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THE UPGRADED ROLE OF THE VALUE STREAM DESIGN FOR REDESIGNING THE FACTORY LAYOUT

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Abstract
The case study shows the re-optimization of an initial new factory layout design with Value Stream Design (VSD). The VSD is a quantitative method and its' final goal is to make a waste free optimized material flow. The primary goal of arrangement is to reduce transportation distances and frequencies, optimize human load. Initially the whole factory shop floor layout design was already made in push concept. The plans were made by production management, logistics, engineering department at the headquarter of the multinational automotive company with based on VDI2870 holistic concept linking strategy on tactics and operation. On the layout (v1.) the hundreds of machines were placed and arranged by CAD (Computer Design) engineers to fit the space. The factory building has 15,000 m^2 with empty shop floor waiting for the final decisions for equipment. The factory production area was shared into six main production areas (P1-P6), which correlates with their product complexity of the product families. Each production area output can be finished product (FP) or semi-finished product (SFP) for the next production areas. To validate the whole factory layout it was necessary to involve lean experts that identified disadvantages and constraints. Without lean implementation the company's transportation waste would be 49% more per year. The Value Stream Design importance nowadays is upgrading to a higher level, when the whole global business is changed, the labor force fluctuates, and the cost and delivery time reduction plays a vital role in the company's profit and future. The research shows that if the decision taking is based on real data and facts the controlling and management can do its best in time. Using VSD and re-evaluating the transportation routes, frequency and costs is the first step to define a smooth, low cost, material flow (v2.). This development ensured the company to drive from push to pull production through mixed production system. Originally, the production flow was clockwise orientation. It was changed step by step to mixed production by eliminating work in process storages, implementing FIFO lanes, Milk Run, and Kanban. The total annual transportation distances were reduced from 4,905,000 m between the rump-up and serial production period. The warehouse storage size was reduced to 50% and implementation cost from €75,000 to €32,500. By eliminating work in process storages along production lines it was possible to open a new two way transportation road that also will serve the AGV's operations in industry 4.0 projects. Due to decreased lead time the logistic labor productivity increased by 45%. Besides taking measurements for the VSD it was used Value Stream Mapping as a lean tool and an own designed VSD evaluation and a simulation software. The VSD team's cooperative actions reduced the evaluation and validation time with 65% then it was initially planned. The implementations were evaluated from the rump-up phase to the first serial productions and the results were confirmed by controlling and management.
KEY WORDS: factory layout; distance optimization; push; pull; lean; industry 4.0; Value Stream Design.

Introduction

We are convinced that nothing can be more authentic than Taiichi Ohno's mindset and the efforts implementing the flow concept to reduce the production lead time. Ohno realized that "getting things closer to assembly line is a good thing". (Harada 2015, p14). All processes that Ohno developed under his control was grown. To reduce flow distances and lead time in the machine shop was reduced the changeover times and batch sizes. Despite that some operators were able to handle machines and productivity was increased, but the batch size still did not changed. The breakthrough was when batch size significantly was reduced due to changing the layout and putting machines in process order close as it was possible to limit the transportation and processing distances (Harada 2015). In general at any production company it is important to reduce the production lead-time to be able to satisfy the customer needs against the competitors. Therefore from time to time even for the high productivity companies it is important to re-evaluate the actual total material flow status and to prepare for the future challenges. The future can mean, higher order volumes, new products for existing customers or for new ones. The geographically shifting productions also play an important role even in case of joint ventures.

Any change in business can have drastic consequences if someone can't make quick and effective changes at optimal cost. Building a new factory and installing the production from sketch is a real challenge to find the optimal arrangement for the equipment on the shop-floor that definitely predefines the shortest lead-time. Design of manufacturing and logistics processes with a simulation process computer-assisted procedures are playing an increasingly role in the management of production systems. Designing a production the CAD tools play an important role, but the process and material flow simulation procedures are included just in the special simulation programs. Despite that CAD /CAM (Computer Aided Modeling) software's are efficient, but due to time shortage the management was seeking for quick solutions. The initial planning for the factory was made at HDQ (Headquarter) by production management, logistics, and engineering department. They used CAD to build up the production layout (v1.) by arranging the machines in absolute functional order on 15,000 m^2 factory. The plant layout was designed

