### PAPER Techniques for Measuring Business Process Based on Business Values

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SUMMARY The ultimate purpose of a business process is to promote business values. Thus, any process that fails to enhance or promote business values should be improved or adjusted so that business values can be achieved. Therefore an organization should have the capability of confirming whether a business value is achieved; furthermore, in order to cope with the changes of business environment, it should be able to define the necessary measures on the basis of business values. This paper proposes techniques for measuring a business process based on business values, which can be used to monitor and control business activities focusing on the attainment of business values. To show the feasibility of the techniques, we compare their monitoring and controlling capabilities with those of the current fulfillment process of a company. The results show that the proposed techniques are effective in linking business values to relevant processes and integrating each measurement result in accordance with the management level.

key words: business value, process measurement, business activity monitoring, BSC, GOM

#### 1. Introduction

In management, a business value is a high-level concept that an organization pursues; specifically, it is an informal term for a value which, in the long run, guides corporate decisionmaking and helps determine corporate health. To effectively support corporate decision makers, we need to measure business values and identify problem areas that need quick improvement. However, employees first need to reach a consensus on business values because any employee who is involved in business processes must share the organizational business values. By striving to reach a consensus, employees get a better understanding of their roles and responsibilities (R&Rs) for achieving business values. In turn, they can align their behavior to the business values. However, because organizational business values are described in conceptual and informal terms, we can foster organizational business values by translating top-level business values into multiple indicators at the lower levels, and we can define each value in terms of tactical goals that have a deadline and target value for a given indicator; each indicator measures a specific task and should be easily understood by the employer who is in charge [14].

The measurement and evaluation of business processes are the foundation of process improvement. Activity-based management is widely used to improve process measurement and to support decision-making within an organization [31]. The aim of process measurement is to determine the performance of business processes via a given set of measures [21]. Many organizations measure the performance of their business activities, though the measures often fail to reflect the organization's business goals. Many organizations manage numerous measures, so they spend considerable effort on taking measurement results; however, not all the measurement results are used to improve the performance of business processes. Moreover, the analysis results of collected data are often not shared with practitioners, which mean there is no consensus on data collection among practitioners. Measures consequently fail in their responsibility and seldom have a positive effect.

One of the most influential approaches that have been implemented in many companies is a performance measurement based on the Balanced Scorecard (BSC) [19]. The BSC usually gives a vertical view of the performance of divisions, business units, departments and other organizational units [21]. However, an organization can create business values through business processes, and most business processes are cross-functional. In this respect, the BSC is inadequate for business processes. A successful measurement must generate values: that is, it must identify organizational problems through measurements [24]. For a successful measurement, an organization should define meaningful measures and the data should be easy to collect [16]. Performance measurement frameworks have been developed and discussed in the literature [8], [15], [23], [26]. They include the SMART pyramid [9], the BSC, the results-determinants framework [11], the input-process-output-outcome framework [4], the European Foundation for Quality Management (EFQM) [28], and Performance prism [23]. Neely et al. [23] point out that such a framework should support an organization in identifying performance measures that are consistent with management techniques and improvement initiatives. However, the existing frameworks do not satisfy this expectation nor is it straightforward to adapt them to do so, for example, in the BSC and the SMART pyramid [23].

Pidun et al. [26] reviews whether the models or frameworks enable an organization to focus on the value creating processes with countable measures and whether the models or frameworks rate the success of a process. The review results show that there are no models yet that fully

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address them. Lean manufacturing, Performance management, EFQM, CRM, and Lean Six Sigma partially deal with them, so an organization using them should adapt these models for its domain context. Moreover, although not pointed out in the review of Pidun et al. [26], the existing performance measurement frameworks do not support finding obstacles in achieving an organization's business values in spite of its importance.

Kang et al. [18] proposed a framework for measuring and managing value achievement in business processes on the basis of the organization's business values rather than the monetary value, thereby opening the way to measuring and managing business values in general. This paper builds on Kang et al. [18] and proposes specific techniques for measuring business process based on business values. Although Kang et al. [18] provides a general framework, it does not provide concrete techniques that can be used to monitor and control business activities focusing on the attainment of business values. In these proposed techniques, measures, including the intermediate key performance indicators (KPIs) and subvalues, are connected with relevant processes or tasks for tracking whether business values are achieved and the extent to which business values are achieved can be measured in terms of the R&Rs of practitioners or managers, and also measurement results can be used to improve the relevant processes.

