Using Objectives to Improve Decision-Making in Manufacturing Companies

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Abstract

As a result of increasingly process-oriented enterprises, the interdependencies between production and production logistics have become more and more complex. Consequently, the field of production logistics has turned out to be a meaningful and long-term factor of success, since it is able to contribute to the holistic coping of these complex interdependencies. Normally, there are a lot of alternatives available conducing to improve production logistics. Decision-makers have to evaluate and select alternatives in coincidence with specified objectives. Since several enterprises dispose of limited resources concerning time, staff and budget, decision-makers are usually not able to proceed in a structured and systematical way.

Against this background, the research project empower, conducted in cooperation with the Fraunhofer IPA Project Group Process Innovation, develops a web based decision support system to enhance the efficiency of production logistic processes for manufacturing enterprises. Thereby, the comprehensively identification and ensuing structuring of objectives in a system of objectives provides an obligatory required basis. In doing so, the developed system of objectives has to meet the following five demands: show completeness, feature simplicity, be redundance-free, offer a clearly and accurately measurement and be decomposable. On these grounds, the paper describes first the developing of a comprehensive system

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T. Spengler et al. (Hrsg.), *Entscheidungsunterstützung in Theorie und Praxis*, DOI 10.1007/978-3-658-17580-1_2

of objectives. Subsequently, it is a question whether and to what extend the comprehensively created system satisfies the five demands made on it. For this purpose, the next section starts with a motivation of the topic by defining the term "production logistics" and presenting the potential of improving production logistics. After a definition of the term "decision", section two summarizes the applied research design. Section three is up to the research project empower. Based upon selected examples drawn from literature, the deduction of the developed system of objectives is gradually presented. Afterwards a review of the formulated demands on the developed system follows. The paper finishes by giving a résumé and further research directions.

Content

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1 Arising Importance of Production Logistics

Today, similar types of products are almost identical concerning pricing and quality features. The enhancement of production logistic performance constitutes one possibility to differ from competitors. Therefore, the production logistic processes of an enterprise are an important basis for generating cost and competitive advantages (Luczak, 2004). Furthermore, due to the increasingly process orientation of today's enterprises, the domain of production logistics continues to gain in importance. The conventional operations structuring of manufacturing enterprises was characterized by a distinct separation of production plans and logistical aid functions. Nowadays by contrast, the interdependencies between production and production logistics become more and more complex, so the tasks of production logistics cannot be considered without a reference to production processes. Instead of categorizing production logistics as a functional aid function, the processes of production logistics add value (Probst and Acél, 1996).

The tasks of production logistics involve all planning, implementation and control operations aimed to construct an optimal coordinated material and information flow from the receiving of goods to the shipping of goods (Heiserich, Helbig and Ullmann, 2011; Pawellek, 2007; Koch, 2012; Wyss, 1991). Whereas the operative, short-term view of production logistics intends an optimal regulation between the different processes to fully utilize the available potential, the strategic production logistics focuses the relationship between the business strategy and the domain of production logistics. The objective is to develop a production logistics-oriented strategy and to identify alternatives, which enable a realization of competitive advantages and thus a contribution to an enterprise's strategy (Nebl, 2007; Nyhius, Elsweier and Hertrampf, 2010). This objective is reinforced by the increasingly dynamic of markets and the ascended customer requirements. Consequently, enterprises are confronted with an external constraint to conduct alterations, i.e. to uncover systematically potential economies and demands of restructuring (Luczak, 2004).

Although the procedure of identifying actions presents an essential and promising one, several enterprises are faced with shortcomings during this decision-

making process. The shortcomings arise mostly from the limited equipment with resources. So enterprises usually dispose of insufficient resources with regard to time, staff and budget in order to reach a decision methodically (Luczak, 2004; Schneider, 2013; Behrends, Meyer and Korjamo, 2005). By contrast, decisions are normally made instinctual in a barely systematical structured manner without taking the objectives in the foreground. In doing so, enterprises often select alternatives, which are not or limited conducive to the target achievement (Steinhilper, Köhler and Oechsle, 2011; Oechsle, 2015).

