ANALYSING THE VALUE OF INFORMATION FLOW BY USING THE VALUE ADDED HEAT MAP

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Abstract

Inadequate internal communication and insufficient information transfer is already recognized as a non-value-adding waste. To achieve a higher value creation, an identification and categorization of information transfer is necessary. Common methods are unsuitable especially for visualizing information media disruptions and lead to errors in the added value. Moreover, media disruptions mostly cause redundancy and additional effort, which are reflected in non-value added activities. The Value Added Heat Map is a visualization tool that categorizes and visualize the information flow different from other visualization tools e.g. the value stream analysis. The first step in categorizing the information flow using the Value Added Heat Map is the value analysis of the information transmission. In a second step, the information flow is visualized in the factory layout depending on the value. The innovative method Value Added Heat Map is described and exemplarily applied to an information flow of a production shop floor. The results show that the Value Added Heat Map method can contribute to a better transparency of the often not fully documented internal information flows. This innovative approach enables the visualization of media disruptions via colour transitions and thus helps value added processes by identifying and eliminating possible sources of waste.

Key words: Value Added Heat Map, Value of an Information, Value Added Concentration, Information Flow, Digitalization, Digitalization Degree, Media disruptions

1. INTRODUCTION

An information flow uses data and documents to describe the communication between production and controlling processes (Erlach, 2010, p. 32-33 as well as Koch, 2015, p. 138). In literature, there are data visualization methods in application to big data (Gorodov & Gubarev, 2013, p. 3-7), but there are only a few approaches for visualizing information flows for intralogistics processes (Günthner & Schneider, 2011, p. 32). Know visualizing tools, e. g. Value Stream Analysis or Sankey-Diagram,

focus on the material flow than on the information flow. Moreover to date there exists no adequate methods, including the Value Stream Analysis or Sankey-Diagram that classifies the value of an information flow.

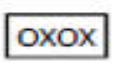
1.1. Scientific Aim of Analysing the Value of Information Flow by Using the Value Added Heat Map

Inadequate internal communication or defective information transfer is already recognized as waste (Schröder & Tomanek, 2012, p. 17). Notwithstanding the importance of information in the era of digitalization, the visualization of information flow in production shop floor has still a marginal meaning. The aim of this paper is to point out the value of information flow and media disruptions. For this reason the authors developed an innovative evaluation scale to classify information flow following the added value. There is no comparable method existing for evaluation of information to date. This value added scale has been verified by the authors in the shop floor of a production. The collected data was visualized by using the Value Added Heat Map by Schröder and Tomanek, which has been for the first time adapted to the analysis of the value of information.

1.2. Value Stream Analysis

Value Stream Analysis is a proven method for identifying and avoiding wastage within a production process. Originally developed in the 1990's and linked with the Toyota Production System, Value Stream Analysis is used today in many industries for process improvement. In the Value Stream Analysis arrows are generally used as a symbol for the information flow (Table 1). A jagged arrow symbolizes electronic information, e.g. a master over the ERP system. A straight arrow represents a manual information transfer. This may, for example, be the master giving the worker previously received oral instructions from the company software. Transmission of information, in particular in the production sector can also be mapped through a go-and-see planning, a levelled production planning or a Kanban symbol (Balsliemke, 2015, p. 9 as well as Rother & Shook, 2000, p. 100-101).

Table 1. Value Stream Analysis - symbols for the visualization of an information flow

Symbols for the information flow	Meaning
	manual information flow
	electronic information flow
	electronic information flow
	levelled production planning
	Route of a kanban card

Source: Balsliemke, 2015, p. 9 as well as Rother & Shook, 2000, p. 100-101

1.3. Sankey-Diagram

The Sankey-Diagram had originally only been used for thermodynamic systems. Heat losses could be easily identified with this tool. Step by step this method has been successfully applied to other disciplines (Sankey, 1896, p. 182–212 as well as Schmidt, 2008, p. 82-94). Today the Sankey-Diagram is a well-known analyzing tool is used to. Applied to a shop floor it can be used to visualize the flows of materials or costs and identify material losses, for instance by production faults or inefficient processes. The main component of a Sankey-Diagram are arrows. They interlink the individual process steps and the direction of the flow. The thickness of the visualized arrows represents the quantity of the substance, which occurs in the flow (Sankey, 1896, p. 182–212 as well as Schmidt, 2008, p. 82-94).