This paper is organized as follows: Sect. 2 describes the background knowledge used in this paper. Section 3 introduces our measurement and management techniques for business processes. Section 4 analyzes an example of fulfillment work and compares our approach with an existing measurement and management approach. Section 4 discusses the comparative results. Finally, Sect. 5 presents our conclusions and suggests future directions for extending our work.

#### 2. Background

This section describes the BSC, the goal question metric (GQM), and the BSC + GQM approach, which form the basis of our techniques.

The motivation behind the GQM [6], [25] is that software measurement should be goal-oriented. The GQM approach derives measures (e.g., Number\_of\_Shippings) that are well aligned to goals (e.g., Average shipping cycle time of 2 days); it also gives a rationale for each measure. Goalbased methods, including the GQM and the goal question indicator measure (GQ(I)M) [13], have achieved demonstrable and quantifiable results in practical and academic studies, but they have weaknesses such as the possible growth of an unmanageable amount of measures and overheads due to goal setting and negotiations [3]. The GQ(I)M approach helps identify goal-oriented measures. The GQ(I)M is initiated by defining goals, decomposing them into subgoals, and then developing indicators or measures that pertain to the fulfillment of those goals. Accordingly, the GQ(I)M approach facilitates the collection of data elements that are consistent with the established goals. The BSC is a management tool that provides senior executives with a comprehensive measure of how the organization is progressing towards its strategic goals [1]. Designed to help strategy-focused organizations translate their strategy into operational terms, the BSC aligns the organization to the strategy; it also makes strategy a continual process and an everyday job for everyone in the organization [20]. It was initially developed in the business domain but has recently been adapted to the software domain. Note especially that the business process management (BPM)-based BSC aligns KPIs (e.g., Average shipping cycle time) and processes. The KPI-process alignment enables an organization to establish work directions for each team and individual on the basis of organizational strategies. Furthermore, an organization can anticipate the problems of realizing strategies and cope with the problems proactively. However, because the BPM-based BSC fails to differentiate the achievement level of KPIs for each level of management, there is a difficulty in providing correct information that meets the needs for the specific R&Rs (e.g., Inventory mgt. process has a role for achieving an atomic value Guaranteed quick delivery and its responsibility is 40% of the relevant atomic value's assigned goal.) of practitioners or managers.

The BSC helps an organization consider its strategic goals in terms of a measurement system, especially a measurement system based on the viewpoint of strategy, management, and personal levels of work. Therefore, the BSC can support the use of the GQM in the establishment of a strategic measurement system [2]. Becker and & Bostelmann [2] tried to integrate the BSC and the GQM and introduce a common framework for formalizing the data collection so that organization's strategic and project management system could be aligned. Goethert and Fisher [13] proposed a method for deriving enterprise-wide measures by combining the advantages of the BSC and the GQ(I)M approach. This hybrid approach uses the GQM approach to derive strategic goals and sub-goals from the mission and vision statement and then maps them to the scorecard. The scorecard helps to determine whether the mission, goals, and sub-goals are stated correctly [13].

According to de Waal [10], knowing which business processes are related to goals and measures, i.e. who is responsible for what, is important for determining which factors will be measured. In contrast to software processes, business processes are hierarchical and, in many cases, non-sequential. Most business processes are also crossfunctional. Thus, when measures are being derived, it is efficient to establish the relations between goals or measures and business processes. Most research to date has been focused on methods for deriving measures. To resolve these problems, we propose techniques that involve the use of the BSC and the GQM to derive suitable measures from business values and along with the deriving measures it also supports the establishment of links with the relevant business processes. The integration of the BSC and the GQM exposes what aspects we should focus on, so they make it possible to derive measures well-aligned with business values. In the proposed technique, business values have a hierarchical structure along with business processes with trace links between them and business processes have assigned R&Rs, so the corrective actions to overcome obstacles can be implemented for business value achievement.

As the previous work on value measurement considered only the notion of benefit as value, Kang et al. [18] developed a framework for measuring and managing business values in general, which makes it possible to measure value achievement at appropriate places in the processes, trace values to business processes, and take necessary actions in response to the measured progress in value achievement. However, Kang et al. [18] does not provide detailed techniques which allow measures, including the intermediate key performance indicators (KPIs) and subvalues, to be connected with relevant processes or tasks in order to track whether business values are achieved and achievement of business values can be measured in terms of the R&Rs of practitioners or managers, and also measurement results can be used to improve the relevant processes. The purpose of this paper is in providing such techniques, which are essential for the framework to be widely used in practice.