in push system and was defined six production areas (P1-P6). The calculation was made for one year period production for 150,000 pcs products for all six product families. Based on the plan v1. the total calculated transportation distance was 4,905,000 m for one year production starting from a large warehouse. The production areas and machines were arranged on clock-wise flow with parallel production lines orientation starting everything from warehouse. The WIP (work in process) time between the productions areas were calculated between 1-1.3 weeks, the average processing time from P1 to P6 was 4.2-5 days, but due to high WIP and waiting the total lead time extended up to 65 days. In the rump-up phase the OEE (Overall Equipment Effectiveness) was 40-60%, and high scrap ratio 8-10%. The target OEE till the end of the year was 70-85 % differing by production areas. The number of forklift drivers per shift was planned 10 in 50 weeks, 7 day production operation. Creating the factory concept the project reached the tactical level where methods for evaluation and validation had to be selected. From the kick-off of the layout planning project until the implementations was initially allocated 8 months. The last two month was planned for validation (Fig. 1).

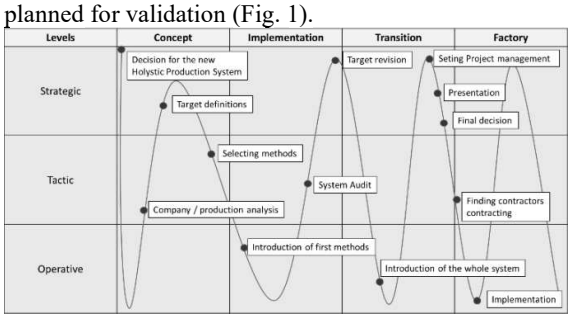

Fig. 1. Holistic approach of the factory layout development
Source: own, based on VSD action

The method

By the decision of the global factory management the lean manufacturing approach was decided to be used for the validation. The lean production includes the capability to create flow including set-up time reduction and pull (Cagliano et.al. 2006). One of most important lean action is to map, analyze and improve all value streams in the business processes to eliminate non-value adding activities. Only those activities that add value for the customer are kept (Jasti - Kodali 2015). The final layout development was used the Value Stream Design method that is originated from Toyota Production System (TPS). The TPS is known as lean production system that was first mentioned in the journal "Triumph of the lean production system".(Krafcik 1988). The main focus in the lean production system is the customer (Schonberger 2007). TPS by the founder Taiichi Ohno words is "all we are doing is looking at the time line from the moment the customer gives us an order to the point we collect the cash." (Liker 2004, p7). In other words the total value chain is from customer order till customer pays for the product or service.

To make good improvement is to generate solution for the detected issues. Therefore was used the Kaizen approach to turn ideas into reality that is the part of the TPS culture as well. The Kaizen gives the possibility to make small step by step improvements. Kaizen was mentioned first by Masaaki Imai as continuous improvement (Imai 1986). As much people are involved in Kaizen the result gets better. The everyday VSD work must be public to all employees. The Kaizen activities practice by everyone, everywhere in company and every day (Imai 2006).

Genba or Gemba both expressions are correct. The meaning of gen is real. As context with the production gemba means is the real place where the actual work is done.(https://blog.toyota.co.uk/genba-toyota-production-system). In general refers to the place where business activities are done - like the planning, production and selling. Now adapted in management terminology to mean the 'workplace' or the place where value is added and where the abnormalities happen. In manufacturing it usually refers to the shop floor.

Before starting the VSD actions all existing employees in the old factory were informed during Gemba Kanri (Shop floor management) about the purpose of VSD project. Everyone had the same chance to give freely improvements in a designated postbox. The Kaizen ideas were next day evaluated. Direct implemented Kaizen ideas were 22 out of 52. In 21 days it is considered good participation that meant that the employees were interested in their potential future workplace that had to apply. One of the Kaizen principle during the problem solving, is to go to the real place, location is called genchi. The goal to investigate and understand the situation, to collect real objects, data, and facts about the process. Object and acts are called gembutsu. The expression in Japanese is genchi gembutsu. (Liker 2004). In English lean terms it is used "go and see". In this way misunderstandings, false data can be much more easily detected, based on real information and the decisions will be more precise. The Gemba approach is very useful, because one object was hidden on the v1. CAD layout. It caused that one group of machine was wrong designed on v1 plan. On one hand during the development was used CAD digital interface but, it was check and validate in live environment.