On these grounds, the paper describes the developing of a comprehensive system of objectives. Subsequently, it is a question whether and in what way the created system satisfies the five required demands.

2 Research Design to Create a Comprehensive System of Objectives

2.1 Steps to Develop a System of Objectives

A decision is defined as a more or less conscious choice of one or more alternatives of a large set of alternatives (Laux, 2005). The selected alternative results from a multitude of preliminary considerations. Therefore, a decision describes a decision-making and problem solving process, which contains not only the phase of taking a resolution but also making its preparations (Jacob, 2012; Becker, 1996). Decisions are reached to achieve one or often more objectives, so the effects of choosing one alternative may only be evaluated, if the set of objectives is known (Laux, 2005; Eisenführ and Weber, 2003). The term objective covers information about desired future conditions by the decision-makers, e. g. maximize profit or minimize CO_2 emission (Rommelfanger and Eickemeier, 2002; Sieben and Schildbach, 1994). Since the questions what the decision-makers would like to achieve and how these intentions are interrelated are of particular importance, the development of a system of objectives seems to be inevitable (Rommelfanger and Eickemeier, 2002). Therefore, the competitive strategy of an enterprise aimed at

achieving competitive advantages has to become manifested in the system of objectives (Luczak, 2004; Batista, 2012).

Following the recommendation of Ude (2010), developing a system of objectives consists of the following four steps which are also applied in this paper: Collect all crucial objectives, group the identified objectives, construct an objective hierarchy and operationalize the included objectives.

In the first step, it is necessary to **collect all crucial objectives** (Ude, 2010). On the one hand all decision relevant objectives have to be considered because a lack of important objectives questions the usefulness of the whole system. On the other hand, objectives of no significance for the subsequent decision should be neglected from the outset (Rommelfanger and Eickemeier, 2002). Normally, objectives are not simply available but have to be worked out hard by reflecting intensely. Although a lot of people tend to avoid this work, meaningful and tough decisions require to concentrate on thinking about objectives or rather values (Eisenführ and Weber, 2003).

Keeney's value-focused thinking-approach is based on this idea.[2] In contrast to this approach, Keeney refers to alternative-focused thinking for describing how decisions are generally made. According to this view, a lot of people identify apparent alternatives, which have proved to be acceptable in similar situations in the past, in order to solve current decision-making problems. Most of the effort is invested in evaluating the identified alternatives while it cannot be ensured that attractive alternatives are available at all. Keeney passes criticism in this way of thinking by introduction the value-focused thinking-approach. As the name implies, Keeney focuses firstly on values, which are translated afterwards in objectives. Recently, Siebert and Keeney (2015) comprehensively prove in a series of five experiments that using objectives as stimulus leads to more and better alternatives. Thus, an objective-oriented way of thinking facilitates searching decision opportunities and creating new ones in accordance with the pursued objectives.

[2] See here and subsequent Keeney (1992).

Beside explicit questions like "What are the targets of your production strategy?", there are additional possibilities to become aware of one's own objectives.[3] First, shortages in current or expected conditions in future form the basis for generating new objectives. Second, a comparison between the available alternatives allows decision-makers to identify important differences which are suggestive of objectives. Third, strategic objectives, like health protection, which are not bounded to a specific decision situation, serve also as a support in generating new objectives. Fourth, external standards, e. g. the amount of production output or the volume of sales, commonly describe a kind of point targets set on grounds of motivation, planning and coordination. Those standards often stand for optimizing-oriented objectives. Fifth, decision-makers should ask themselves who will be affected by the decision and what objectives those people could have. Sixth, with the target of providing a comprehensive basis for potential objectives in the field of production logistics, a study of literature appears reasonable.

The second step in developing a system of objectives contains a **grouping of the identified objectives**.[4] In doing so, objectives are classified thematically and identical ones are sorted out. A discussion about the residual objectives and a hereby given possibility to add missing ones completes the second step (Batista, 2012). For this purpose, expert interviews and workshops with policy makers of an enterprise are recommended.

