

Universal Logistic Information System Evaluating Logistical Measures within the Supply Chain

Michael Grigutsch*, Julian Becker** and Peter Nyhuis***

In the course of globalizing productions and the tremendous competition accompanying it, enterprises are now confronted with new challenges. With the aid of selected logistic measures, enterprises are in the position to counter the competitive pressure. By investing in measures a company can increase their logistic performance and assert themselves over the competition significantly. In order to be able to create a quantifiably comprehensible basis for a decision, enterprises need a suitable management-tool for logistically and monetarily evaluating measures in production. Within the frame of Collaborate Research Centre 489 (SFB 489), referred to as 'Transfer Project T7', a Logistic Information System was developed at the Institute for Production Systems and Logistics (IFA) to evaluate logistical measures. This model is based on a universal approach for logistically and monetarily evaluating production measures. This paper focuses on the analytical structure of the model and the different possibilities evaluating logistical measures specifically.

Field of Research: Production Engineering

1. Introduction

Companies with global operations are facing an immense pressure to change, in order to adapt to the constant changes in market conditions. These changes include strong fluctuations in the buyer markets and the constant struggle for market share to avoid being displaced by the competition. It is due to these constantly varying factors that companies are being repeatedly forced to examine and modify their logistical processes at short intervals. Appropriate logistical measures can be employed to equip manufacturing companies with the means of countering this increasingly complex market situation to maximum effect. Now, the challenge for companies is to select those logistical measures that promise the greatest potential and to employ their existing investment capital in improving their logistical performance capability.

Consequently, what businesses need is an effective decision-making support model that can provide them with a sound decision-making tool on which to base monetary and logistical assessments of logistical measures in production (Nyhuis, Busse & Wriggers 2008; Grigutsch, Kennemann & Nyhuis 2012; Wildemann 2004; Jodlbauer 2007). The content of the paper is the completed development of a so called decision-making tool, which allows the user evaluating various logistical measures based on the Economic-Value-Added. Already existing logistical models allow evaluating logistical measures based on logistical KPI (Key Performance Indicators) like lead time and schedule reliability. From now on, the tool allows the user assessing the logistical measures with economic KPIs like costs per piece and the economic value added beside logistical KPIs.

*Michael Grigutsch, Institute of Production Systems and Logistics, Leibniz University Hanover, Germany. Email : grigutsch@ifa.uni-hannover.de

** Julian Becker, Institute of Production Systems and Logistics, Leibniz University Hanover, Germany. Email:becker@ifa.uni-hannover.de

*** Professor Peter Nyhuis, Lead of Institute of Production Systems and Logistics, Leibniz University Hanover, Germany. Email: nyhuis@ifa.uni-hannover.de

The presented paper is organized as follows: After the introduction in the literature review the pre-studies and the limitations of the further LIS will be presented. Within the chapter methodology the developed model and tool is presented. The chapter results consist of a practical example and the successful validation of the tool. The paper is finished by the chapter conclusion, within the new findings by the research project and the limitation of the model.

2. Literature Review

Numerous research projects conducted at the Institute of Production Systems and Logistics (IFA) have shown that even logistics measures with low investment costs can significantly enhance a company's logistics performance. For instance, schedule deviations with respect to downstream processes or customers can be reduced by consistently implementing a deadline-based sequencing rule (Nyhuis & Wiendahl 2009; Windt & Wittekindt 2002). However, neither the national nor the international literature currently offers an approach that equips companies with a quantitative and universally valid basis of evaluation that enables them to select measures in production. The classic literature only covers approaches that permit a monetary evaluation of measures (Kerner 2002; Nyhuis, Busse & Wriggers 2008; Wildemann 2004).

A logistics information system (LIS) based on the specific requirements of a metal forging process was developed within Collaborative Research Centre 489 (SFB489). This controlling and decision-making model is based on Microsoft Excel© and allows the user to evaluate selected logistical measures on the basis of monetary and logistical variables (e.g. residual profit or supply performance) (Nyhuis, Busse & Wriggers 2008). The research requirements for a universally valid model by which logistical measures can be assessed were derived from the preliminary work conducted by SFB 489 and approved by the German Research Foundation (DFG) within the framework of a transfer project (T07 'Evaluating of measures in production'). The decision support system developed within the research project enables the modelling of various process structures, which, in turn, permit a universally valid assessment of measures in production (Grigutsch, Kennemann & Nyhuis 2012). The enhanced LIS that was developed in the transfer project is based on a decision logic that creates a link between the logistic models and the so-called Economic Value Added (EVA) or residual gain (RG) driver tree (cf. Figure 1).

This enables simultaneous evaluation of all the logistical measures in production with regard to both monetary and logistical aspects. The basic concept of the LIS is based on drawing a comparison between the actual values and the key figures (RG) that can be realised by applying the measures and thereby assessing the efficiency and potential of the selected measure. The overall RG key figure is an established and tested method in industry (Fischer 2003; Lambert 2000; Fernández 2002). The RG is defined as the net operating profit after taxes at the end of a period minus the product of the weighted average costs of capital and the total capital costs at the beginning of a period; capital and functional costs can then be evaluated with the aid of this key figure (Kennemann & Wriggers 2009; Fernandez 2002). This enables the user to estimate the change in functional and capital costs induced by the measure. In this way, the LIS is based on a decision logic that renders a comprehensive selection of logistics measures open to evaluate by way of a monetary key figure (e.g. RG).