For the layout development the cross-functional team was engaged from the local employees led by an external lean Toyota Grade 4 TPS expert. After the presentation of the v1. plan several questions were raised. The distances were checked on the Gemba because of the equipment what is going to be installed will really fit to the shop floor as it was planned.

The Lean concept is based on five principles (Table 1) and is the key management concept of the Toyota Production System. The Value Stream Mapping and design has to cover all the value chain, from supplier to customer.

The case study is limited to internal flow development for the factory shop floor. The lean principles define the simplest 5 steps to find and elimination the waste.

Table 1. The 5 key lean principles
Source: Liker 2004

	Principle	Description
1	Value	Identify the value for the customer in product or service
2	Value Stream	Identify the vital steps that create value and eliminate the waste
3	Flow	Identify all processes that cause disruption in flow, delay, waiting
4	Pull	Supply only on demand
5	Perfection	Strive to perfection by reducing consecutively the waste

Just In Time (JIT) concept is one pillar of the TPS house (Tapping et.al. 2002). It is responsible for production speed to produce product. Just in Time defines to produce only what is needed, just what the customer needs at the right time in the right quality and lowest price as it possible. The opposite actions are to produce something else, not at the right time, quantity or quality. Any kind of activities during a day is time bounded.

By lean principles the indirect activities are all considered waste. Waste are generating cost also generates non-satisfaction for the internal and external customer. The lean approach based development result in higher delivery reliability, shorter lead times and thus quicker response to demand, hence better customer response performance and higher customer satisfaction (Wilson-Collier, 2000). The TPS focuses on the customer that is paying for the product or service the waste elimination concept is strong integrated as upstream and downstream processes in the whole value chain. (Liker-Morgan 2006). The upstream- downstream is an analogy like a river that flows. In lean culture the upstream means previous process, the downstream means the next process or element and all the value chain can be investigated based on this concept. Enhancing this link pair it is symbolized as supplier-customer relationship. The internal customer definition term is rooted from above approach.

The high flow oriented workplace organization of the production components ensure the basis for high efficiency The first two steps of the 5S method is about the JIT foundation. With the words of Hirano Hiroyuki Sortly, the first pillar of the visual workplace corresponds to the Just In Time (JIT) principle of ”only what is needed, only in the amounts needed, and only when it is needed”. In other words Sort means that you remove all items from the workplace that are not needed for current production (or clerical) operations.” (Hirano 1996). Elimination of unnecessary things even in an early stage and setting the right order make the foundation of the takt time based production, with smooth flow, based on pull principles. The not satisfactory layout arrangement always generates stress, overload (muri), waste (muda) and unplanned dysfunctional variability (mura). Often is mentioned as 3Mu. These must be eliminated or reduces as much is possible (Hopp-Spearman 2004).

The visualization (visual control) is also part of TPS base system and strongly influences the layout design. The decision about the main transportation roads in the factory and safety has legal and vital importance. The visual management is not only about making markings on the floor, it is about to see all the status of the productivity performance at a glance. Must be considered: the production lines orientation and distances, WIP storages locations, transportation roads, transportation equipment and size, the handling, machines, logistical equipment, electrical forklift loading stations, evacuation, escape roads, crane activity ranges, fire stations, energy sources, waste bins, empty container location, first aid points and more. On the v1. CAD layout several objects were not designed just the machinery of production lines. The CAD version served as a good static starting point for development. The biggest challenge was the ability to reveal to surface in the early stage the wastes and to design into the future flow with all necessary objects.

The lean manufacturing operational stability (Ohno 1988) is reflected by the standardized work. The standard work operation is based on factory layout as the roots in the factory, production lines, layout organization and operation. The tree elements of standardized work as follows: takt time, work sequence, and standard work in-process inventory.

VSD’s goal was to set up the right place and quantity for standard work in-process inventory. It was defined the input and output locations on the layout with 5S approach for material and equipment. For all product families takt time was calculated to have the big picture how often is produced a product that has to meet the customer demand (Lander-Liker 2007) and how much space will need on the shop floor.

Another JIT tool is the Kanban system (Gross 2003) that coordinates the flow by demand limiting and optimizing the WIP volume and flow. The production leveling is the task for production management and tends to satisfy as much as possible the customer demand by takt time.

