

# Comparison of performance measurement-systems used for order-picking

Frederik Heine\*  
Sigrid Wenzel\*\*

\* Hella KGaA Hueck & Co.  
Logistics Department, Lippstadt

\*\* University of Kassel,  
Institute of Production Technologies and Logistics  
Division Production Organization and Factory Planning

**I**n consequence of rapidly changing market demands companies are permanently encouraged to review their own processes and structures and to modify them. Being one of these developments, order-picking is involved as part of an intra-logistics system. But to take appropriate actions, system performance and system costs have to be measured permanently. Concerning this the use of performance measurement-systems as further development of traditional systems of key figures is suitable. In this paper various performance measurement-systems are compared and their suitability for an implementation in order-picking systems is estimated. On the basis of the result of the evaluation a first concept of a performance measurement-system for order-picking will be developed by using typical key figures that are mentioned in academic literature. Finally, hints for a necessary detailed implementation and evaluation in practice will be given.

[Keywords: System of key figures, Order-Picking System, Performance Measurement, Logistics controlling]

## 1 INTRODUCTION

Growing dynamism of the market demands a rapid adaption of the company's structures to changing requirements of the surrounding. In the last few years efficient corporate logistics became a major differentiator from the competition. Continuous improvement of logistics processes is therefore inevitable for the future viability of a company [Heß11]. For this, a reduction of logistics costs and an increase of logistics performance are necessary. Moreover, a continuous measuring of these two variables is required to obtain a sufficient knowledge of the state of improvements. The use of a system of key figures is therefore appropriate, which represents an adequate and well-tried tool for the navigation and control of logistics systems [Pre10]. Both navigation and control of logistics systems are furthermore parts of logistics controlling [Heu11].

The function of order-picking systems is to supply the consuming points (production, assembly and shipping)

from the warehouse. Consequently order-picking systems have an important role in intra-logistics. Especially in distribution logistics order-picking describes a central value adding process [HSN07]. On the basis of its cost intensity that is based primarily in the high number of personnel, there is a compelling need to measure logistics cost and performance of an order-picking system permanently. Due to this, a continuous improvement process can be furthered. Secondly processes and structures can be adapted to the changing market situation in time and with requirements to receive the company's competitiveness.

A precondition for successful monitoring and evaluation of order-picking activities in a company is the use of a system of key figures that informs concisely and precisely about the most important facts of the system; especially about the costs of the system and the performance requirements for the order-picking. The last are quantified by measuring the current assortment and customer order data [Gud10]. In academic literature there are listed a lot of key figures for order-picking. For example, VDI guideline 4490 contains an extensive collection [VDI4490]. A consolidation to a performance measurement-system for order-picking systems does not exist so far. In the next chapters four commonly discussed performance measurement-systems in academic literature are compared in terms of their suitability concerning the described problem. Following, a first concept of a performance measurement-system for order-picking will be developed on the basis of the executed comparison and of frequently used key figures for logistics.

## 2 PERFORMANCE MEASUREMENT-SYSTEMS

Key figures are defined as a representation of quantitatively available facts in a concentrated form [Rei11]. If these key figures are placed into an objectively reasonable reference that they complement each other and are focused on a superior issue it is a system of key figures [LM12]. Traditional systems of key figures are usually based on financial key figures. This one-dimensional view is not sufficiently so that threats or opportunities due to a late identification of changes in the business environment

can be the result. Against this background and with the idea of performance measurement a new concept of corporate management has developed. A performance measurement system is a management concept with a multidimensional control of a system [BS08]. In the academic literature there are different specifications of this concept but the implementation is always in the form of a system of key figures [Pre10]. It is based on a balanced and forward-looking system with backward-looking financial and profit-related key figures next to non-financial performance measures as well as quantitative and qualitative indicators [Ple08]. The terms performance measurement system and system of key figures are often used synonymously in the academic literature [Heu11]. In this paper the system of key figures is understood as a tool of performance measurement.