The visualization of a Sankey-Diagram can be combined with a layout of a shop floor. The drafting of this diagram starts always with recording the flows of the occurring substance within the analyzed subsystem. The result is a simple, model-like diagram of the analyzed process steps and material flows, which allows a practical assessment of the regarded system. Within a shop floor the Sankey-Diagram can e.g. display crossing material flows, which cause production backlogs. Transport bottlenecks or material loops are further examples that can be visualized by this method. Consequently, waiting times in the production could be explained.

1.4. Value of an Information

The transmission of electronic information in an oral form constitutes a media break. A media break is a change of medium during the transmission of information within the transmission chain (Gabler Wirtschaftslexikon, 2015, online). If received information is further developed into another form, then this development may create communication problems. Mistakes in the transmission of information can lead to errors in the added value. Moreover, media disruptions cause redundancy and additional effort, which are reflected in non-value added activities such as printing, copying and scanning. From an added-value perspective, media disruptions should be minimized, or, better still, eliminated.

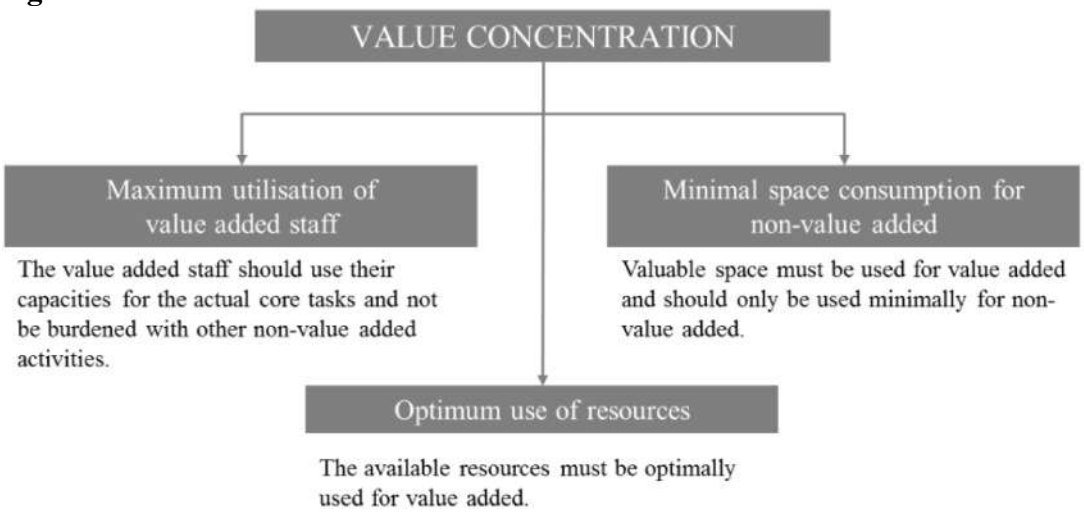
Identifying media disruptions is sometimes very difficult in practice. The problem lies both in the lack of transparency in the information flow within the company and in the absence of adequate forms of design. In the literature, for example, no independent symbol exists for the visualization of media disruptions.

1.5. Value Added Concentration

Operational activities that are not creating value are equal to wastage that should be minimalized or eliminated. Wastage is defined as a creation effort that a customer is not willing to pay for (Bergmann & Lacker, 2009, p. 161 as well as Bhasin & Burcher, 2006, p. 56 - 72). An approach to assess the added value is the analysis of the Value Added Concentration. The Value Added Concentration negatively correlates to wastage. The less wastage occurs within a process the higher is the Value Added Concentration. The same applies vice versa.

Three key factors covers the assessing of the Value Added Concentration: personnel deployment, resource usage and space usage (Schröder & Tomanek, 2012, p. 21). A maximum utilization of the personnel, which is directly participating in the value creation, is expedient because they perform the creation of products or services. In order to concentrate the value added, the value added staff members should focus their working capacity and on their core tasks. Optimization of the resource usage, e.g. equipment or machines, should also be pursued to ensure the maximum concentration of benefit. Spaces within the shop floor are usually a highly limited good. Unused or reserved space create no or only limited value. The primary aim should be to reduce spaces that do not create value, to ensure that sufficient space for the actual value adding process is available (see Fig. 1).

Figure 1. Value Added Concentration



Source: own research

An innovating method for the analysis of the Value Added Concentration in a shop floor is the Value Added Heat Map by Schröder and Tomanek.