In TPS to have production stability it is needed the Jidoka what is the right pillar of the TPS house. Jidoka function is visualization of any problems that have effect on quality or flow. If abnormality occurs the process stops. By example this can be a very simple thing like a missing object, information, material. The key concept is to produce only quality at the first time.

The layout of a factory defines the product creation process and the order processing in time and volume. The flexible lean manufacturing means to change even the layout of the factory when the lead time and costs can be reduced.

From lean manufacturing process point of view supplying the customers there are two major activities in production or service process. One kind of activity is the value added (VA), that the customers are willing to pay for. All other activities are non-value added (NVA), known as waste. The muda approach in TPS production plays an extremely high importance. Waste means always cost. Regarding the Value Stream Mapping and Value Stream Design the principles lays on identifying all the processes steps, information and

material flow as theoretically and practically. The goal is finding bottlenecks by eliminating any kind of waste based on NVA (Shah-Ward 2003). A special Non Value Added activity is the business NVA (BNVA) that cannot be eliminated from the processes, it is the minimal required waste to process the product (Rother et al. 1999) This can be a necessary transportation to and from the production lines and it is included and calculated in manufacturing time. It has to be minimal. Generally the cycle times are very difficult to reduce significantly therefore the VSD focus on the transportation between the production areas. As final result all the processing transportation and waiting times are added all together and defines the factory lead time. The ratio of VA/NVA defines a production capacity and shows the room for improvements. As shows in this study the 4.5 day processing time is pushed out up to 65 days.

The cross analysis of product family VSD's has to be done with grate attention and accuracy, because one change can have multiple effect on the total Value Stream. The effect can be positive and negative as well. The Value Stream Design was done in the frame of the existing production. The ideal Value Stream Map would cover the whole, but there is needed for a manageable size (Jones 2011). VSD is to define the future or ideal status a wasteless production arrangement with smooth flow. The primary goal of VSD was to shorten the transportation ways. All other goals are listed in Table 2.

Table 2. The primary and secondary goals
Source: own, based on VSD action

I.	**Primary goals**
1	To find the best optimized material flow for the whole main product families 20%
2	To reduce transportation distance by 20%
3	Reduce lead time & cost 10.000 €
4	To find transportation flows bottlenecks (less crossroads, less accident)
5	Prepare the flow from push to pull production
II.	Secondary goals
6	Prepare the factory for future material flow for indusrtry 4.0
7	Milk-Run logistics by fork lift train (less cost)
8	AGV – Automated Guided Vehicle transportation
9	Increasing logistic labor productivity 30%
10	Reducing the risk of labor force shortage
11	Reduce maintenance cost by less usage of transportation tools

The four member core team with dedicated roles built up a development plan based on PDCA. The first practical action was the evaluating the present state (v1.) by identifying at the macro level the processes with existing data. The actual layout was given with all machines and sizes in CAD file. A mobile rolling office was set up on the gemba. The digital distance measurements were performed parallel on notebook. The measurement data was immediately validated by laser measurement by the team on site. Every change variation was numbered and saved in separate folder and paper together. The layout processes and object arrangement technological sequences were evaluated conform the planned material flow registered in production process documents. Every day the progress was reported for the top management through project management interface with attached data. As starting background there was used the previous built factory layout in CAD plan (v1.). All data was compared with the reality on the gemba. The VSD development process is visualized in the (Fig. 2).

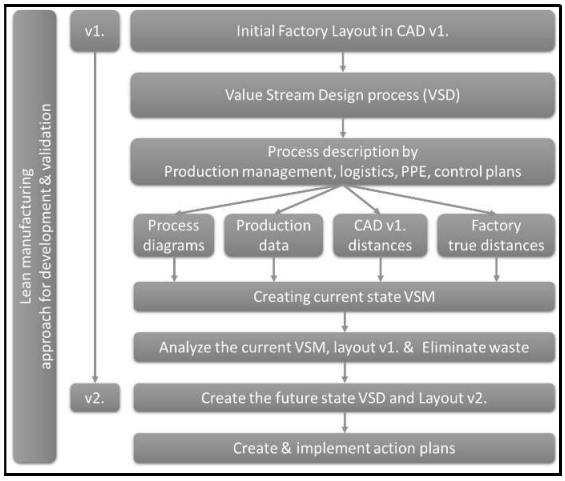

Fig. 2. The VSD development process from initial plan (v1.) to final plan (v2.)
Source: own, based on VSD action