A lot of systems of key figures with a multidimensional approach in terms of a performance measurement concept exist in the academic literature. Due to the high variety it is impossible to examine all the systems in the following with regard to their suitability. Therefore four of the most known performance measurement-systems will be examined. Their selection is based on the following:

- *Tableau de Bord* is one of the first systems that considers non-financial additionally to financial measures. Moreover it is a concept which has been proved in French companies for many years [Jun07].
- *Balanced Scorecard* represents the mostly described performance measurement system in the academic literature and is consequently the best known concept of performance measurement [Gie12].
- The *Skandia Navigator* puts the focus on the intellectual capital of a company. As a result, the employees are in the center of observations, resulting in an additive perspective in comparison to Balanced Scorecard.
- The *Concept of selective key figures* is not widely used in practical work but it has a special focus on the logistics [WS11] and is therefore considered in detail.

Other well-known concepts of performance measurement are the EFQM-model of the European Foundation for Quality Management (EFQM), the Performance Pyramid and the Quantum Performance Measurement-concept. In comparison to the above four instruments there are fundamentally different frameworks and different priorities but no further issues. Therefore these instruments are not examined in the following.

In the next chapters the four concepts are first briefly discussed. The focus is on the objectives of the concepts

and the perspectives to view the organization. Following the suitability is analyzed regarding the use for the control of order-picking systems within the logistics controlling in the third chapter of this paper.

## 2.1 TABLEAU DE BORD

Originally Tableau de Bord has been successfully implemented in French companies since the 50s of the last century [Web06]. The aim of this concept is the integration of a tool into the corporate management that is focused on decision-relevant information about processes in the operating areas in a concise form [Gie12]. The result is a compact system with predominantly non-financial key figures [Pae12]. A standardized framework of a Tableau de Bord does not exist. Consequently the form of presentation is very individual [Grü02].

## 2.2 BALANCED SCORECARD

The strategy of the Balanced Scorecard is based on a research study by Kaplan and Norton in cooperation with twelve US-American companies. The aim was to adapt the traditional finance-oriented und backward-looking systems of key figure to the changing requirements of the business. The object of Balanced Scorecard is, on the one hand, the use of forward-looking indicators in addition to backward-looking and profit related key figures. On the other hand, there is an extension of the financial perspective by three further perspectives [WS11]:

- Customer knowledge
- Internal business processes
- Learning and growth

These four perspectives are not fixed but can be expanded by additional perspectives depending on the company's aims such as a surrounding perspective [Heu11].

## 2.3 SKANDIA-NAVIGATOR

The concept of the Swedish insurance group Skandia targets the intellectual capital of a company. This includes the knowledge of the employees, the organizational knowledge in the form of patents and technologies as well as the brand name and the customer master. The aim of the Skandia Navigator is the representation of a balanced ratio between financial and intellectual capital [Gie12]. Therefore five perspectives are considered that are associated with the temporal dimensions of the past, present and future [AB09]:

- A view to the past is ensured by backward-looking key figures in the *financial focus*.
- The current situation of the company is drawn by the *process focus*, the *customer focus* and the *human focus*.

- The *renewal and development focus* is the foundation for future success.

## 2.4 SELECTIVE KEY FIGURES

The concept of selective key figures is the result of an extensive study group at Otto Beisheim School of Management (WHU) in Vallendar for logistics controlling and focused on the development systems of key figure in logistics. Aim of this concept is the implementation of the strategic positioning of a company logistics in its business operations. This tool is based on a reasonable aggregation of logistical performance figures in a system of key figures [WW10].

This system of key figures is considered from two perspectives: strategic indicators are aligned to central objectives such as market shares and reduction of costs. The operational business of the logistics system is measured

by key figures that are aligned with their critical bottlenecks. In contrast to the strategic key figures these key figures are subjected to frequent changes and thus have to be permanently updated [WS11]. Consequently this concept considers both strategic and operational perspective. The motivation for this is the knowledge that unexpended problems in the implementation of strategies can lead to a failure of the defined strategies [WW10].