2. METHOD DESCRIPTION – VALUE ADDED HEAT MAP

The Value Added Heat Map by Schröder and Tomanek is an innovative visualization tool that indicates the level value creation concerning production relevant factors. It is following the methodically of a thermal heat map camera.

This method is e. g. already used to visualize the usage of production space with regard to their value. Spaces in a shop floor have different values. For example, spaces are maximum, limited and no value added.

Spaces that are directly used for value creation, e.g. production machines, are maximum valuable. But in production, you can also find spaces that are not directly used for value creation. These spaces are necessary for operating the plant - e g. staging areas for required materials, spaces for intermediates and finished goods or transport routes for reaching the plants. These spaces have limited added value contribution. Spaces do not contribute to value creation, when they are not used at all.

In a Value Added Heat Map, each square meter of an analysed shop floor is evaluated with regard to a value level (Tomanek & Schröder, 2016, p. 315-323). The Value Added Heat Map supports the optimizing of a production layout. It aims to generate smaller area with the same value.

In general the Value Added Heat Map helps to visualize the value added level of production relevant factors by using colour scaling and develops a conclusive key performance indicator. The graphical result of the analysis resembles a thermal image; therefore, it is called Value Added Heat Map. Potentials for improvement can easily be recognized by using this method. The Value Added Heat Map is not limited to improve the usage of available space. It can be applied to further production relevant factors like internal traffic (Tomanek & Schröder, 2017) or information flow.

2.2. Value Added Heat Map - Evaluation Scale for Information Flow

Concerning the information flow, it is important to note that information contribute differently to the added value. As shown in Table 2, the information flow is classified by the authors in six value added levels from zero to five. As a scale for the categorisation serves the effort that is need for the information exchange. The higher the effort, the lower the value added level and vice versa.

Insufficient, incorrect or unnecessary exchange of information cause effort by failures. This not value added and has the level “0”. The colour dark blue represents this category.

Written exchange of information (e.g. paper document, fax, e-mail, etc.) is limited added value, but it has still a high potential for improving. The time needed for writing consumes human resources. It is classified with the level “1”.

Verbal or visual exchange of information is classified with the value added level of “2” because it’s less time-consuming than writing. Nevertheless speeches or visuals cues can be often get misunderstood that leads to a low added value.

A higher categorisation has an electronic exchange of information. In the case of electronic exchange, it makes sense to differentiate between an information flow in real-time and not real-time. A spreadsheet application for example is a time-delayed presentation of the data. Furthermore the data maintenance of a spreadsheet is time-consuming than a system application. This is why an electronic information flow not in real-time has the value added level of “3” and in real-time the level “4”.

The highest value added level for information flow is represented by digitalisation. Implementing Internet of Things and Services in a shop floor workers and machines communicates in a network in real-time. The digital exchange of information is maximum added value and has the level “5”.

Table 2. Value Added Heat Map - Evaluation Scale for Information Flow

Categorization	Value Added Level	Dimension of Information Flow	Scale
No Added Value	0	Insufficient, incorrect or unnecessary exchange of information	Effort
Limited Added Value	1	Written exchange of information (e.g. paper document, fax, e-mail, etc.)	
	2	Verbal or visual exchange of information	
	3	Electronical exchange of information not real-time (e.g. by spreadsheet application)	
	4	Electronical exchange of information real-time (e.g. by system-application)	
Maximum Added Value	5	Digital exchange of information real-time (e.g. by Internet of Things and Services)	

Source: own research

3. SURVEY DESCRIPTION

A current layout of the analysed shop floor is required to draft a Value Added Heat Map. The layout serves as the basis for the assessment of the information flow. The information flow is represented by arrows. In a Value Added Heat Map, the arrow's thickness represents the quantity of the substance, which occurs in the flow. In the case of analysing the information flow, the thickness refers to the amount of information units.

To identify the information exchange of a process it is helpful to visualize and quantify the material flow first. It is important to investigate, which information enhance the material flow. It is also relevant to record the number of information units, which generated and transferred by the process. It is advisable to adjust the dimension of the information flow to a time unit. The authors recommend a shift or a day as a suitable time unit.

Each information transfer has to be determined according to the evaluation scale for information flow (Table 2). The pursued information flow corresponds to a digital exchange of information in real-time without media disruptions.