A simple collection of objectives is insufficient. Since decision-makers need a clear structure in depth for taking a decision, subsequent to the second step follows up the **construction of an objective hierarchy**.[5] Therefore, Keeney advises to differentiate between fundamental objectives and means objectives. Whereas fundamental objectives are pursued intrinsically and do not require any justification, means objectives are followed to achieve fundamental ones. The question "Why is that important?" provides assistance in distinguishing between fundamental and means objectives. If the answer is, the considered objective is only important to

[3] See here and subsequent Eisenführ and Weber (2003).
[4] See here and subsequent Ude (2010).
[5] See here and subsequent Keeney (1994) and Ude (2010).

reach another one, the objective is a means objective and provides an indication of other objectives. Compared to means objectives, fundamental objectives are essential reasons for interest in the decision situation. An appropriate method for structuring the objectives is an illustration of objectives carried out by one of two possible methods.[6] On the one hand it is possible to structure objectives *top-down*.

Thereby, a higher-level objective is disaggregated in some lower-lever objectives to concretize the overall objective until sufficient measurable objectives are available. On the other hand, objectives can be structured *bottom-up*. By using the bottom-up approach, the decision-makers' narrow view on specific issues is expanded sequentially by aggregating lower-level objectives to higher-level ones.
In practice a mixture of both approaches is applied.
The last step includes the **operationalization** of objectives by suitable attributes (Ude, 2010). Even if the structured objectives provide a sound basis for evaluating alternatives, inappropriate attributes can impair the choice. To avoid this, Keeney determines five desirable properties of good attributes by presenting the characteristics of unambiguous, comprehensive, direct, operational and understandable (Keeney and Gregory, 2005).

2.2 Demands Made on the System of Objectives

The developed system of objectives will contribute to the underlying decision problem to a great extent, if the objectives fulfill desirable properties (Keeney and Gregory, 2005). According to Keeney (1992), a system of objectives has to meet five demands.[7] First, the developed system should be **complete**. Decision-makers need to be sure of considering all substantial objectives, which are essential in a certain decision context. Second, it is important to create a system of objectives **redundance-free.** With the aim of allocating preference-oriented weights to objectives, one system should not include objectives with the same meaning. Otherwise, the danger arises that one objective receives unconsciously more weight than

[6] See here and subsequent originally presented by Keeney (1992) and likewise mentioned by Eisenführ and Weber (2003).
[7] See here and subsequent Keeney (1992), Eisenführ and Weber (2003).

it actually shows. Third, the objective has to be measured **clearly** and **accurately** as much as possible. The term "clearly" means that one measurement should offer a slight area of fuzziness which enables a clearly measurement of the target achievement after eliminating the uncertainty. In order to measure what is really important for the decision-makers, they need to understand the meaning of the used objectives accurately. Fourth, the decision-makers should be able to express their preferences relating to different developments of one objective irrespective of the development of the remaining ones. So the objectives should be **decomposable**. The last request demands **simplicity** of the developed system of objectives. Following the convenience of a system, less objectives in the whole system are connected to less complexity in the continuing procedure of structuring preferences and evaluating alternatives.

3 Empower Research Project

3.1 Enhancements of Performance Measurement Systems

Performance Measurement Systems, containing a lot of attributes, circulate in practice for quite some time (Kramer, 2002; Keeney and Gregory, 2005). A well-known and widely-used one is the DuPont analysis introduced by the enterprise DuPont in the year 1919 (Dehler, Göbel and Schenk, 1999; Schott, 1981). Characteristic for the DuPont analysis is that one superior performance measure, the return on investment, is disaggregated gradual mathematically in its single elements (Syska, 1990). Seeing that other non-financial measures or attributes are not included, nowadays such financial related and analytical created systems, which are oriented towards the past, seem more and more inappropriate as a decision support in the area of production logistics and hence need to be refined (Weber and Schäffer, 1999; Kramer, 2002; Giannakis, 2007; Chan and Qi, 2003). By and by, a multitude of systems and concepts has appeared addressing the problem associated with traditional performance measurement systems.