# 3. Business Values Measurement and Management Techniques

In a mission and vision statement, the mission describes the raison d'être of an organization and the vision describes how the organization is expected to perform the mission in the near-term, mid-term, and long-term [13]. As a high-level concept derived from mission and vision statements, business values offer guidelines to help the organization pursue its objectives and course of action [7]. Business goals have concrete content and deadlines. While business goals contain qualitative and quantitative aspects, business values have no time constraints or concrete content that helps determine whether a specific value has been achieved.

Business values themselves fail to make clear which elements of an organization's structure have R&Rs for achieving specific values; nor do they show how we can measure and evaluate the achievement of specific values because the definition of a value is too abstract. Furthermore, because of the complex nature of business values, it is difficult to determine the R&Rs and measures from a single aspect. For example, the identified R&Rs and measures for a business value might differ according to specific aspects, such as the financial aspect or the customer aspect. This section explains the method of measuring the degree of business value achievement, deriving measures, and mapping the measures to business processes so that business processes can be monitored and controlled in accordance with the R&Rs. The R&Rs for achieving a business value are determined by the mapped business processes because each business process already has an R&R.

Measurements, feedback, and actions are keys to improving business processes. The measurement results should be fed back to those who perform activities so that they can improve their performance. In addition, a manager can make intelligent decisions to control and manage their business processes [22]. These factors are the key enablers that support processes [29]. They agree with the strategic performance management development cycle proposed by de Waal [10] and the success factors of performance measurement reviewed by Gresty [15]. Our Business Values Measurement and Management Techniques (BVMMT) provide ways to systematically link these aspects and overcome the limitations of the existing frameworks discussed in the Introduction section.

In order to address these essential aspects of a business process performance measurement, the BVMMT includes techniques defined from the three dimensions as Fig. 1 describes; the measures derivation dimension, the mappingto-process dimension, and the performance management dimension. In the measures derivation dimension, the defined technique recursively decomposes a business value into subvalues so that it can be measured quantitatively and objectively. In addition, KPIs and tactical goals must be established for assessing the practical aspects of achieving business values. In Fig. 1, arrow in the forward direction indicates decomposition of a business value into measures. During the decomposition of business values, the business values and their subvalues are assigned to business processes; this occurs in the mapping-to-process dimension. The BVMMT from the mapping-to-process dimension provide a technique that helps determine in which business process the measurements should take place from and who should receive feedback on the measurement results. Furthermore, in the performance management dimension, a technique that defines the integration functions at each level of decomposition and subsequently used to calculate the degree to which the business values are achieved at each level in the hierarchy of business values. In Fig. 1, arrow in the backward direction indicates integration of the values achieved at the relevant step. The performance management dimension also provides a technique for deciding which business values are not being achieved and which processes should be controlled in order to solve problems. In contrast with the strategic performance management development cycle proposed by de Waal [10], techniques from these three dimensions complement each other and are executed in parallel, which makes the measurement and management activities based on the BVMMT focus on the achievement of business value. Detailed descriptions of the three dimensions are given in Sects. 3.1 to 3.3.

#### 3.1 A BVMMT Technique from the Measures Derivation Dimension

This BVMMT technique derives indicators by recursively decomposing a business value into atomic business values; this provides the rationale for each atomic business value and directs those values to the proper indicators. This BVMMT technique uses the BSC and the GQM to



Fig. 1 Three dimensions of the BVMMT.



Fig. 2 A BVMMT technique from the measures derivation dimension.

decompose the business values. The BSC is used to translate business values (or subvalues) into measures with the BSC perspective; it then confirms if the business values (or subvalues) and goals are stated correctly. In addition, the GQM is used to pose relevant questions from the four perspectives of the BSC for the purpose of decomposing the values; the GQM is also used to derive KPIs that address the business values for each BSC quadrant. Figure 2 describes this BVMMT technique from the measures derivation dimension.

Each step in Fig. 2 is explained below:

**Step 1 (Identify business values)** Business values, which are a guide for deciding an organization's objectives and the direction of its actions are identified. A common understanding of business values motivates the stakeholders of an organization to bind together.