## 3 COMPARISON AND EVALUATION

To evaluate the suitability of one of the specified performance measurement-systems for measuring the performance in order-picking systems appropriate appraisal factors have to be formulated. For this it is useful to identify the requirements that those systems have to establish. Helpful are ideas of logistics and supply chain controlling.

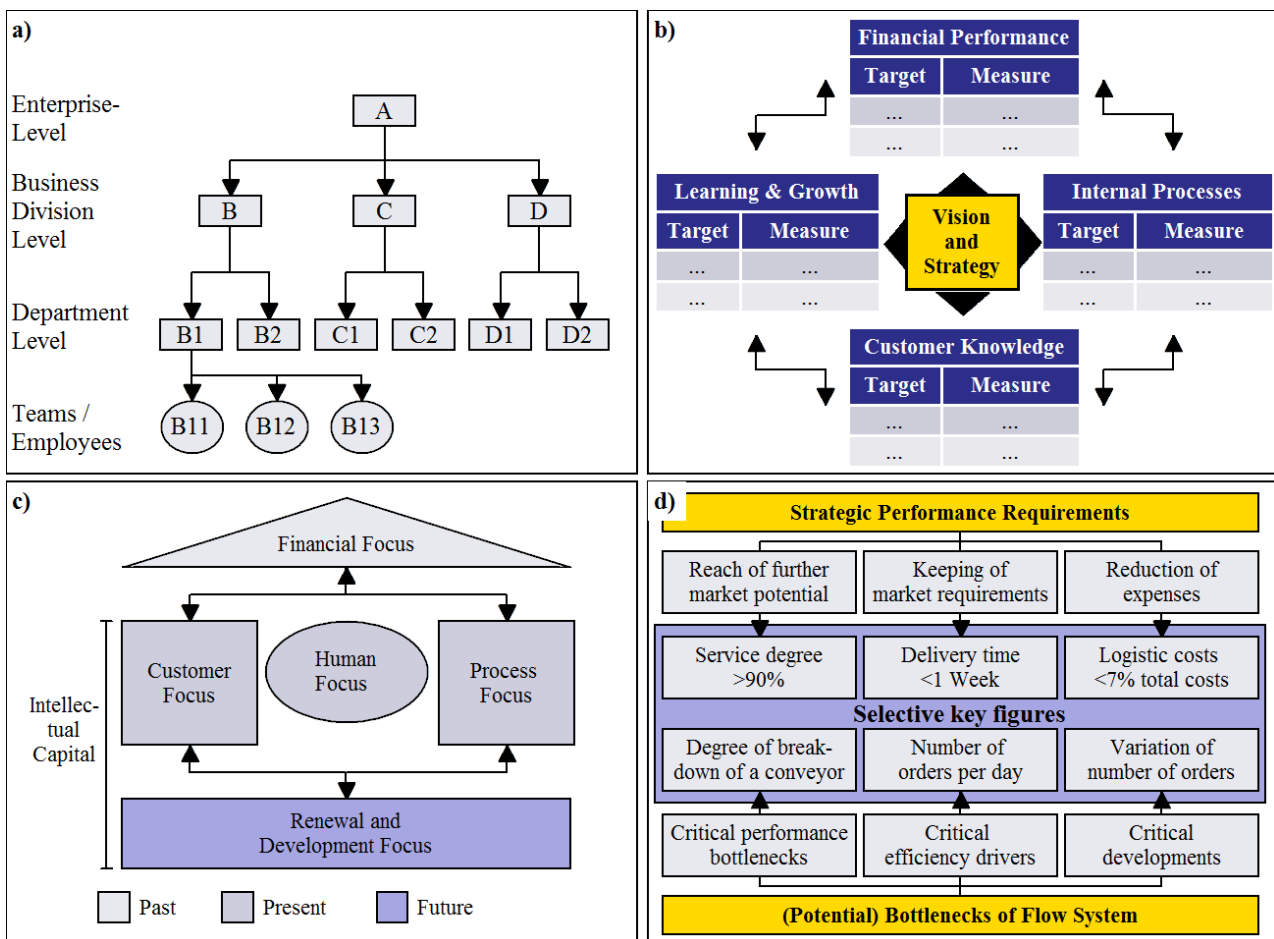


Figure 1. a) Tableau de Bord, b) Balanced Scorecard, c) Skandia Navigator, d) Concept of selective key figures [Gie12, p. 48-60]