Consequently the value added level of the information exchange determinates a digitalisation degree. The Value Added Heat Map for the production relevant factor information flow is supplemented by the key performance indicator "layout-specific digitalisation degree". The layout-specific digitalisation degree is calculated from the quotient of the sum of each information transfer multiplied with the corresponding value added level and the amount of transferred information per time unit multiplied

with the highest possible value added level (see Equation 1). Following the evaluation scale for information flow in Table 2, the highest possible value added level is "5". The layout-specific digitalisation degree indicates, which percentage the degree of information flow promotes added value.

Equation 1. Key Performance Indicator "(Layout-specific) Digitalisation Degree"

$$(Layout-specific)\ DIGITALISATION\ DEGREE =$$

$$= \frac{\sum_{i=1}^{N}(Information\ Transfer \times\ Value\ Added\ Level)_i}{N\ \times\ Max(Value\ Added\ Level)}\ x\ 100;$$

$$Information\ Transfer\ \ i = 1, \dots, N;$$

$$N\ =\ Amount\ of\ transferred\ information\ per\ time\ unit$$

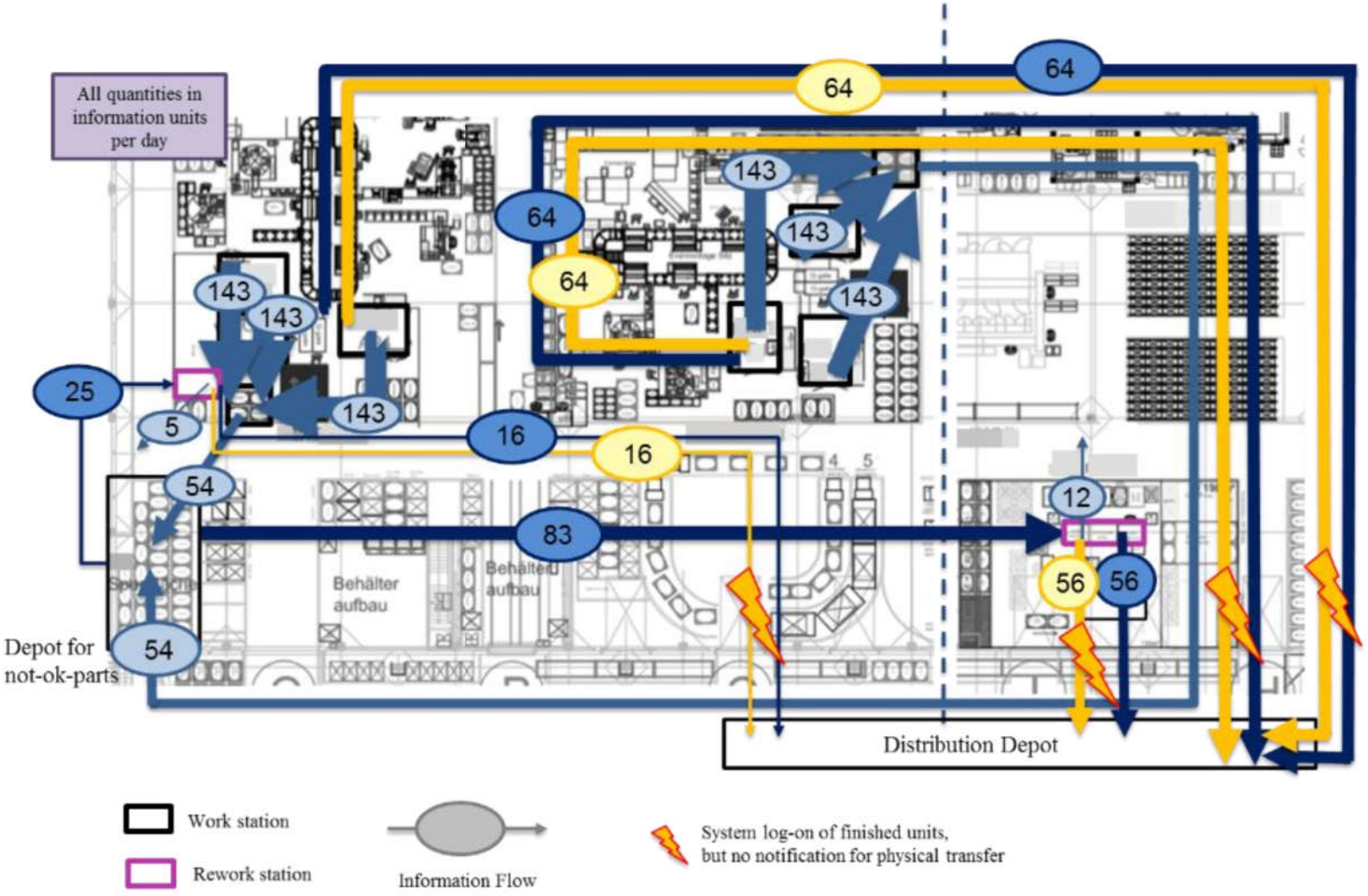
$$Value\ Added\ Level\ =\ 0, \dots, 5;$$