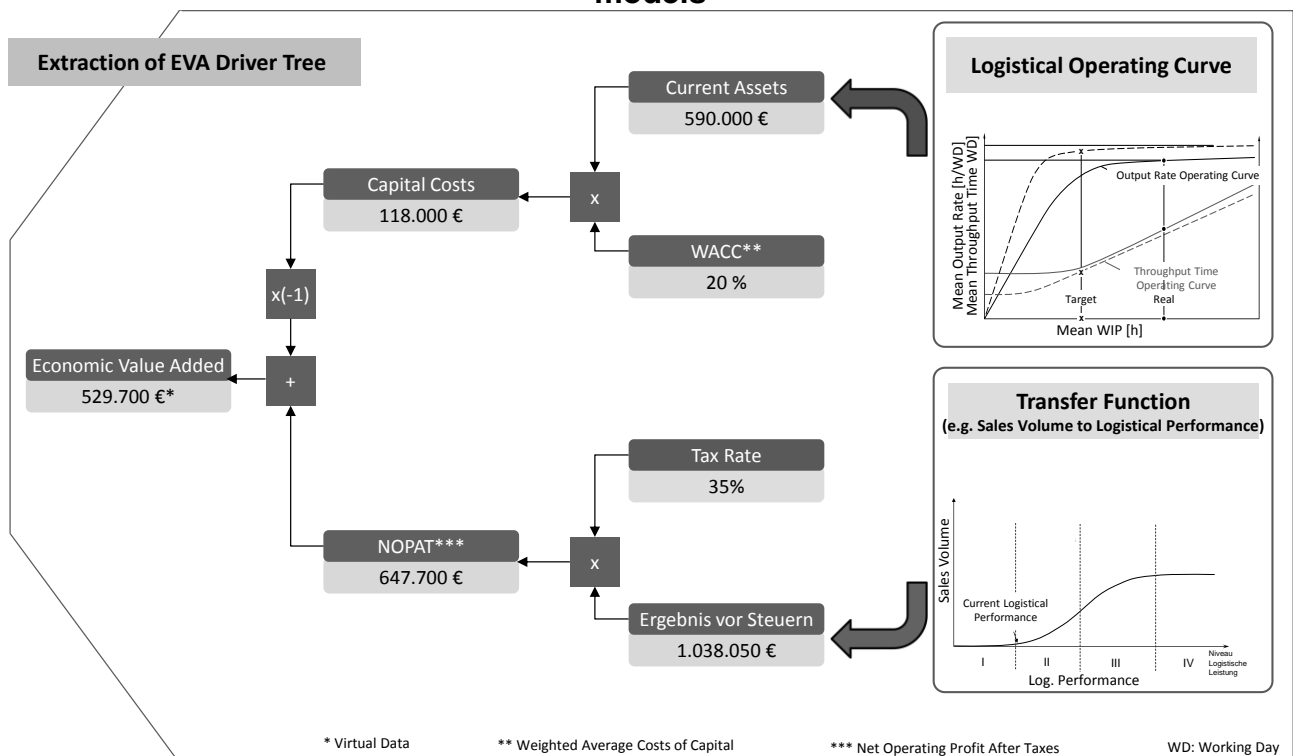
The new LIS was developed to evaluate logistical measures economically and logistically. Concerning previous studies the new development represents a further step in universal evaluation of logistical measures. The new tool is based on a previous tool developed

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within Collaborative Research Centre 489 (SFB489), which includes specific requirements of a metal forging process. The special requirements of a metal forging process (e.g. linear material flow, no variance in sequence-rules) do not allow the application in different industry sectors. There can be monitored different requirements like diverging and converging material flows, a wider product spectrum and the possibility of more logistical measures implementing in the production system. Likewise the previous tool is based on two basic logistical models. The first model is the so called Production Operating Curve by Nyhuis (Nyhuis & Wiendahl, 2009), whereby an evaluation of the WIP (Work in Process) by a defined grade of utilization can be conducted. Another model included within the previous tool is the so called Schedule Reliability Operating Curve (Yu, 2001), whereby an evaluation of the scheduled reliability by a defined grade of WIP can be conducted.

In the new LIS different recently developed logistical models are included. For example the Schedule Compliance Operating Curves, whereby the schedule compliance can be evaluated by a certain WIP in the last stage of production (Schmidt, Bertsch & Nyhuis 2013). A higher WIP results in higher schedule compliance at the end of the final production stage. Based on implementing further logistical models the user is allowed to evaluate more logistical measure with a higher accuracy. One of the most important is the higher universality of the model. Now the user is allowed to apply the new LIS on different process structures (converging material flows) and a wide product spectrum. In conclusion, the newly developed LIS represents new findings in the target evaluating logistical measures universally.