### 3.1 REQUIREMENTS FROM LOGISTICS CONTROLLING

Wicht defined five requirements that must be considered when designing a performance measurement-system as instrument of logistics controlling [Wic01]:

- Structure: Aggregation of key figures according to the phase of material flow and the functional subsystems of intra-logistics.
- Uniformity: Standardized presentation of key figures to increase comprehensibility and clarity of the system of key figures.
- Planning reference: operational und strategic key figures in consideration of the recipient of information.
- Mixing system: qualified mixture of arithmetic, classification and target systems so that key figures complement and explain each other.
- Flexibility: Adaption of the system of key figures to reduce the effort for changed processes in intra-logistics.

Order-picking represents the connection between the warehouse and the consuming function [HSN07]. Thus it characterizes a phase of the material flow within the storage as subsystem of intra-logistics. According to the VDI-guideline 3590 an order-picking system is divided into the subsystems material flow, flow of information and organization. Their interaction implies the functionality of the order-picking system [HSB11; VDI3590]. That is why an observation of individual subsystems should be avoided. Consequently a structure of the performance measurement-system for different phases and subsystems of not logistics is not meaningful. Furthermore the first requirement made by Wicht can be cancelled. The remaining four requirements are included as criteria in the evaluation.

### 3.2 REQUIREMENTS FROM SUPPLY CHAIN CONTROLLING

For the evaluation of performance measurement-systems in supply chain controlling Giese defined ten criteria that are partially conform to previously requirements of logistics controlling. These are especially the following criteria [Gie12]:

- Time: Consideration of backward-looking and forward-looking data and information.
- Alignment: Consideration of internal (e.g. employees) and external stakeholders (e.g. customer).
- Control objective: short- and long-term optimizations at all performance levels.

- Dimension: Consideration of financial and non-financial key figures.
- Format: Consideration of qualitative and quantitative key figures.
- Planning reference: Consideration of strategic and operational key figures.
- Incentive reference: Support of continuous improvements and variance reductions.
- Multi-level reference: Performance measurement of the whole supply chain and of various supply chain partners.
- Process orientation: Reduction of interfaces between supply chain partners and increasing process orientation.
- Flexibility: Moderate effort for operating the system of key figures and for its adaption in the case of a modified network structure.

The requirements for seven of ten criteria represent general features of performance measurement systems. Thus they can be considered as criteria for order-picking systems. These are the following criteria: time, alignment, dimension, format, planning reference, incentive reference and flexibility. The other three criteria are aligned to the specific needs of the supply chain so that they have to be modified with regard to the special requirements of order-picking systems. The reason for this is that an order-picking system is, as being a part of an intra-logistics system, a level of hierarchy in a company. Contrary to that inter-company management of the whole, value chain is the key part of supply chain [WW10]. Thus the criterion control objective does not have to track short- and long-term improvements at all performance levels but rather within the order-picking system. The multi-level reference must be modified for the above reasons as well. Useful is here the integration into the superior management system of intra-logistics or the company. As a result of the high costs of operating, a system of key figures is reduced as part of corporate management. In addition, the criterion process orientation has to be adjusted. The requirement for a high process orientation remains, but the reduction of interfaces between partners within an order-picking system is not necessary.