Step 2 (Derive atomic business values by decomposing the identified business values) An atomic business value is a business value that cannot be decomposed any further. The abstract or subjective nature of business values can complicate the task of determining their R&Rs and deriving the measures or metrics. We therefore decompose each business value from the three BSC perspectives: namely, the finance, customer, and learning perspectives. This process is achieved with the sub-steps listed below. The remaining perspective, namely the process perspective, is used to link the relevant processes. The four BSC perspectives help us to decompose a business value more accurately and easily. In addition, to derive KPIs that are well aligned to a business value, we introduce the GQM concept and use the following types of basic questions to decompose the business values: 'What do I need to do to achieve business values?' or 'What attributes do I have to manage to achieve business values?' From the answers to these questions, we derive subvalues that are aligned to the preceding level of a business value. This step is divided into the following five sub-steps:

- Sub-step 2.1: Participants of this dimension enumerate suggestions for upholding a business value in accordance with their roles. Relevant questions are asked to participants of this dimension from the three BSC perspectives to derive suggestions.
- Sub-step 2.2: Each suggestion is refined further and the subvalues are developed. Any particular suggestion that may be inappropriate or unnecessary is not transformed into a set of subvalues.
- Sub-step 2.3: The subvalues are evaluated and prioritized. Parts of the subvalues are selected according to their contribution to their parent business value; we use the terminology of a tree structure, such as root, parent, and child, to indicate items in the business value hierarchy. The children of a business value might be validated to ensure their appropriateness for their parent business value.
- Sub-step 2.4: The integration function is defined by setting the contribution ratio of each decomposed subvalue and reflecting the mathematical relations among the decomposed subvalues.
- Sub-step 2.5: If the subvalues are not adjudged to be atomic, Sub-steps 2.1 through 2.5 are repeated.

Step 3 (Select and define KPIs for monitoring each atomic value) A determination is made of the performance indicators, which are used to monitor and control how successfully an atomic business value is achieved. To derive KPIs that are well aligned to the atomic business values, we apply the GQM concept and the BSC perspectives in the same way as in Step 2. This step consists of the following sub-steps:

- Sub-step 3.1: KPIs are derived from an atomic business value by applying the GQM approach and the BSC perspectives.
- Sub-step 3.2: KPIs are validated in terms of their contribution to the accomplishment of the relevant atomic

#### business value.

**Step 4 (Cascade KPIs to define the tactical goals)** KPIs are assigned in accordance with their importance in accomplishing atomic business values at the appropriate level of the process hierarchy. A tactical goal defines the outcomes of linked processes that must be achieved in order for the organization to reach its business values. Tactical goals for KPIs have deadlines and they must be:

- · measurable
- · based on a consensus of stakeholders
- consistent with the organization's business values and
- validated by external and internal experts (whereas KPIs and atomic values are validated by internal experts).

Also Tactical goals must:

- · define their artifacts and roles exactly and
- embody the principle of equity in accordance with the R&Rs of the relevant business processes through a mediation meeting [5], [12].

**Step 5 (Derive measures)** The measures that will be used for the KPIs and the methods of collecting data are defined. Their relations and origins have been defined in Step 2 and Step 3, which means the grounds for their interpretation are already specified.

In the measures derivation dimension, a user selects various KPIs and measures from a set of business values. Thus, the owner or manager of a business process can track the cost, overall customer satisfaction, or any other variables. Fairly derived KPIs and measures from business values help all members of an organization to focus on top-level objectives pertaining to their R&Rs. Our BVMMT from the measures derivation dimension can guide users to avoid inappropriate measures. These techniques help all organizational processes add values towards the defined top-level business values.

#### 3.2 A BVMMT Technique from the Mapping-to-Process Dimension

As shown in the lower part of Fig. 1, business processes have a hierarchy: a mega-process consists of two or more process chains; each process chain is classified into either a core process chain or a support process chain [27], and a process chain in turn consists of two or more processes. As the organization's business values are decomposed by means of our approach and consequently become more specific, they are mapped onto the organization's business process hierarchy. In some cases, the relevant processes that help achieve the business values can be easily identified; however, in many cases, due to the high abstraction level of a business value, it may not be easy to determine those processes. Furthermore, certain processes may be more important that other processes for the purpose of achieving the business value. Our BVMMT method assumes that all or a more important subset of the relevant processes have been identified in advance before its application. Significance of the relevant processes is reflected in the integration function as it combines contributions of the subvalues mapped to the relevant processes according to their contribution ratios. Business values are then assigned to processes and articulated during the decomposition phase to make them quantifiable. The mapping results are subsequently used as a basis for determining R&Rs.