Wiendahl (1997), for instance, was one of the most influential authors who dealt with objectives concerning production logistics and introduced a system of

objectives pursuing the overall objective of a "high logistics efficiency".[8] The objective "high logistics efficiency" itself is composed of the objectives "low logistic costs" and "high logistic performance". Whereas the former objective covers the lower-level objectives "low production costs" and "low costs of the employed capital", the last mentioned one purposes the lower-level objectives "high delivery reliability" and "short delivery period". The third level of the system involves the objectives "high degree of capacity utilization", "low inventory", "high adherence to schedules" and "short throughput times". Beside the overall objective, Wiendahl's system of objectives covers altogether ten objectives allocated to three different levels.

During the renewal years, a lot of other systems of objectives were evolved. The new developments base mainly upon Wiendahl's system of objectives while expanding the number of objectives and thus increasing the level of detail. On the one hand, some authors, like Martin (2014), focus on special details in the system to decompose them further. In doing so, Martin divides the objective "low order lead time" into the lower-level objectives "low administrative time", "low production time", "low internal material flow time" and "low external commodity flow time". Related to each higher-level objective, the second level contains between one and four additional lower-level objectives. On the other hand, a lot of authors are engaged in refining and broadening the whole system of objectives (Sesterhenn et al., 2004). Kramer (2002), for instance, highlights the importance of additional aspects, like flexibility, quality, ecology and humanity.[9] Consequently, Kramer developed a value-added oriented system of objectives by including those aspects as additional objectives at the first level and decomposing them into further lower-level objectives. All in all, Kramer's system of objectives compromises 41 objectives assigned to four different levels.

[8] See here and subsequent Wiendahl (2014).
[9] See here and subsequent Kramer (2002).

3.2 Deduction and Description of the EMPOWER Project Results

Since only a complete overview of those objectives, which may be affected by the planning process of an enterprise, permits optimal aligned and coordinated activities, the research project empower focuses on developing a new comprehensive system of objectives derived from literature considering practitioners' and experts' views. The latter are generally surveyed during several workshops with enterprises from Upper Franconia sited in the manufacturing industry. By using the top-down and bottom-up approach, the system of objectives developed during the course of the project covers 67 objectives allocated to five levels. Fig. 1 overviews the developed system of objectives.

Each system of objectives requires one overall objective as a root (Schneeweiß, 1991; Ossadnik, 1998). First, Westkämper (2000) categorizes the creation of value as the most important economic objective of profit-oriented enterprises. Second, the term "value-added" specifies not only the economic benefit but also the value for other stakeholders within the meaning of a pluralistic embossed objective. Third, Hahn (1996) claims that objectives should be framed as comparative competitive advantage ones by declaring pursued conditions in future relatively to the competitors.

Since Porter (1999) ascribes the achieving of competitive advantages exclusively to the existence of a value added chain, a "Value-added production system" seems suitable as the overall objective and is chosen likewise in the developed system of objectives as superior one.

Afterwards, the fundamental objectives, i. e. the objectives at the second level, are determined. The objectives "Maximize Performance" and "Minimize Costs" are counted among strategic objectives and are taken out from Wiendahl's approach, where they represent the only ones categorized as fundamental objectives (Eidenmüller, 1991). Additionally, the term "responsibility" is nowadays of great importance.