Source: own research

4. RESULTS

The authors applied the Value Added Heat Map method at a production facility of an automotive supplier. The information flow of a production process including the rework are analysed with said method. The analysed production line area contains six working stations. From these working stations ok-parts are transported directly to the distribution depot and not-ok-parts have to be reworked in two rework stations. For the reason of a high rework effort, not-ok-parts has to be temporary stored in a depot. The resulting Value Added Heat Map for Information Flow is shown in Fig. 2. It displays the colour scaling and the relative to value added levels. The layout-based digitalisation degree of the shown example is 21%.

Figure 2. Example of a Value Added Heat Map for a Production Line Analysing the Information Flow



Source: own research

Based on data from a multi-moment-recording, an information flow of 1.491 information units per day was identified. A total of 308 information units per day were no added value. They were classified with the value added level "0". This corresponds to 20% of the recorded information flow. This group contains missing notification for physical transport of goods. Based on observations, the forklift operators were searching for the boxes with ok-parts and not-ok-parts. This insufficient exchange of information caused non-value-adding wastage: unnecessary searches and handling for the forklift operators, stock keeping in the production line, and empty journeys of the forklift. In Figure 2, the non-value-adding information flow is coloured in dark blue.

A total of 983 information units per day were written notification that were classified with the value added level "1". This corresponds to 66% of the registered information flow. In Figure 2 written exchange of information has the colour light blue.

Verbal or visual exchange of information corresponding to the value added level "2" was not identified in the analysed production line.

A non-real-time electronical exchange of information was found 200 times a day. This matches to 13% of the registered information flow. In Figure 2 this information flow is represented in by yellow arrows that corresponds to the value added level "3".

Both electronical and digital exchanges of information in real-time, which are classified with the value added levels "4" and "5", were not identified.

5. CONCLUSION

The value stream method visualizes in an outstanding way the material flow. By contrast the potentials of the description of the information flow is not visible at first appearance. Stock, latency or lay time get negative influenced by missing, sluggish and incomplete information flow and consequently they extend generally the cycle time. The presented method of the Value Added Heat Map analysing the information flow shows a possibility, how losses of time can be visualized through deficient or defective information. Key recommendations from this work are: optimize the information flow, benchmark the information flow and transfer the Value Added Heat Map to other production relevant factors.

5.1. Optimize the Information Flow

The information flow promotes added value. A layout-based digitalisation degree of 21% in the shown example points out potential for improvement regarding the value added degree. In the first step the information flow with the value added level "0" has to be eliminated immediately. In the shown example the notification for the transport of ok-parts and not-ok-parts must be available to the forklift operator. A technical possibility is that the already existing electronic system log-on of finished goods request a physical transfer of good directly by the forklift operator.

In a second step the information flow with the value added level "1" has to be minimized. A to 66 percent paper-based production line in Figure 2 disclosure savings potentials. Through digitalisation 983 written documents per day can be saved. This reflects not only in saved costs, but also in time saved by reducing the writing effort. In general the intension of an improvement of the information flow through digitalisation is an improvement of the value creation. This includes also the minimisation of media disruptions. Multiple media disruptions in Figure 2 are visualised by colour shifts of the information flow.

Summarizing the application of the Value Added Heat Map can be used to optimize the information flow by pointing out a missing information exchange, determining the digitalisation degree and visualizing media disruptions.

5.2. Benchmark the Information Flow

The Value Added Heat Map method can be used to visualize and benchmark the information flow of different single production lines or even different production plants of one company. An industry-wide benchmark is also possible. Furthermore the Value Added Heat Map can be applied to analyse and benchmark the information flow in service companies. The benchmarking could be carried out for cross-industry comparison of business service and production sectors.

5.3. Transfer the Value Added Heat Map to other Production Relevant Factors

The Value Added Heat Map by Schröder and Tomanek has been applied so far to production relevant factors like space usage, traffic load and information flow. This methodology can be adapted easily to other factors. Possible example to apply this method in future could be the equipment utilization in manufacturing companies.

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