While business values are being decomposed, relevant components of a process map are assigned so that when a business value is not achieved the links between the business value hierarchy and the process hierarchy can be used to trace the threats to business value achievement. Through this dimension, relations are established between business values and their associated processes. With traceable links, feedback on problematic R&Rs can be provided to relevant persons so that they can take appropriate actions.

3.3 A BVMMT Technique from the Performance Management Dimension

A manager generally identifies goals to be accomplished and organizes the processes needed to accomplish those goals. In addition, a manager monitors the processes to ensure the processes meet their assigned goals; the manager also diagnoses problems and fixes them whenever the output of a process is inadequate [17]. For each process, this dimension determines how much each element of the process hierarchy must achieve to accomplish the assigned goal; it also uses predefined integration functions to integrate the achievement results. Whenever a business value is decomposed into subvalues, a function for integrating the subvalues should be defined in accordance with the assigned R&Rs and their assigned values. As described in Fig. 3, an integration function is defined whenever decomposition occurs. Before functions are defined, the responsibilities of each assigned element of the business process hierarchy are determined through a cascading process. An integration function is used to manage the level of business value achievement at each decomposition level. Before tactical goals are



**Fig.3** A BVMMT technique from the performance management dimension.

assigned to the KPIs of atomic values, the tactical goals of an atomic value can be decomposed for the same reason as the business values.

For example, when an integration function is defined as *On-time delivery* = 0.4 \* Accuracy of delivery estimate + 0.6\* *Guaranteed quick delivery*, any process assigned to Accuracy of delivery estimate is responsible for achieving 40% of the assigned value of On-time delivery; in the same way, any process related to Guaranteed quick delivery is responsible for achieving 60% of it. When atomic values are converted into KPIs, tactical goals are assigned; and, if necessary, the tactical goals can be decomposed. In the same manner, integration functions must be defined at every decomposition level. Otherwise the tactical goals of the atomic values and KPIs coincide with each other.

The performance management dimension, as with the mapping-to-process dimension, integrates business values with business process management. This dimension makes it possible to assess the gap between the current performance and the desired performance in business terms [30]; that is, tactical goals defined in Step 4 of measures derivation dimension. On the basis of the assessment results, a manager can design a management plan that clearly indicates the R&Rs of executing the plan.

## 4. Applying the BVMMT to the H-Shopping's Business Process<sup> $\dagger$ </sup>

H-shopping<sup>††</sup> is engaged in the distribution business. It has a plan to develop a measurement system for monitoring the fulfillment process, one of its key processes. H-shopping wanted to formulate an activity monitoring system that helps it cope immediately with problems of performance achievement. Accordingly, they devised various monitoring methods for efficient monitoring of KPI cascading results.

Section 4.1 describes the measurement practice currently used by H-shopping and discusses the problems with the practice. Section 4.2 shows how business process measurement can be changed by the application of the BVMMT. Section 4.3 compares the BVMMT with the current practice and discusses how the problems in the current practice of H-shopping can be solved with the BVMMT.

#### 4.1 The Current Measurement Practice of H-Shopping

H-shopping selected and defined indicators by using the following procedure:

**Step H1.** Analyzing processes and activities of fulfillment work

**Step H2.** Deriving the monitoring and controlling factors for measuring process performance

**Step H3.** Deciding KPIs with achievement deadlines after cascading them to organizational units.

Mega Processes	Processes	<u>Activities</u>	
Order	Order Approval	Order Approval	
Fulfillment	Supply Planning	Plans for Sales and Put-away Order As	ousing SN
	Put-away Mgt.	Put-away Center	
	•••		
	Return Mgt.	Gather Returns Put-away Returns S	Ship Returns
		Manage ReturnDelay	
Post-Sale	Cancel/Modification	Create Cancel Modify Items N	Aodify Dlv. nformation
Service	Exchange/Return	Create Exchange Create Return	

Fig. 4 The process hierarchy for the fulfillment work of H-shopping.

After the cascading, all individuals within the organization are assigned a special set of KPIs and objectives, which they try to reach within a fixed period. Performance reviews are conducted periodically to determine how close individuals are to attaining their assigned objectives.

