses that are found, however, warrant a further question "How should it happen?" The answer is unique.

By optimization of the material flows plus by abolishment of intermediate storage will be an essential part of material supply of Press-150 improved.In order to achieve this it is necessary to have a definition of a standard. In this case the standard is a timetable for the route. Further, it is very helpful to take early measures of deviation from standard (non-compliance of time table).For introduction of a lift truck-operate it is necessary

that the pull-principle at the press shop is present. Further the transport-route from Coil4 to Press-150 shall be replaced by a short-route.

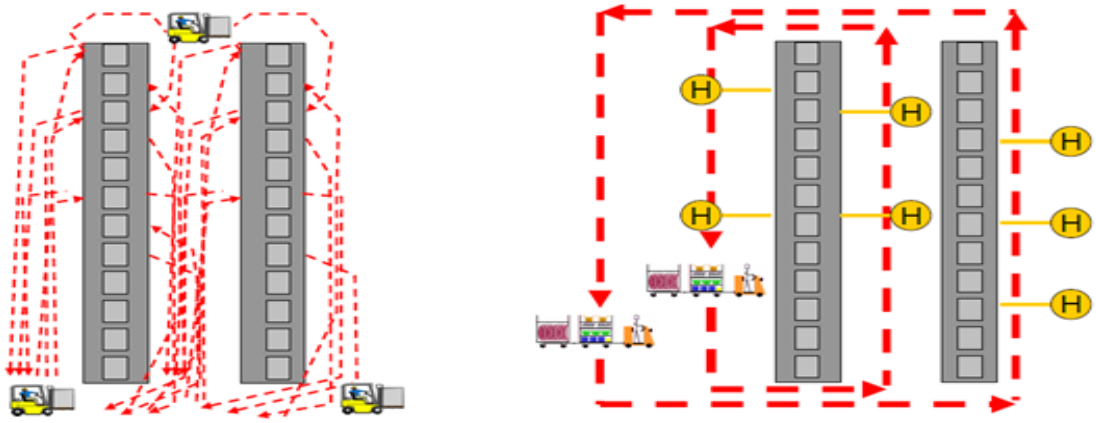


Figure 10: Transport route

4.6.2 New-transport path

Furthermore, a new transport-route shown in figure 10 will be implemented. These are more efficient and more time-saving than the old route. Because the production material will be transported directly, from MBCS, Coil4 and BCS, without intermediate storage, to the staging area of Press-150.

The changeover on the new route is beneficial as the employee does not follow up the metal blanks for the production because they have a permanent parking space. With the help of this new path the Volkswagen Group can save 120,71 km per year.

Table 3: Transport time of the new travel path

Transport-time of the new travel path			
Route	**Length in meter**	**Voyage out in seconds**	**Return journey in seconds**
Coil4 → press-150	132	69,1	68,67

Hence it is possible to

- The Prevention revent the development of residues- so the Coil-size is equal to the lot-size of press-150 150.
- The intermediate storage of press-150 can be removed and at press-150 can be the metal blanks of actual and following production/manufacturing set.

*4.6.*3. The optimization of order of Coils

Step 1: The process of optimization of ordering of coils:

In the future, the order of the coils are done only by contemporary cutting-system-staff.. This means 45 minutes before handling them (attention should be paid to the 2 hours supply).So a surplus value, reduction of coil-stock on 50% can be derived. One positive effect is the reduced control of coils (now only by one person).

Step 2: Adaptation of coil-size:

Another aim of this thesis is the matching of coil-size with the metal blank production- also lot-size in the production. Hence the coil-size will be used as a control factor because there will be a constant lot-size between the cutting system and press shop. Further the residues of metal blanks at the intermediate storage will disappear; the effort will be a less handling.

Step 3: Shipping- and buying metal blanks:

The last aim of this work is the optimization of shipping and buying metal blanks. Thus a need-based and continuous supply is needed. The department cutting-system and press shop shall supply and be supplied from external customer consumption-based and continuously occur in the future. The purpose is to reduce the area and material stocks.

V. CONCLUSION

The aim of this thesis was to create a concept to optimize the material flow between the cutting system and press shop in consideration of Volkswagen Production System.

The main aim was the actual condition analysis of the work processes within press shop and cutting system and based on this the preparation of target-concept for the identified improvements.