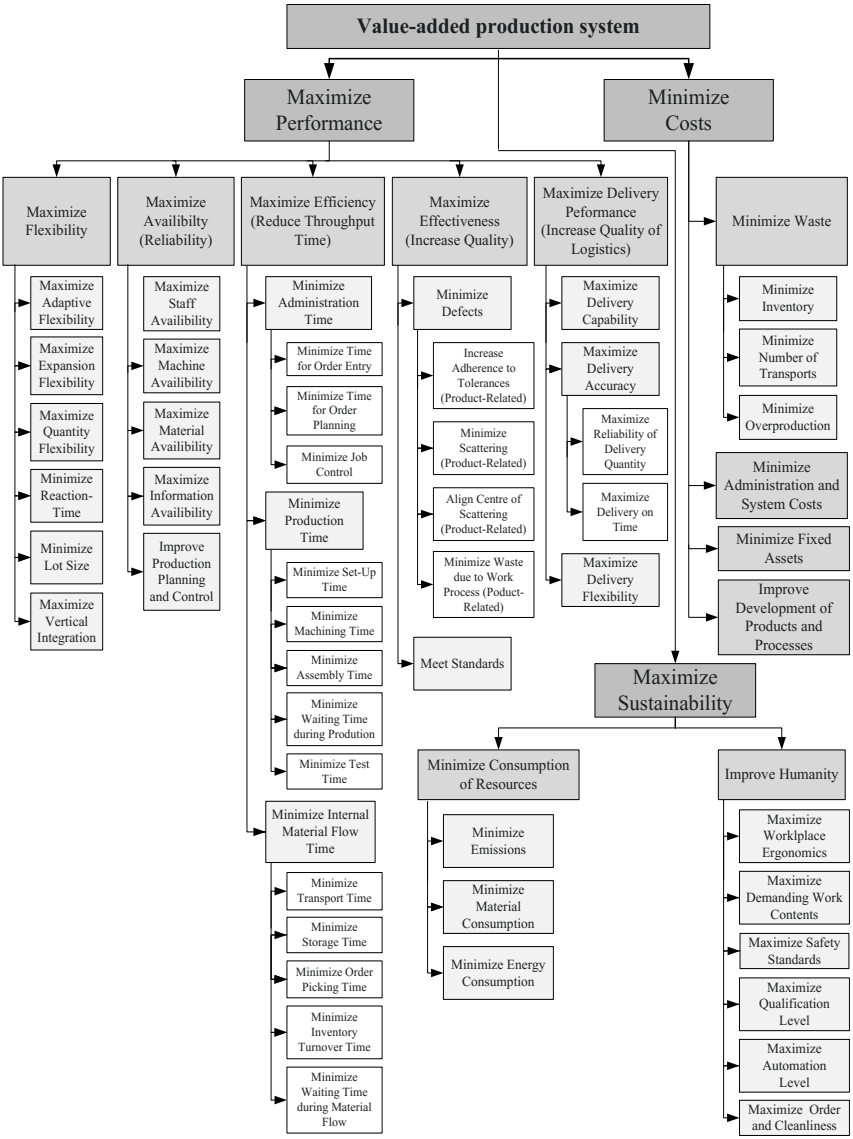

Fig. 1: Developed System of Objectives for the Design of a Value-Added Production System.[10]

[10] In dependence on Drews et al. (2015a) and Drews et al. (2015b).

On the one hand a lot of worldwide acting enterprises, like Audi or BMW, incorporate social and ecological responsibility into their corporate governance principles (Audi AG, 2016; BMW Group, 2016; Andersen and Skjoett-Larsen, 2009). With statements like “We are living responsibility” (Audi AG, 2016), enterprises emphasize the significance of sustainability. On the other hand Milberg (2000) points out that the objective “Realize a Profit” is consistent to the objective “Consider Social Responsibility”. Similarly, Zahn and Schmid (1996) state that social-, human- and ecological-oriented objectives complement the traditional formal and factual related ones. Therefore, the second level of the developed system of objectives covers the objectives "Maximize Performance" and "Minimize Costs" as well as the fundamental objective "Maximize Sustainability".

Subsequently, the three fundamental objectives at the second level are decomposed into lower-level objectives at the third level. First, due to increasingly dynamic markets connected with fast and surprisingly changing customer requirements, the property of flexibility gains in importance (Kramer, 2002). Flexibility is defined as one’s adaptability to respond to modified circumstances.[11] Regarding the definition of flexibility, Zahn and Schmid (1996) comment that the term “Maximize Flexibility” is intrinsically tied to the performance of an enterprise and thus a lower-level objective of “Maximize Performance”.[12]

Second, the main objectives of a process-oriented organizational design are according to Eversheim (1995) the three classic objectives “Time”, “Costs” and “Quality”. Quality management means to understand the customer requirements right, to satisfy them and finally to outperform them (Pfeifer, 1993; Viaene and Verbeke, 1998). So the objective “Maximize Effectiveness” is aimed at creating processes in such a way that failures are avoided and at the same time the performance is increased. Likewise, time measures are of prime importance. The performance of an enterprise is significantly influenced by a quick realization. A distinction to competitors is especially reached by a time optimal and efficient creation of business processes (Eversheim, 1995). On these grounds the third level

[11] See here and subsequent Zahn and Schmid (1996) and Yi et al. (2011).
[12] For empirical evidence see Yi et al. (2011).

maps two further objectives “Maximize Effectiveness” and “Maximize Efficiency”.