The current stage Value Stream Map harmonized with the production process controls data. For the operative work calculations and visualization for the VSD was used an additional VSM tool an own developed Excel based software together with "Paper Kaizen". Paper Kaizen means the color proportional hardcopies of "CAD" factory's layout that served to make the layout items modifications. The paper kaizen has great advantages for the teamwork. it has large scale, for each team viewpoint is possible to observe the subject, to have the same focus and field of view, therefore due to visualization was the communication was effective with less misunderstanding. The cut out of paper of the areas or machines could be easy quick relocated, combined, simplified on an empty printed layout. All work in process and production input-output points on the Paper kaizen were marked and physically linked with a thin wire. During development the production elements were moved by hand on the paper. If it was placed to a longer distance as initially was, the wire had to be cut and needed an objective explanation based on data that decreased the risk of wrong decision.

Each change combination of layout were immediately recorded in excel so the data has shown the change direction and percentage to initial plan because the target was 20% better results for the flow. The method's next step is to set up metrics. The metrics was given. For visualization each product family was created a unique value stream but by the data analysis could be seen as a whole output.

The (Fig. 3) shows a 12,500 m transportation distance for one of the product family before improvement. The total distance of transportation was 4,905,000 m / year.

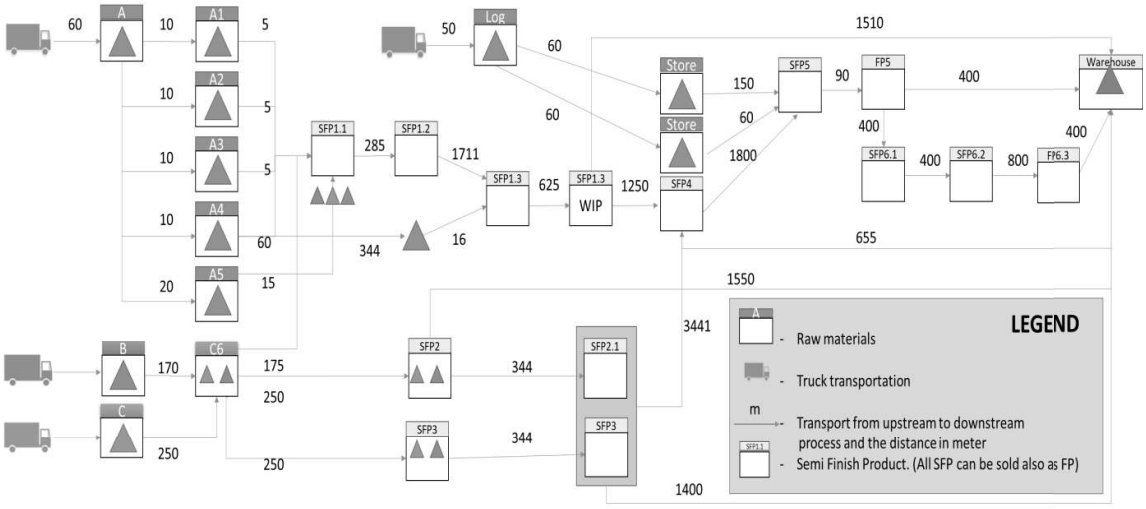

Fig. 3. Current state VSM of a product family show the transportation distances between processes that was more than 12500 m / year in this case.
Source: own, based on VSD action

As significant potential developments were identified as follows:

- by the original plan the transportation on the road between P5 –P6 areas was possible just by turning around 180,
- in case of abnormality the road should be blocked by maintenance works,
- the parallel arranged machines defines long transportation distances,
- the layout does not serve as advanced transportation means implementation for AGV(Automated Guided Vehicles)-s,
- every WIP is moved by forklift and human power even on the shortest distance,
- there was no commissioning area and only one main gate was used for delivery to customer where bottleneck can occur,
- the truck gate 5.,6.,7 was not in use just for evacuation purposes,
- everything was calculated for normal production situation and the abnormalities planned to be balanced with high WIP storages and the warehouse
- no space dedicated for side materials,
- evacuation road was not set,
- crane operation range was wrong calculated,
- the warehouse has only one entrance,
- P4 production line had no ventilation equipment.

For the total VSD analysis the basic yearly quantity information are in the Table 3. The data analysis included cross-check between product families regarding the used resources.