**Step H1 (Analyzing processes and activities of fulfillment work)** As shown in Fig. 4, the fulfillment work consists of three mega processes: the order process, the fulfillment process, and the post-sale service. Twenty four of the various activities in 9 processes shown in Fig. 4 were selected as relevant activities of fulfillment work. However, analyzing 9 processes and 24 activities as a whole are too complex to control. Furthermore, it is difficult to analyze the relations among the various activities or processes.

Step H2 (Deriving the monitoring and controlling factors for measuring process performance) As a result of analyzing the fulfillment work, three data interfaces were derived from the order approval process, the cancel or modification process, and the exchange or return process (bold lined boxes in Fig. 4). Seventeen monitoring and controlling factors were derived from the supply planning process, the put-away management process, the shipping process, the delivery process, and the return management process. Process maps that describe the relations among processes and monitoring factors were derived from each process. Three data interfaces monitored at the interfaces between the processes not in the processes were excluded from the cascading process.

In the current approach of H-shopping, the process hierarchy is analyzed as a whole. In most cases, the analysis is based on subjective know-how or information, without any standard rules or criteria.

Step H3 (Deciding KPIs with achievement deadlines after cascading them to organizational units) For the seamless monitoring and control of fulfillment work, 12 indicators were derived from an enterprise-wide scope, and 602 indicators with achievement deadlines were then selected after 12 indicators were cascaded to organizational units. The KPIs were selected and defined after the cascading. Each KPI has criteria for evaluating progress; the

<sup>&</sup>lt;sup>†</sup>Part of this case study was used to illustrate the framework of [18].

<sup>&</sup>lt;sup>††</sup>The number of employees of the organization is 6,500 and the sales volume is one billion dollars per year.

organizational units are monitored by dashboards which contain information on the participant organizational units, the deadline (year, quarter, or month), and the person in charge.

However, the current method does not provide a rationale of how KPIs are selected, and the achievement goals are assigned from the factors derived in Step H2. We found that H-shopping's process of deriving indicators has the following problems:

- P1. No rationales are provided for the derived indicators.
- P2. The extent of each indicator's contribution to the accomplishment of the overall performance of an organization is difficult to estimate. (The monitoring and control of indicators require considerable effort.)
- P3. Links between data, indicators, processes, performance objectives, and strategic goals are not tracked. (These links help an organization understand the indicators and cope with exceptional conditions.)
- P4. The importance of indicators is difficult to understand. (High priority indicators should be monitored and managed, and special consideration should be given by ensuring that integration weights are enhanced in accordance with the priority.)
- P5. There is no way of forming a consensus among stakeholders with regard to the derivation of KPIs. (There is a lack of consensus.)
- 4.2 Process Measurement with the BVMMT

This section explains how our approach determines the indicators and measures of fulfillment work, including R&Rs, and how the measurement results are used for each R&R. Figure 5 shows a business value map that describes the relations between business values and key processes that contribute to the achievement of those values. The business values are decomposed from financial and customer



Fig. 5 Business value map for the fulfillment work.

perspectives; and the internal process perspective helps find relevant business processes. The decomposed business values constitute the business value hierarchy, and the trace links to the business process hierarchy are established together with the decomposition.

4.2.1 Applying the BVMMT from the Measures Derivation Dimension

Together with the derivation of KPIs and measures from business values, our BVMMT defines the integration functions and trace links between the business values and processes. In the measures derivation dimension, the following five steps are implemented to make the business values quantifiable:

**Step 1 (Identify business values)** The defined business values of H-shopping are customer satisfaction and customer profitability. Customers take precedence over other values, so H-shopping is devoted to the R&Rs of its customers.

Step 2 (Derive atomic business values by decomposing the identified business values) To derive atomic business values, we repeated Sub-steps 2.1 through 2.5 of our BVMMT. While deriving subvalues, we performed business value-process cascading so that we could elicit processes that specify R&Rs that help achieve the relevant business value. In addition, whenever subvalues were decomposed, we defined a function for integrating child business values with their parent business value. We decomposed the value of customer satisfaction into the subvalues of ontime delivery and on-time delivery communication. The subvalue on-time delivery was subsequently broken down into atomic values of accuracy of delivery estimate and guaranteed quick delivery. The following equation represents the integration function for defining the relation between the two atomic values:

On-time delivery = 0.4 \* Accuracy of delivery estimate + 0.6 \* Guaranteed quick delivery.