Figure 1: The Economic-Value-Added Driver Tree and the implemented impact models



3. The Methodology and Model

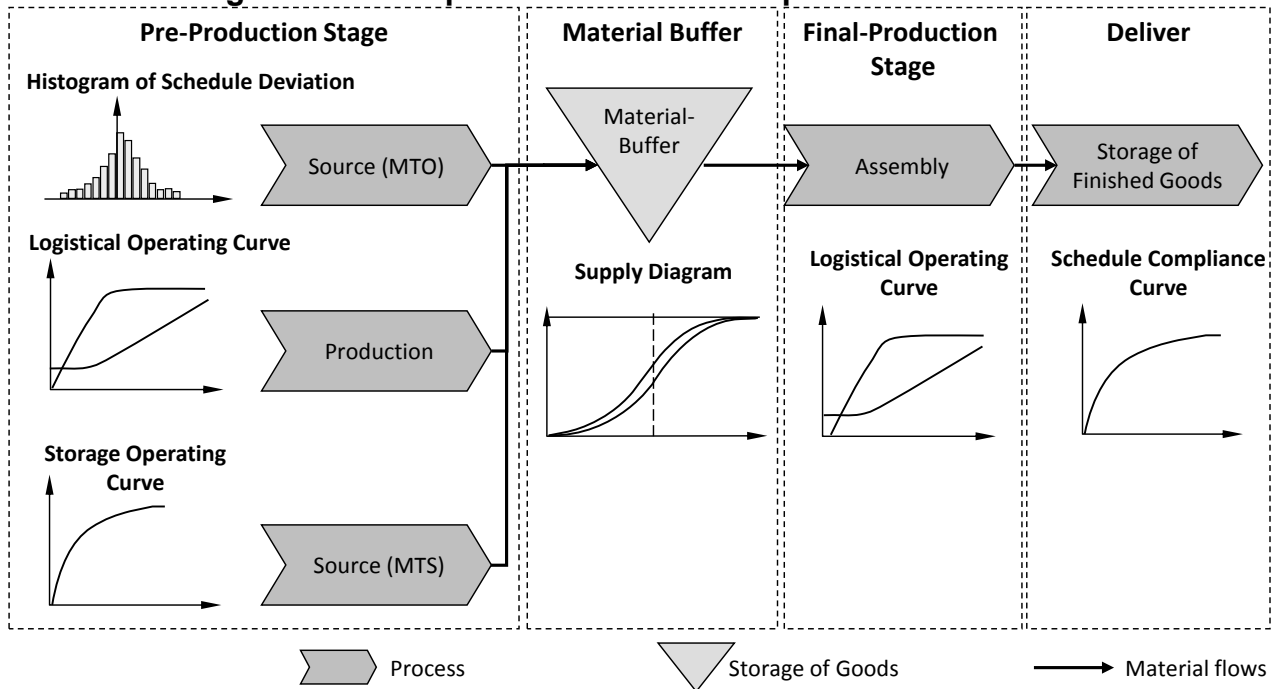
3.1 User Environment of the Logistics Information System (LIS)

Using the application, the user has to make different steps using this developed LIS for evaluating measures in production. The first step is to enter the available company-specific monetary variables (e.g. material costs per period, production and inventory costs, Taxes Rate) into the tool. Once these have been inputted, the feedback data from production or assembly is collected by already developed and used IFA-based tools. The feedback data from production comprises input and output data, total lead times, and monetarily weighted schedule deviations at defined feedback points, to enable the generation not only of the operative curve for production but also of further logistical operating curves developed at the IFA, such as the supply diagram or the schedule deviation curve (Beck 2013; Schmidt, Bertsch & Nyhuis 2013; Nyhuis, Beck & Schmidt 2013). In addition to creating a model for analysing logistical key figure changes, the correlation between logistics performance and sales figure fluctuations is also modelled. For this purpose, the LIS employs a so-called transfer function, which is capable of determining the minimum increase in sales that can be achieved by an improvement in delivery performance. Before this can be done, however, the company must conduct a conjoint analysis, which has been adapted for this project, in order to determine the relationship with market volume, the price for products and the potential of sales volume. Based on this transfer function, with every increasing of logistical performance indicators the potential in sales volume can be illustrated (Nyhuis, Grigutsch & Keil 2013).

3.2 Constructing the Basic Structure of the Logistic Information System

The correlation between the implementation of a measure in production and the RG is represented by a driver tree in conjunction with the logistic models developed at the IFA (Grigutsch & Nyhuis 2013). The driver tree is supplied with a logic which, among other things, is able to create a link between the logistic variables (schedule compliance etc.) and the process and capital commitment costs. In contrast to the LIS previously developed in SFB489, additional logistic models for evaluating production-logistical measures have now also been implemented. These additional models were implemented on the basis of the structure of a production area as illustrated in Figure 2.