Table 3. The planned yearly product mix
Source: own, based on VSD action

Product family	Product /year (psc/year)	%	Cummulated %
A	31 000	21%	21%
B	26 000	17%	38%
C	30 000	20%	58%
D	25 000	17%	75%
E	25 000	17%	91%
F	13 000	9%	100%
Total product	150 000		

One product family covers several final products and the production steps are very similar. This is extremely useful because one improvement of VSD has effect on more products.

Results

To eliminate transportation distance, resources, time there was necessary to decrease with the layout change the work in process quantity. On the layout was optimized from push production to a new mixed production layout was created.

The production (P1, P2) was rotated by 90° Clock Wise and designed by capacity to deliver 50% in pull flow following the Make To Order (MTO) Strategy for product families A, B.

The other product families were covered by the other 50% capacity of the other production lines. These products are produced in Make To Stock (MTS) strategy from P3 to P6 production area. In this sense

the 60% of the factory area is prepared for pull flow improvements by shortening drastically the transportation routes changing the orientation of machines and the layout itself.

It was developed FIFO lines for the short distance material movements using the gravity. In this way was saved time and human resource of operators and logistics personnel, too. For this development was required to consider the 5S method regarding layout crowd and also helped in decision of use for transportation means. An overcrowded workplace (Hirano 1996) reduces work efficiency. The eliminated equipment contributed also for freeing up shop floor space, 120 m^2 and enhanced the production safety. During VSD the logistic labor productivity increased by 45%. This was reached by implementing logistical train making possible transportation of two to six trolleys at the same time. The transportation load was not taking the operator's time and they can focus on production. Material was moved between productions and downstream only by logistical persons regulated by standard work. The cycle was one hour. In every shift was required three to six logistical operator called "water strider", Misuzumashi in Japanese. The forklift by small modification could be used and logistical train based on Kaizen ideas. The implementation cost of the milk run set up was covered by the saving from the 50% decreasing of the warehouse size.

During VSD development there was considered the effect of the changed layout that can be balanced with a number of milk run trains. In extreme abnormal cases raw material could be purchased from branch companies at internal prices in one day. The lead time reduction, contributed to 30% productivity improvement that can cover the production time necessity until the abnormality elimination is no more than above value.

Conform the logistics 7 Rights principles that are very similar to JIT concept as follows:

- the right product or service,
- right quality and quantity,
- right condition,
- right customer,
- right place,
- right time,
- right costs.

The VSD was driven by the last three principles (place, time, cost). The transportation distance data was analyzed related to transportation frequency. This was the practical VSD method of the improvement variations and decision. Multiplying the two data pairs resulted the intensity of transportation. Using the graphical method was possible to reach the 49% improvement. The Fig. 4. and Fig. 5 served as decision for modification step by step.