Third, by reason of a process-oriented creation of logistic activities, the objectives “Maximize Availability” and “Maximize Delivery Performance” have to be incorporated into the developed system of objectives as performance supporting objectives. Whereas the objective “Maximize Delivery Performance” refers to the performance of the delivering logistics system, the objective “Maximize Availability” belongs to the supplying logistics system (Sesterhenn et al., 2004; Eidenmüller, 1991).

Fourth, Eversheim (1995) emphasizes the changed importance of the objectives “Improve Humanity” and “Minimize Consumption of Resources” because of a more and more fast alteration of corporate general conditions. Humans will take center stage in corporate policy due to the fact that the demands of tomorrow will solely be overcome by the use of qualified and motivated employees (Simon, 1993). Complementary, in past it has been desirable to reach a degree of capacity utilization as high as possible. In contrast to this, nowadays, it is essential to deploy optimally the existing resources (Eversheim, 1995). That is why the fundamental objective “Maximize Sustainability” is differentiated in the two lower-level objectives “Improve Humanity” and “Minimize Consumption of Resources” at the third level.

Fifth, the elimination of waste, so-called muda, facilitates to reduce costs. The item “muda” summarizes all unnecessary operations and objects, which enhance the costs without contributing to the creation of value (Traeger, 1994; Kramer, 2002; Emiliani et al., 2005). Beside the “Minimizing of Waste”, the objectives “Minimize Administration and System Costs”, “Minimize Fixed Assets” and “Improve Development of Products and Processes” account for achieving the fundamental objective “Minimize Costs” (Konrad, 2005; Mehlan, 2005; Kaltschmitt and Wiese, 1995; Schildknecht, 1998; Monden, 1998). All in all, the third level of the developed system of objectives covers eleven objectives. The objectives at the third level are successively decomposed into 50 lower-level objectives positioned to two additional levels.

3.3 Discussion

With the aim of determining the contribution of the developed system of objectives to serve as a solid basis for solving decision problems, the five demands according to Keeney are revised below. First, the system of objectives was developed by the use of expert consultations, literature studies and the value-focused thinking-approach. These methods are instrumental in capturing objectives as completely as possible (Eisenführ and Weber, 2003). Equally, the developed system of objectives gathers the effectiveness of an enterprise to a greater extent than previous appeared systems which comprise mostly efficiency related objectives.[13] Beside included objectives like "Maximize Delivery in Time" or "Maximize Reliability of Delivery Quantity", a consideration of those objectives or rather divisions which are likewise responsible for revenue supporting product features of quality and function, leads to a more effectiveness-oriented view of enterprises (Kramer, 2002; Dellmann and Pedell, 1994). Since the divisions product development, procurement, marketing and selling are mainly implied, additional objectives like "Improve Development of Products and Processes", "Minimize Administration Time", "Meet Standards" and "Minimize Waste" seem inevitable and are comprised by the developed system. Thus, the developed system of objectives convinces by a high degree of **completeness**.

Moreover, the developed system of objectives enables to consider different degrees of complexity. Therefore, decision-makers are able either to zoom into different levels or to take a superordinate view. Second, the requirement of completeness is in conflict with featuring simplicity (Little, 2004). The more objectives the system contains the more complex the structuring of preferences proves to be (Eisenführ and Weber, 2003). Since the system of objectives is characterized by a high degree of completeness, it is adversely affected by a limited degree of **simplicity**.

Third, a multitude of objectives is connected to the danger of being more or less redundancy. The third level of the developed hierarchy contains the objectives

[13] For examples see Sesterhenn et al. (2004), Schulte (2013) and Martin (2014).