### 3.3 EVALUATION OF THE PERFORMANCE MEASUREMENT-SYSTEMS

From the previous descriptions twelve criteria can be used to evaluate the four performance measurement-systems described/presented in chapter 2. These are the criteria uniformity, planning references, mixing system, flexibility, time, alignment, control objective, dimension, format, incentive reference, multi-level reference and process orientation. A detailed assessment with the criteria in chapter 3.2 to various performance measurement-systems

has already been done by Giese [Gie12], based on a large literary research. Among others the four systems from this paper were investigated. The demands on the seven criteria planning reference, flexibility, time, alignment, dimension, format and incentive reference are independent from the application, in this case by an insert in supply chain management or in order-picking systems. Therefore the results from Giese can be taken over for the following. It turns out that Tableau de Bord considered strategic and operational, backward- and forward-looking as well as financial and non-financial key figures. The criteria flexibility, alignment and format are not directly involved but can be implemented due to the design of flexibility of the concept. The goal of continuous improvement is not supported.

Excluding flexibility all criteria are completely considered in Balanced Scorecard. In any case, the criterion flexibility is severely limited because there is an increased effort especially to organizational changes expected. In a similar way Skandia Navigator is evaluated. An exception is the inclusion of strategic key figures based on corporate or logistics objectives. A fixed pool of 165 key figures is available so that the consideration of strategic objectives is a secondary part.

The concept of selective key figures is very open so that a lot of criteria are not explicitly included but can be integrated easily into that concept. This concept asks for the explicit inclusion of strategic and operational key figures so that the criterion planning reference is completely fulfilled. Moreover the effort for modification is low due to the simplicity of the concept [Gie12].

In the following, criteria from logistics controlling uniformity and mixing systems and the three modified criteria control target, multi-level reference and process orientation are analyzed closer and evaluated.

The criterion uniformity requires a high standardized presentation. This is primarily important for the understandability of the performance measurement-system and consequently for the users acceptance [Wic01]. In academic literature there are schematic visualizations especially for the Balanced Scorecard, the Skandia Navigator and the concept of selective key figures used so that the formal design of these concepts has got a high structure in any case. As described in chapter 2.1, there is no standardized approach to a Tableau de Bord. The formal design is thus very individual. However, a structured design of the implementation in a company is useful.

The criterion mixing system aims at a mixture of arithmetic, classification and target system. For imaging the target performance measurement-system must be able to illustrate all relevant objectives of a company or its divisions and departments [Wic01]. This is ensured by the derivation of key figures from division targets in all four performance measurement-systems. In contrast the con-

sideration of an arithmetic system is more problematic. Hereby a system of key figures is meant, in which all key figures are arithmetically connected. Effects to one key figure consequently have effects on the connected key figures [Bre12]. These key figures are usually financial- and profit-oriented. Particularly this attribute of traditional systems of key figures is not a part of a performance measurement-system as it was already shown in chapter 2. Thus, none of the four systems owns the feature mixing system.

Criterion control objective requires short- and long-term improvements. This request is fulfilled especially by the use of strategic and operational key figures. Particularly Tableau de Bord is focused on the processes in the operational areas and neglecting long-term improvements [Grü02] so that this criterion is not fulfilled. In consequence of the focus on the future at Balanced Scorecard and Skandia Navigator as well as the top-down-oriented analysis of strategic logistics objectives and bottom-up-looking consideration of operational bottlenecks within the system the control objective is sufficiently considered in this performance measurement-systems.

Integration into the superior control system of intra-logistics is meant by criterion multi-level reference. That means that the performance measurement-system must be able to formulate suitable division objectives out of the top-down derived objectives of superior divisions and to measure these objectives with key figures. Particularly Tableau de Bord, Skandia Navigator and Balanced Scorecard are characterized by the fact that every business division has its own system of key figures. The various systems are combined by breaking down the company's goals. The concept of selective key figures is originally designed for logistics. It is aimed at a high aggregation of key figures. Based on the strategic performance requirements of logistics key figures are derived. Thus, integration into the superior system is fulfilled in this case.

Process orientation is considered in Balanced Scorecard and Skandia Navigator because every process sight has its own perspective. Therefore suitable key figures can be defined. The focus on processes is different and not included in Tableau de Bord [Gie12]. The concept of selective key figures does not explicitly regard the use of process-oriented key figures either. These systems are designed so that the formulation of relevant key figures is possible.