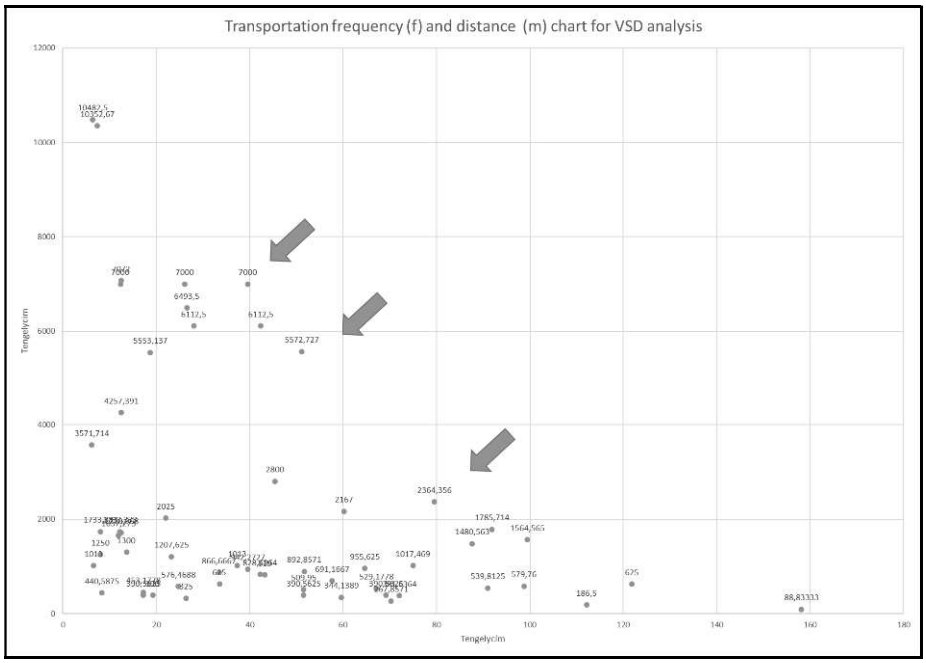

Fig. 4. Data visualization of the transportation frequency and distance plot chart guides for choosing the improvement and the improvement order
Source: own, based on VSD action

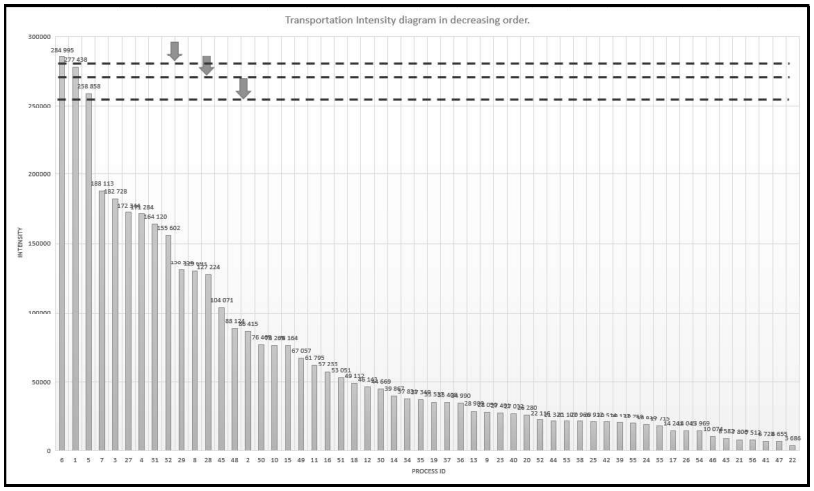

Fig. 5. Transportation intensity bar chart giudes how to select the improvement orderby „pusshing down" the red „ruler"
Source: own, based on VSD action

Using the mentioned two figures together (Fig. 4, Fig. 5) was a good visual method to find and decide which waste to decrease and in witch order. It is needed because a shorter distance with high frequency can be in time bigger loss as bigger distance transportation with low occurrence. Eliminating one waste the graph automatically rearrange after deleting the data from the VSD. Therefore the order sequence is instantly changed and the cross-check can be done by evaluating the data because the data shows the place of transportation.

The all VSD analysis was planned 32 days and due to the used methods there was 65 % time saving. The VSD analysis was fulfilled during 11 days. Because of it the implementation operations could be started 21 days earlier.

The total transportation distances improved from 4,905 km to 2,401 km/year. 49% is the result of implementing VSD. The 49% are the major 15 improvements listed in the Table 4. The decisions was supported using the four Kaizen basic principles ECRS (Imai 2012). The ECRS meaning and order is the next:

- E – eliminate totally
- C – combine
- R – rearrange
- S – simplify

The table shows the relevance of the VSD where the rearrange Kaizen implementations took 47% of the total VSD makro improvements (7 out of 15) itself.

Table 4. VSD related changes
Source: own, based on VSD action

ID	Changes during VSD developments that contributed to transportation distance and time reduction	E	C	C	R-S
	ECRS methods	**3**	**5**	**1**	**7**
1	Rotating P1, P2 area CW ensuring MTO and implementing Kanban for the high runner low variation products				x
2	Creation of a commissioning area for each truck gate next togate (4, 5, 6, 7 gates) .Opening truck gates for MTO products (6, 7)		x		
3	Removing the wall from back of the highstorage area ensuring immediate access from many direction	x			
4	Swap and internal redesigning of P3 with P4 area. Swapping P5 and P6 areas because of transportation frequency.				x
5	Rearranging or creating flow oriented inputs and output for all areas as close as possible	x			x
6	Adding one additional route through the warehouse. Creation of FIFO lanes to close transportation distances.		x		
7	Removing one row of racks P1-P4 (removing 2 rows of storage P5,P6)	x			
8	Opening rout between of P5-P6 area		x		
9	Change of P4 orientation			x	
10	Reworking warehouse routes and adding more rack space vertically				x
11	Removing the wall from warehouse and ensure straight transportation in-out	x			
12	Reworked P4 outgoing goods direct to warehouse		x		x
13	Added necessary route area to avoid collisions between SFG and finished goods in P3-P4 area		x		
14	Repositioning of the charging stations				x
15	Adding Milk-run way by shifting 2m to right the P5, P6 area				x

The schematic factory layout plan before improvement shows (Fig. 6) the parallel production area orientations and in top middle the oversized warehouse.