Essential method to identify the main information such as Management process, Core process and Support process was the Process Map. In the next step a value analysis to identify the information and material flow and the weaknesses between the Departments was done. For optimizing the basic approach of business process and process optimization were used and a target concept for the identified weaknesses was done to improve the material flow at press shop.As a case study a part of press shop and cutting system were analysed in detail: the press street 150 and the cutting systems (Coil4, BCS, MBCS) which the press-street 150 supply.As essential weaknesses and starting points to realization of optimization this potential was detected:

Conversation of manufacture from push to pull-principle:

Through here the material stock can be minimized, process stability increased, processing time reduced and moreover the cost saved because the material wait time is shortened. Through small lots will be the stock of material manufactured according to the customers demand and the material can be handled Just in time

Increasing the transparency:

By increasing the transparency and the mutual understanding between cutting system and press shop, e.g. from visualization of metal blanks the communication between interface Departments can be improved. Besides with the help of visualization management (Volkswagen Production System) the communication between the interface Departments through easy accessibility of material stocks can be optimized.

Reducing the material stock:

According to nine types of waste, the material stock is a waste. By reducing the metal blank stocks in cutting systems the part of value added activities can be increased. Furthermore is therefore minimizing of capital cost possible actual the circulating stock are 750.00 metal blank within this stocks are daily 150.000 cut metal blanks. The internal guidelines of 1,5-Shift before further process (press shop) cannot be realized because of lack of space and because of new orders partly observed.

Improving the fifo-principle and unpacking processes:

Due the small material stock place the implementing of fifo is not available. Further on the metal blank have repacked so the approach to the necessary metal blanks can be available. Through long travel path the search effort is increased. It is possible with the help of visual management. So a fix assignment of metal blanks to the material stock places is available.

Perfection of coil ordering and size:

The actual coil ordering does not take place close/prompt to the time prior to being machined. Thus it is practical to order these prompt and to lot size correspondingly. So the residual amount of metal blank is prevented.

For this purpose optimization proposal complied to work on by step to step the apart deficit.All in all between the cutting room and the press shop a new concept for a new route and a clocked-route-transport was implemented. So a just in time supply is possible and it prevents high material stocks.In agreement with the people responsible for optimization of ordering und shipping the high material stock will be eliminated too and at the press-150 only one person will plan and control the production-order.The following figure shows the savings:

Table 4: The Savings through the Process Improvement

	Before	now	Saving
Drive in summary	231,19 km	110,48 km	120,71 km
Drive to BZA	40,18 km	0 km	40,18 km
Work-hours/ employee	23,43 h: Stock-BCS 20,00 h: Stock-MBCS 8,81 h: BCS	32,03	20,21 h
Intermediate storages	847,8 square meters	50 square meters	797,8 square meters

REFERENCES

[1]. Wagner, K. W.; Käfer, R. (2003): PQM- Prozessorientiertes Qualitätsmanagement, 2. Auflage, Carl Hanser-Verlag, München, Wien

[2]. Schneider, Gabriel; Geiger, Ingrid Katharina; Scheuring, Johannes (2008): Prozess- und Qualitätsmanagement- Grundlagen der Prozessgestaltung und Qualitätsverbesserung mit zahlreichen Beispielen, Repetitionsfragen und Antworten, Compendio Bildungsmedien AG-Verlag, Zürich.

[3]. Bergsmann, S. (2011): End-to-End-Geschäftsprozessmanagement - Organisationselement Integrationsinstrument Managementansatz, Springer-Verlag, Berlin Heidelberg

[4]. Gaitanides, M. et. al. (1994): Prozeßmanagement- Konzepte, Umsetzungen und Erfahrungen des Reengineering, Hanser-Verlag, München, Wien

[5]. Hirzel, Matthias; Kühn, Frank; Gaida, Ingo (2005): Prozessmanagement in der Praxis- Wertschöpfungsketten planan, optimieren und erfolgreich steuern, Gabler-Verlag, Wiesbaden.

[6]. Hellstern, G.-M.; Buchenau, G. (2004): Geschäftsprozessmanagement- Praxisorientiert umgesetzt, 2. Auflage, Lit- Verlag, Münster

[7]. Ferk, H. (1996): Geschäftsprozessmanagement- Ganzheitliche Prozeßoptimierung durch die Cost Driver-Analyse- Methodik, Implementierung, Erfahrungen, Franz Vahlen- Verlag, München

[8]. Corsten, H. (1997): Management von Geschäftsprozessen, Kohlhammer-Verlag, Stuttgart/Berlin

[9]. Kletti, Jürgen; Schumacher, Jochen (2011): Die perfekte Produktion [Elektronische Ressource] : Manufacturing Excellence durch Short Interval Technology (SIT), Springer-Verlag, Berlin Heidelberg

[10]. Wildemann, Horst (1995): Lean Management- Methoden, Vorgehensweisen und Wirkungsanalysen, 2., überarbeitete Auflage, TCW Transfer-Centrum-Verlag, München

[11]. Ohno, T. (1993): Das Toyota-Produktionssystem- Der Begründer der Lean Production zeigt, wie sie entstand und wo sie Reinkultur betrieben wird, Campus-Verlag, New York

[12]. Volkswagen Intranet