Figure 2: The impact model within the production structure

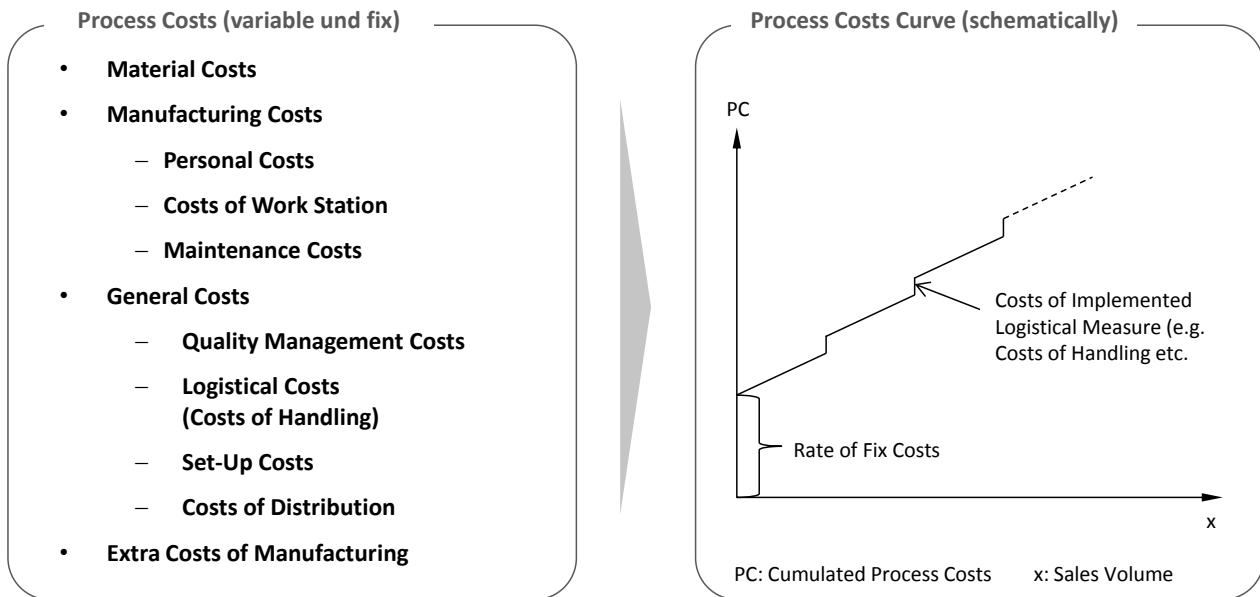


The illustration shows a number of different causal models along the value chain that have been incorporated in the decision support system. In addition to the previously implemented operating curve for production, Beck's (2013) supply diagram and Schmidt's et al. (2013) schedule compliance operating curve, among others, have also been realised. The supply diagram enables the user to measure the schedule deviation of the pre-supplying processes with respect to the prevailing inventory in the material buffer prior to an assembly process. For example, by implementing a measure, (reducing the average value or dispersion of the schedule deviation) in the pre-supplying production process, the reduction potential with respect to the inventory kept in the material buffer can be identified. Using the schedule compliance operating curve, it is also possible to describe the correlation between the safety time, the inventory of finished goods and the schedule compliance at the end of the supply chain (Schmidt, Bertsch & Nyhuis 2013; Beck 2013).

Besides implementing further causal models, this promotes additional differentiation between process cost types. The individual subdivision of process cost types is shown in Figure 3 on the left. Besides the pure material costs, the production costs and, similarly, the overheads are also subjected to subdivision, with the effect that individual elements, such as the run-based production costs or the effect resulting from increased handling costs due to higher inventory levels, is identified differently within the LIS. The number of produced parts or tooling cycles (job retooling costs) is defined as the cost driver for process costs induced by product/service quantities. Besides the variables induced by product/service quantity, there are also cost types which are neutral with respect to product/service quantity, with the effect that in the event of a higher output, a decreasing trend in fixed costs can be indicated. This then leads to a reduction in the process cost rate and, in turn, the unit costs, as the existing fixed costs are distributed among the units sold. The process cost curve is illustrated schematically in Figure 3 on the right.

Based on the implemented logistical model and the implemented process costs curve the new developed tool defines a big further step concerning the previous LIS. With the new LIS the evaluation of more logistical measures and the application with various production structures will become possible.