In summary the results are shown in Table 1. The evaluation was carried out on a scale of 0 to 2. A 0 means that requirement is not and a 2 the requirement is completely met. When the request was partially fulfilled and modifications are necessary then a 1 was awarded. On this basis the evaluations added to a performance measurement-system and the totals are compared. The criteria are considered as equivalent, so that a weight is not required.

This is justified on the basis of the requirements such as the use of strategic and operational as well as financial and non-financial key figures that are within the meaning of multi-dimensionality explicitly called for the implementation of a successful performance measurement system (see also chapter 2).

According to that, it can be said that the consideration of the four systems Balanced Scorecard meets most requirements. For this reason a performance measurement-system for order-picking will be developed in the following that is based on the concept of Balanced Scorecard.

Table 1. Evaluation of systems of key figures

Criterion	Requirement	Tableau de Bord	Balanced Scorecard	Skandia Navigator	Selective key figures
Uniformity	High standardized representation	1	2	2	2
Planning reference	Strategic and operational key figures	2	2	0	2
Mixing system	Arithmetic, classification and target systems	0	0	0	0
Flexibility	Moderate expense for adaptations	1	0	0	2
Time	Backward- and forward-looking data and information	2	2	2	1
Alignment	Internal and external stakeholders	1	2	2	1
Control objective	Short-term and long-term improvements	0	2	2	2
Dimension	Financial and non-financial key figures	2	2	2	1
Format	Qualitative and quantitative key figures	1	2	2	1
Incentive reference	Continuous improvements and variance reductions	0	2	2	1
Multi-level reference	Integration into the superior control system	2	2	2	2
Process orientation	High process orientation	1	2	2	1
<b>Result</b>		<b>13</b>	<b>20</b>	<b>18</b>	<b>16</b>

#### 4 FIRST CONCEPT OF A PERFORMANCE MEASUREMENT-SYSTEM FOR ORDER-PICKING

The core of the Balanced Scorecard is the consideration of corporate division from four perspectives. For these perspectives appropriate targets must be defined and operationalized with the help of key figures first. The key figures to be drafted are formed on the basis of typical figures that are mentioned in the academic literature for the use in order-picking systems. Here there are a lot of collections of key figures to control order-picking systems. Typical key figures are, among others, in the VDI-guideline 4490 [VDI4490] which forms the basis of the derivation of the key figures of the objectives in the following.

The main objective of the *financial perspective* is to realize the highest possible profit. For the internal logistics system this means the reduction of logistics costs. Together with the increase of logistics performance these are the two main objectives of logistics [Heß11]. From a financial perspective, the ultimate goal is therefore to reduce logistics costs, which can be measured within the order-picking system by total order-picking costs. In addition, the other important objective is to reduce order-picking costs which can be defined by costs per order-picking order.

The second pillar of logistics, increasing logistics performance, may be called a major objective of the *internal process perspective*. Broken down to the considered order-picking system this is the primary objective to increase the order-picking, which can be measured by the number of order-picking orders per day. Also figures the speed of order processing, as measured by the throughput time per order-picking order, a crucial role for a high order-picking performance. In addition, the flexibility, understood as the ability of logistics systems to adapt suitably to changes in the corporate surrounding, gets an increasing importance [Heß11]. To operationalize the key figure the utilization of the order-picking warehouse can be used.

Frequently mentioned exemplary objective targets of *customer knowledge perspective* in academic literature are the increase of customer profitability, of the customer master and of the customer satisfaction [i.e. Pre10]. To measure the customer profitability key figure profit margin per customer order can be used. Customer data are evaluated by the amount of order-picking orders per customer. The key figure complaint rate represents a key figure to evaluate the customer satisfaction.

A key element of the *learn and growth perspective* is the increase of the employees' satisfaction and of their

expertise. Herewith the goals of the other perspectives can be reached [Heu11]. Exemplary key figures for reaching these goals are labor turnover rate as well as the amount of training days per employee [Bre12].