“Minimize Waste” and “Minimize Fixed Assets”. By eliminating needles fixed assets which do not or not sufficiently create value the objective “Minimize Fixed Assets” adds indirectly to the objective “Minimize Waste”. Although the meaning of both objectives coincides, the objectives are positioned at the same level and thus are redundant. Another example of redundancy is caused by the objectives “Maximize Effectiveness" and “Maximize Delivery Performance”. If the quality or rather effectiveness is not commanded by an enterprise, it will be impossible to increase the "Delivery Performance". In consequence, a high-level of effectiveness provides a basis for improving the delivery performance and so both objectives are not redundant free (Panskus, Fuchs and Mählck, 1995). To follow examples, the developed objective hierarchy shows **redundancies**.

Fourth, the identified dependencies between the objectives “Minimize Fixed Assets” and “Minimize Waste” on the one hand and between the objectives “Maximize Effectiveness” and “Maximize Delivery Performance” on the other hand occupy that the demand of **decomposability** is not fulfilled on the whole. The objective “Maximize Delivery Performance” is the more important, the higher evaluated the objective “Maximize Effectiveness” is. Hence, the decision makers are not able to express their preferences relating to different developments of the objective “Maximize Delivery Performance” irrespective of the development of the remaining objective “Maximize Effectiveness”.

Fifth, the process of measurement is facilitated by decomposing repeatedly one higher-level objective in several lower-level objectives. Generally, lower-level objectives are more concrete and thus better measurable than higher positioned ones. The developed system of objectives covers 67 objectives allocated to five levels, whereupon 50 objectives are positioned either at the fourth or at the fifth level. That is why the developed system of objectives offers the possibility to measure the target achievement **clearly** and **accurately** as much as possible.

4 Conclusions

Created on the basis of expert consultations, literature studies and the value-focused thinking-approach, the developed system of objectives provides a comprehensive collection of objectives in the field of production logistics and thus distinguishes itself by a high degree of completeness. Furthermore, the structuring of objectives to lower-levels enables a clearly and accurately measurement of the target achievement. In contrast to this, the system's high degree of completeness is attended with objectives both limited redundant-free and narrowed decomposable. Additionally, the included multitude of objectives accounted for a restricted degree of simplicity.

The article was targeted on the development of a comprehensive system of objectives. Since the created system of objectives serves initially as a starting point for the following validation and modification process, the demands of redundant-freeness, decomposability and simplicity become less important. All included objectives have to be reviewed by experts in the course of the validation process. In doing so, some objectives will be added to the developed system, a couple of objectives will be summed up and others will be removed from the system. In consequence, it is first anticipated that redundant objectives will be either eliminated or compressed, why the demand of redundant-freeness will be fulfilled. Second, the validation and modification process should also focus on objectives which are not decomposable. It is recommended to work on those non-decomposable objectives to reach a degree of decomposability as high as possible. Third, as the demands of simplicity and completeness are conflicting ones, a reasonable compromise between both of them seems essential.

Several authors like Bond et al. (2008) show that decision-makers are faced with extensive shortcomings in the generation of objectives. The benefit provided by this paper is to solve this issue by offering decision-makers an all-encompassing basis of structured objectives which may be adapted individually. All in all, the developed system acts as a sound initial point for further research and developments. Beside the validation and modification process of the developed system

of objectives, the scope of suitable alternatives enhancing the efficiency of production logistic processes has to be fixed. Subsequently, the expected effects of chosen alternatives on the target achievement should be evaluated. On the one hand it is questionable which objectives of the developed system are affected by the selection of an alternative. On the other hand, the extent to which an objective changes by the use of an alternative has to be determined. All research questions have to be handled by the empower research project and thus present the next necessary steps.

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http://www.springer.com/978-3-658-17579-5

Entscheidungsunterstützung in Theorie und Praxis
Tagungsband zum Workshop FEU 2016 der Gesellschaft für Operations Research e.V.
Spengler, Th.; Fichtner, W.; Geiger, M.J.; Rommelfanger, H.; Metzger, O. (Hrsg.)
2017, IX, 195 S. 38 Abb., Softcover
ISBN: 978-3-658-17579-5