Figure 3: The elements of Process Costs and the cumulated Process Costs Curve



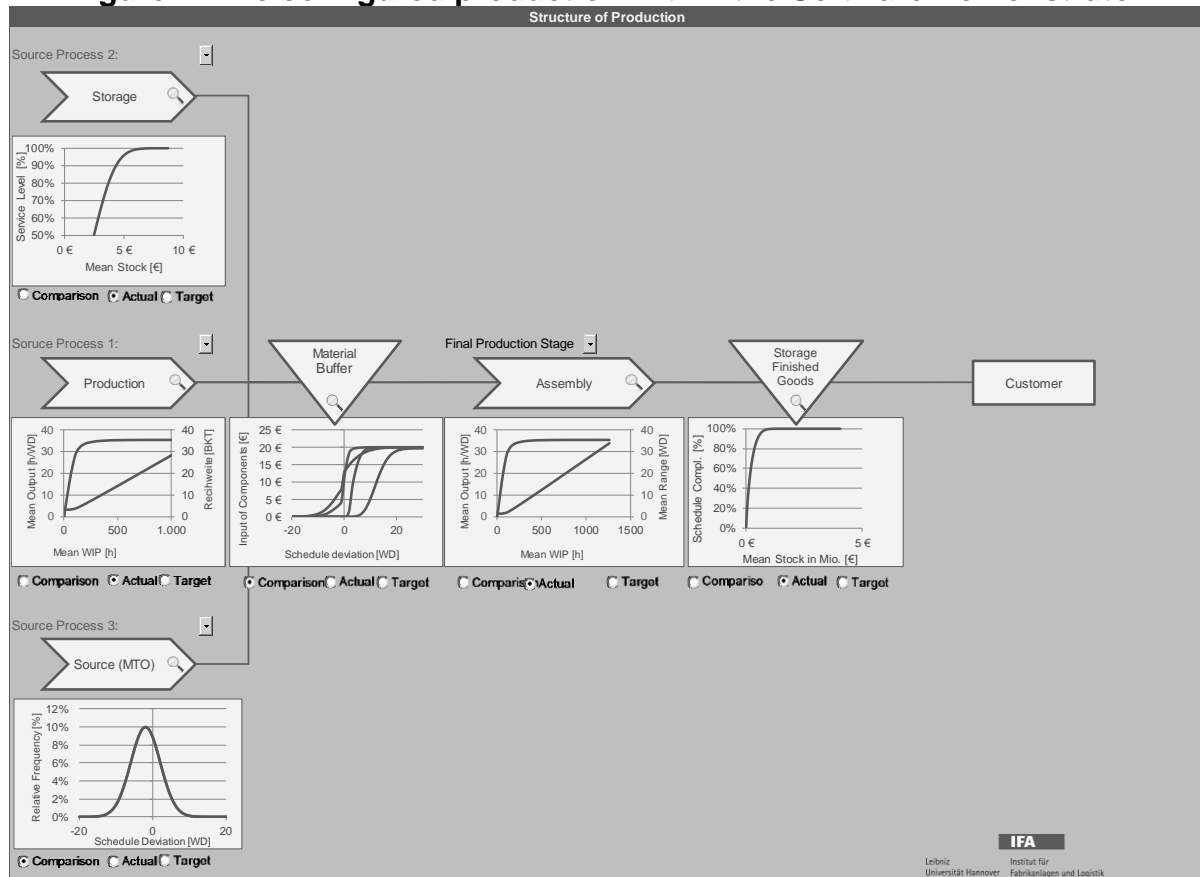
3.3 The Logistic Information System as a Software Demonstrator

To enable the user to make an efficient evaluation after implementation of the logistical measures within the production area under examination, a new software demonstrator has been developed based on Visual Basic, Microsoft Excel©. Both the causal models described in the foregoing and the EVA driver tree were incorporated in the development of the software demonstrator, thus enabling comprehensive assessment of the measures in production. As well as implementing the logistical causal models, further transfer functions within the software demonstrator, such as the process cost curve, have been implemented. The development also took into consideration the need to reduce the complexity of the software demonstrator application as far as possible, to ensure simple and efficient handling within the user group. Attention was given during the conceptual design phase of the software demonstrator to ensuring an appropriate cost-benefit relationship between the data input and the pre-configuration of the software demonstrator. The development also addressed the need to be able to use the application with a minimum possible knowledge of logic.

To use the software demonstrator, the user must first pre-configure the tool. In the first step, the user models his production area within the software demonstrator, such that the supply chain is represented as closely as possible by the process elements. The user is instructed to choose between the MTO or MTS order execution sequence, thereby defining the basic order type. For example, the order execution type MTO employs a different logistic causal model to describe the distribution warehouse as does an MTS production process. The order execution type thus defines the fundamental logistic models to be employed. The individual divisions within the supply chain are then configured. This involves selecting the process elements occurring in these divisions. Among other things, a distinction is drawn as to whether the production facility employs an assembly process in the final production stage or if the assembly facility is supplied by a pre-production or final-production process. The process element of the material buffer represents the point of convergence and at the same time the dividing line between the pre-and final production stage areas. The preliminary production stage can consist of up to three pre-production process elements, whereby it is possible to choose between a

production, procurement and warehouse process. The configuration of the supply chain in the software demonstrator is shown in Figure 4.

Figure 4: The configured production within the Software Demonstrator



Once the supply chain itself has been configured and the order execution type has been defined, the next step involves defining the basic parameters for characterising the production area to be considered. This not only involves transferring the capacities for each production/assembly process but also, for example, the number of products sold in the last period and the maximum number of products that can be sold from capacity. Once the basic key figures have been entered into the input mask of the software demonstrator, the next step consists of entering the key figures for the individual process elements. For example, the process element of production or assembly is described by the key figures of the average total lead time and the dispersion thereof. The parameters for the warehouse in the preliminary production stage, for example, are the key figures of the existing service level or average inventory level. Once the process elements have been described by the key resource figures, the key order figures must be entered. The key order figures comprise among other things the average schedule deviation or the dispersion thereof, whereby the software demonstrator also permits assessment of measures concerning schedule compliance or adherence at the end of the supply chain or the end of specific processes. The described resource-specific or order-specific key figures are determined using the software tools previously developed at the IFA. To this end, the feedback data from a work system, such as entry and exit dates, are entered, so that the specific key figures are available for subsequent processing in the software demonstrator. The data collection flow is illustrated in Figure 5.