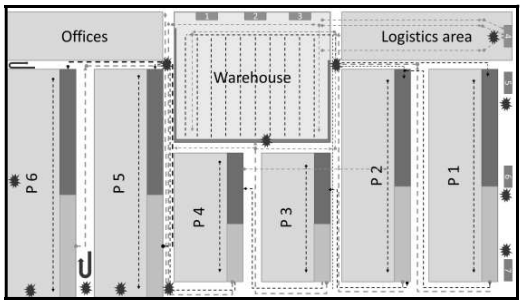

Fig. 6. The v1. factory layout plan before improvement
Source: own, based on VSD action

The material flow starts always from the warehouse towards the production areas. In the push system the production areas are functional arrangement of the production. The production speed is unique for each production area and it is not balanced. Therefore, the abnormalities are handled with a huge WIP beside the lines, not taking into consideration the changeover caused waiting times.

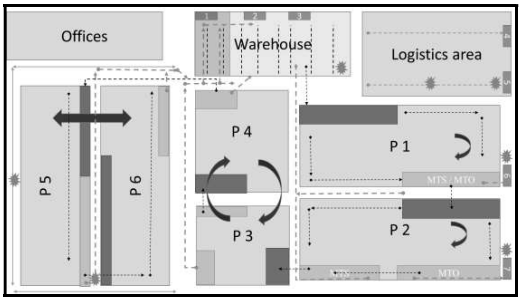

Fig. 7. The v2. factory layout plan after improvement
Source: own, based on VSD action

The Figure 7 is the final result of the VSD actions showing a significant change in orientation. The P1-P4 are the 60% of the factory layout running in mixed production are prepared for pull flow production implementation. It is characterized by short inter-production area transportation ways and the finished product of P1, P2 can be immediately loaded to the truck thru the gates 6, 7 that initially were inoperable.

Each production area can work in sequence, too providing higher and higher complexity by customer need. The low work in process ensured the quality improvement that was decreased from 10% to 4% during in one year production.

The OEE was increased on the pull area up to 82%.

Additional saving was recorded by the maintenance in operating the forklift charging cost that was decreased with 45% due the balanced use of the forklifts. They were not overused and could be maintained more regularly with less serious parts change.

The absolutely new development open the gate to use advanced transportation technologies like AGV's in the area of P5-P6. There is possible to design and operate industry 4.0 oriented AGV system.

Conclusions

By accepting and implementing the initial concept results which had partial elements of the lean concept, the company would highly risk on long term loosing capacity income and customers.

The practical VSD implementation proves how powerful can be the production development in the very early stage using scientific methods of lean manufacturing approach on the shop floor. The study has shown that on one hand the in-house production experience accumulated during the several years is very precious, but on other hand does not fulfilling the requirements of modern flow design. So there is the need for paradigm change and tools. The focused improvement ensure in advance wasting high amount of financial resources leading to early savings before any bolt is purchased tightened on the shop floor. The direct cost can be easily evaluated, but the indirect additional savings plays an important role to fulfill the financial targets of the company. With VSD can save money, time, resources and more important keeping the customers that is the heart of the business.

Until there is value and waste the problem the lean paradigm lives. The problems have to be evaluated from many directions accepting also new methods. Building up hierarchical value stream is the key for future industry 4.0 by lean 4.0 methods as digital VSD.

The special situations need special solutions. The case study shows that a method can be improved and combining with the other quality and productivity improvement techniques. As known the lean focuses on the waste elimination but the implementation cannot be executed without Kaizen improvements.

The team oriented focused developments like the VSD needs human creativity. Itself the IT technology helps in data processing but the decision is the human side because machines cannot give new ideas.

As it is obvious that there is no same situation and solution for a problem but always we have to follow the principles driven by scientific methods and views.

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