These defined operational targets as well as their quantization with suitable key figures is presented in Table 2. These are a matter of exemplary operational targets and key figures from academic literature. An evaluation of targets and key figures in sales and industries is recommendable in a further step (compare chapter 5).

Table 2. *Balanced Scorecard for order-picking*

Perspectives	Targets	Key figures
Financial performance	Reducing logistics costs	Total order-picking costs
	Reducing order-picking costs	Costs per order-picking order
Internal processes	Increasing order-picking performance	Order-picking orders per day
	Speed of order processing	Throughput time per order-picking order
	Order flexibility	Utilization of order-picking warehouse
Customer knowledge	Increasing customer profitability	Profit margin per customer order
	Increasing customer master	Order-picking orders per customer
	Increasing customer satisfaction	complaint rate
Learning and growth	Increasing employees satisfaction	Labor turnover rate
	Increasing employees expertise	Amount of trainings per employee

## 5 FURTHER TASKS TO DETAIL THE CONCEPT

The developed first concept of the Balanced Scorecard must be detailed for use in practice. In this context the key figures, that were derived from the literature analysis, should be evaluated in terms of their practical relevance. For the evaluation of the key figures a survey of experts is reasonable who have a sufficient knowledge about order-picking. In addition to the executives of the logistics staff of the subordinate hierarchy levels has to be included because they possess also a sufficient knowledge due to their daily work [May13].

In addition to the evaluation of the key figures the cause-and-effect-relationships between the targets have to be detailed. These relationships visualize the effects of non-achieving of one target to other targets. It is useful that these cause-and-effect-relationships are developed by a team of experts in workshops.

For use within a company it is also recommended to check the consistency of the detailed targets for order-picking. For this, the targets of the Balanced Scorecard for order-picking should be aligned bottom-up with the strategic targets of the superior logistics department and possibly supplemented by other company-specific targets to derive a consistent strategy from the corporate targets to the order-picking-system. The four perspectives are not fixed but other perspectives can be added [Pre10]. Depending on the company's and logistics goals it is possible to integrate perspectives such as changeability or environmental protection. Whether these are integrated in the form of an additional perspective or as a supplement to other targets and key figures in the existing perspectives depends on the specific situation of the company.

## 6 SUMMARY

Systems of key figures in the sense of performance measurement are suitable tools to measure logistics performance and costs. As a part of intra-logistics order-picking has a special meaning because of its function. To measure performance and costs in a suitable form in order-picking systems, four of the best known performance measurement-systems were compared and evaluated for their ability to control order-picking systems in this paper. Contrary to the philosophy of traditional systems of key figures the focus was not only on quantitative financial and profit-related key figures but also on non-financial key figures and qualitative indicators.

Particularly suitable for this case Balanced Scorecard has been evaluated. On this basis appropriate targets and key figures to evaluate an order-picking system have been formulated in which a first concept of a Balanced Scorecard for the use in order-picking was developed. Finally, hints for necessary detailed implementation and evaluation in practice were given.

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- Dipl.-Logist. Frederik Heine**, born in 1983, studied logistics at the University of Dortmund. Since 2009 he is working in the logistical planning department for Hella KGaA Hueck & Co. in Lippstadt.



Address: Hella KGaA Hueck & Co., Rixbecker Straße  
75, 59552 Lippstadt, Germany, Phone: +49 2941 38-0, E-  
Mail: info@hella.com

**Univ.-Prof. Dr.-Ing. Sigrid Wenzel** is managing direc-  
tor of the Institute of Production Technologies and Logis-  
tics at the University of Kassel and is manager of the Di-  
vision Production Organization and Factory Planning.

Address: Institute of Production Technologies and Logis-  
tics, Division Production Organization and Factory Plan-  
ning, University of Kassel, Kurt-Wolters-Straße 3, 34125  
Kassel, Germany, Phone: +49 561 804-1851, E-Mail:  
sekretariat-pfp@uni-kassel.de