Figure 5: The input data mask for a certain impact model within the software

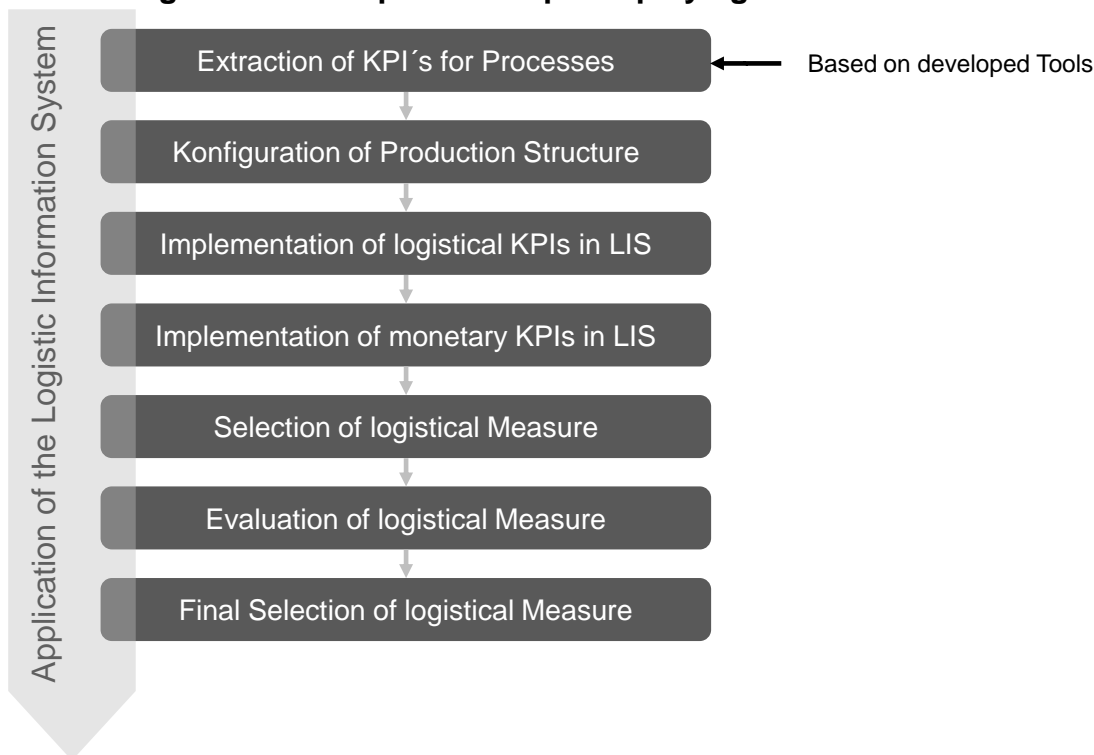
Source Process 1: Production	
Sum of Input Components [€]	10000000
Mean Schedule Deviation [WD]	1
Standard Schedule Deviation [WD]	7
Amount of Components for Assembly	10
Source Process 2: Storage	
Sum of Input Components [€]	4000000
Servicelevel[%]	92
Components per Assembly order	14
Source Process 3: Source	
Sum of Input Components [€]	6000000
Mean Schedule Deviation [WD]	-2
Standard Schedule Deviation [WD]	4
Amount of Components for Assembly	6

In addition to the key logistic figures, the key operational figures are entered as well. These include, for example, the circulating stocks measured in the period under examination, in the form of raw materials and semi-finished and finished products. The key operational figures also include asset holdings and depreciation sums incurred in the period in question. In addition to the capital cost block, functional and process costs must also be entered in the software demonstrator. All the process costs specified in Figure 3 must be specifically entered, to ensure that the change in process costs caused by implementation of a logistical measure can be quantified. As well as entering process costs, the final step consists of implementing the key figures of relevance to sales and against which the enhanced sales delivery performance function can be modelled. Among other things, the parameters of product price, sales quantity and delivery time are transferred into a matrix, to enable modelling of the relations among the key figures relevant to logistic performance. The results can be given in the form of a sales-delivery performance curve, which supplies the probable sales level for the respective parameter settings. This is in turn entered directly in the calculation of the sales quantity in the EVA driver tree, to assess the potential of an increase in sales, in the event of an increase in logistical performance. Thus, it is for example not only possible to attain an improvement in logistic costs but also to increase sales of finished products at the same time by raising logistics performance. The whole steps implementing all parameters are shown in figure 6.

Once all the data has been entered, it is possible to begin with the actual selection of the measures. The user can select a measure from an existing measures database; the measures are arranged in the categories Parameter, Function and Structure. The

Parameter header contains, for example, the measure of 'harmonisation of work content', which can be explicitly used in the context of the process element Production (preliminary or final production stage). After selecting this measure, the user must discretely state the variable parameters for this measure and can in turn examine the impact of the implemented measure. The software demonstrator is fundamentally conceived such that individual measures can only be applied with certain process elements. This means that the user is implicitly steered by his choice of measure, thus minimising user error. After selecting the measures, the user is presented the most important key data in a so-called cockpit. In a cockpit, the target values of specific key figures (EVA, productivity, etc.) are shown in relation to their actual values. This gives the user a precise overview of the extent to which the key figures have been either positively or negatively affected by the implementation of a measure. It is then possible to compare different measures with each other and to derive the cost-benefit relationships. The user thus has a management tool at his disposal that allows him to select an appropriate measure within a production area and product group and to evaluate the selected measure quantitatively against others. The important steps are shown in the flow chart (cf. Figure 6)

Figure 6: The important steps employing the Software Demonstrator



4. The Findings

4.1 Identifying the Potential of the Logistics Measure of Reducing Process Times

The user has a comprehensive measures database at his disposal in the LIS, allowing him to select from a variety of measures based on their potential for improving his logistic performance. To more precisely describe the basic logic of the enhanced LIS, the present document will examine the measure of technological process improvement, or more precisely, reducing implementation time. To analyse the precise monetary and logistical impact of the measures of implementation time reduction, the user must first select the specific company process structure. In addition to selecting the existing structural elements (warehouse, production facility, material buffer, etc.), it also involves defining the

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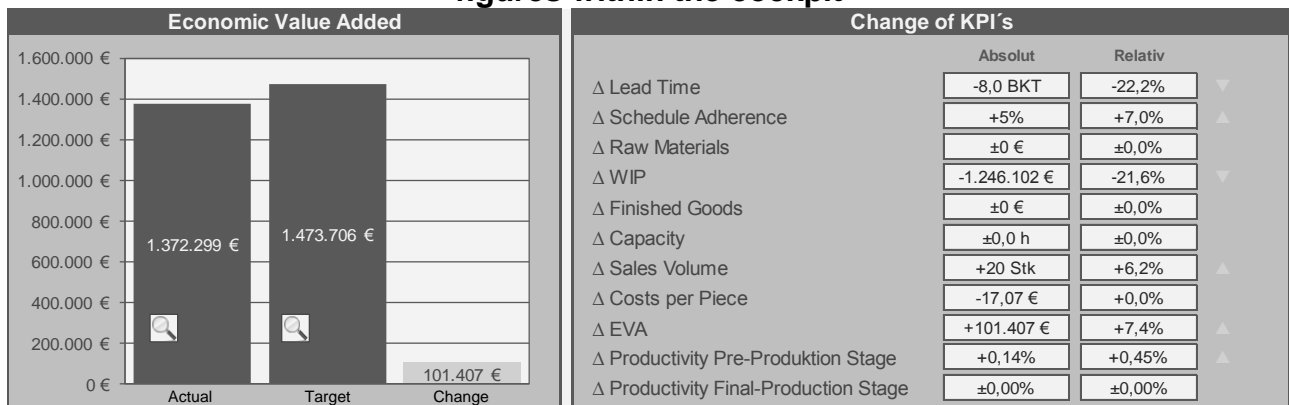
type of order execution, for example. In the present example of production, a make-to-order process is pending, which is reproduced in a structure similar to that in Figure 2. In this example, implementation time reduction reverts to the production process in the field of preliminary production processes (cf. Figure 2). Optimisation of the production technology and consequent shortening of the process time creates significant potential with regard to logistic performance. Besides the impact of the measures on the structure of the operating curve for production, the measure also has a significant effect on the impaired stock in the material buffer, with the result that the newly implemented supply operating curve is now employed for a more precise evaluation.

Shortening the implementation time leads to a reduction in the total production time, defined by the tooling time and the process time (Nyhuis 2009). This lowers the ideal minimum inventory, as a result of which a reduction in the necessary inventory (WIP) is identified by the operating curve for production. This leads to a direct reduction in capital costs within the driver tree, whereby besides gaining a lower WIP, it is also possible to reduce the area currently given over to waiting orders. The tool also takes into account implementation costs (capital costs or process costs) incurred in these measures.

A shorter process time and lower total production time lead to an increase in productivity. This means that the company is now able purely in terms of capacity to generate a higher output and in turn to increase the degree of utilisation in the production area. However, this is only possible if an increase in sales can be achieved by an improvement in the logistic performance on the market and the order composition is then changed by additionally acquired orders. Increasing sales also results in a commensurate increase in total process costs, although the process cost rate falls, resulting in a lower unit cost per product. In addition to the structural change of the operating curve for production brought about by the aforementioned measure, potentials are identified by means of additional operating curves. A reduction of the WIP in front of the production area leads to a lower throughput time dispersion and in turn to a reduced schedule deviation. This in turn has a direct effect on the amount of impaired component stock in the material buffer, which means that a reduction in the WIP would have an immediate impact on capital costs within the driver tree. A more punctual provision of parts by the supply process described would in turn lead to an improvement in the schedule situation at the end of the supply chain, which would in turn lead to a reduction in safety time with no change to the degree of schedule compliance (cf. Figure 7). The improvement in logistic performance capability creates a commensurate reduction in capital costs and a lowering of the process cost rate. The aggregation of all improved respectively downgraded KPIs is shown in Figure 7, the so-called cockpit of the software demonstrator. The example shows that the user is rendered able to evaluate the measures laid down in the LIS comprehensively, in both logistical and monetary terms.

The results by applying the new LIS lead to a new way evaluating production areas monetarily and logistically. With the LIS the user is able to choose the optimal logistical measure improving the performance of production. The LIS allows a user-friendly handling and therefore of a rapid evaluation of the various production structures based on the EVA-KPI. These results are interpreted as a significant step of evaluation companies in economical and logistical way.

Figure 7: The impact of the logistical measure (reducing process time) to the key figures within the cockpit



5. Summary and Conclusions

The enhanced Decision Support System respectively LIS enables the user to evaluate a wide range of measures in production on the basis of logistical and monetary variables. The existing LIS has been expanded to enable it to be applied with universal validity across all industries. So with the new LIS the user can evaluate various production structure based on newly implemented logistical models. Within this research project, requirements were drawn up for a universally valid model, and new causal connections were implemented in the form of logistic operating curves. Similarly, variable and fixed process cost factors were implemented in the LIS, so as to achieve more extensive modelling of the process costs and their changes on the basis of logistic measures. The result represents a significantly improved decision support model in the form of a software demonstrator, which can be used in any industry. Ultimately, any company operating in any area should be able to orient the Decision Support System to its particular process and in turn evaluate selected production measures, both in logistical and monetary terms. Likewise the LIS was developed by definite requirements concerning the didactical aspects. The target of the developed tool is to open a wide range of users without logistical basic understanding. Beside the evaluation of implemented logistical measures the tool can improve the logistical understanding of complex processes within the supply chain.

Further development step are the expansion of the logistical measures included within the LIS. The limitation of the LIS is the limited number of logistical measures for sourcing and production processes. The next step in the development will be the expansion of further logistical measures for the sourcing and the production process. Likewise the LIS will be extend with new logistical measures for distribution respectively transportation processes evaluating the cross-company supply chain.

Acknowledgement

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References

- Beck, S 2013, *Modellgestütztes Logistikcontrolling konvergierender Materialflüsse*. Dissertation, Garbsen.
- Fernández, P 2002, *Valuation methods and shareholder value creation*. Amsterdam.
- Nyhuis, P, Grigutsch, M, Keil, HS 2013, 'Umsatzsteigerung durch Erhöhung der Logistikleistung? Entwicklung eines Ansatzes zur monetären Bewertung von logistischen Maßnahmen', *Productivity Management*, pp. 38–40.
- Fischer, TM, Rödl, K 2003, 'Strategische und wertorientierte Managementkonzepte in der Unternehmenspublizität. Analyse der DAX 30-Geschäftsberichte in einer unternehmenskulturellen Perspektive', *KoR - internationale und kapitalmarktorientierte Rechnungslegung*, IFRS 3, 10, pp. 424–432.
- Grigutsch, M, Nyhuis, P 2012, 'Maßnahmen in der Produktion optimal bewerten. Entwicklung eines allgemeingültigen Entscheidungsunterstützungssystems', *ZWF Zeitschrift für wirtschaftlichen Fabrikbetrieb*, Edition 107, pp. 558–562.
- Grigutsch, M, Nyhuis, P 2013, 'Cost Sensitive Analysis of Production Logistics Measures. A Decision Making Support System for Evaluating Measures in the Production' *WASET 2013 – Proceedings of the World Academy of Science, Engineering and Technology*. Tokyo. 30.-31. May, pp. 591-595.
- Jodlbauer, H 2007, *Produktionsoptimierung. Wertschaffende sowie kundenorientierte Planung und Steuerung*, 1st Edition, Springer Verlag, Wien NewYork.
- Kennemann, M, Wriggers, FS, Nyhuis, P 2009, 'Economic production. Identifying optimal economical and logistical measures', *16th International Conference on Industrial Engineering and Engineering Management, Beijing, IE&EM '09*.
- Kerner, A. 2002, *Modellbasierte Beurteilung der Logistikleistung von Prozessketten*, Dissertation. Hannover.
- Lambert, DM, Burduroglu, R 2000, 'Measuring and Selling the Value of Logistics', *International Journal of Logistics Management*, Vol. 11, pp. 1–18.
- Nyhuis, P, Busse, TD, Wriggers, FS 2008, 'Bewertung strategischer Maßnahmen zur Gestaltung der Lieferkette', *Wettbewerbsfähigkeit durch Arbeits- und Betriebsorganisation*, 2008, pp. 177–196.
- Nyhuis, P, Beck, S, Schmidt, M 2013, 'Model-based logistic controlling of converging material flows', *CIRP Annals - Manufacturing Technology* 62 (1), pp. 431-434.
- Nyhuis, P, Wiendahl, HP 2009: *Fundamentals of Production Logistics. Theory, Tools and Applications*, Berlin, Heidelberg.
- Schmidt, M, Bertsch, S, Nyhuis, P. 2013: 'Schedule compliance operating curves and their application in designing the supply chain of a metal producer', *Production Planning & Control: The Management of Operations* 25 (2), pp. 123-133.
- Wildemann, H, Alt, F 2004, 'Bewertung logistischer Leistungen und Kosten in der Supply Chain'. *Forschungsbericht ; BiLog: Bilanzfähige Logistik*, München: TCW Transfer-Centrum.
- Windt, K, Wittekindt, W 2002, 'Sichert die Optimierung der Logistikleistung den Unternehmenserfolg?' *Zeitschrift für wirtschaftlichen Fabrikbetrieb* 98, pp. 108–111.
- Yu, KW 2001, *Terminkennlinie – Eine Beschreibungsmethodik für die Terminabweichung im Produktionsprozess*, Dissertation Leibniz Universität Hannover, Düsseldorf: Fortschritt-Berichte VDI