In general, the atomic values *accuracy of delivery estimate* and *guaranteed quick delivery* can be calculated by the defined functions. That is, '*accuracy of delivery estimate*' can be calculated as follows:

(Number of evaluated purchase order items for which the actual delivery date is less than or equal to the estimated delivery date) / (Total number of purchase order items) \* 100%.■

In addition, '*guaranteed quick delivery*' can be calculated as follows:

(Number of evaluated purchase order items for which the shipping date is equal to the purchased date)/(Total number of purchase order items) \* 100%.■

Step 3 (Select and define KPIs for monitoring each atomic value). Table 1 shows the results of cascading the atomic business value to processes for the purpose of monitoring the derived atomic business values. Through the cascading process, the R&Rs of each process are assigned for the achievement the business value. The KPIs that are used to monitor the performance of atomic business values are

Atomic value	Process cascading	Responsibility	KPIs	
Guaranteed quick delivery	Inventory mgt.	40	Positive ATP ratio (%)	
	Shipping mgt.	30	Adherence rate of ATP date (from shipping viewpoint)	
	Delivery mgt.	30	Adherence rate of ATP date (from the delivery viewpoint)	
Accuracy of delivery estimate	Put-away mgt.	40	Average put-away cycle time, Registration rate of ASN Adherence rate of ASN	
	Shipping mgt.	40	Adherence rate of ATP date (from the shipping viewpoint) Average shipping cycle time	
	Delivery mgt.	20	Adherence rate of ATP date (from the delivery viewpoint) Average delivery cycle time	

Table 1 Alignment of atomic values and processes.

\* ATP and ASN mean Available To Promise and Advice Ship Notice respectively

Table 2 KPIs, goals, and measures.

KPIs	Goals	Measures	Data elements	Data collection points (tasks)
Adherence rate of ATP date (from shipping viewpoint)	90%	Number_of_ATP_adh erence/Number_of_S hippings * 100%	ATP_Date (from shipping viewpoint) Actural _Shipping_Date Number_of_Ship pings	Shipping_Requ est Shipping_Scan
Average shipping cycle time	2 days	Sum_of_ATP_Date/N umber_of_Shippings		

then selected and defined.

**Step 4 (Cascade KPIs to define tactical goals).** We developed tactical goals and strategies for every KPI that have high priority. The responsibilities listed in Table 1 were cascaded to tactical goals for the KPIs shown in Table 2. The selection of tactical goals is based on a consensus of stakeholders.

**Step 5 (Derive measures).** The measures including data elements and data collection points derived from KPIs are shown in Table 2.

As mentioned in Sect. 3, measurements are useless unless they are used to improve processes. The remaining two dimensions, namely the mapping-to-process dimension and the performance management dimension, provide ways of giving appropriate feedback to appropriate participants of a measurement with opportunities to improve their activities.

#### 4.2.2 Applying the BVMMT from the Mapping-to-Process Dimension

While applying the BVMMT from the measurement dimension the BVMMT from the mapping-to-process dimension is applied. Business value map in Fig. 5 and process cascading in Table 1 partially show the results of the mapping-to-process dimension. As shown in Fig. 5 and Table 1, the value *customer satisfaction* was assigned to the order fulfillment mega process, and the value *on-time delivery* was assigned to the order fulfillment process chain, which is assumed to consist of the following processes: putaway management, inventory management, delivery management, shipping management, and return management. Figure 6 shows how the business value hierarchy and business processes are interrelated. The business process hierarchy is shown at the top, the business value hierarchy is



Fig. 6 Trace links between the business value and the process hierarchy.

shown at the bottom, and the trace links between them are obtained as a result of applying our approach.

By tracking the trace links, managers can find out which process elements help the business values to be achieved. When the actual process achievement does not conform to the planned target, the trace links established in this dimension indicate where the problems occur. The focus of the performance management dimension is on the actual achievements of business activities.

#### 4.2.3 Applying the BVMMT from the Performance Management Dimension

In the measures derivation dimension, the integration functions for calculating the achievement through business processes are defined together with the decomposition of business values. The achievement results calculated with predefined integration functions can be depicted by dashboards.

Figure 7 shows the dashboard of the value *on-time delivery*. The achievement of *on-time delivery* was calculated by using the integration function defined in Step 2. Figure 7 also shows the achievement of its children: namely *accuracy of delivery estimate* and *guaranteed quick delivery*. The manager of *on-time delivery* can check the dashboard for that value as well as the dashboards of its children. In January, the performance of *on-time delivery* was low (achieving only 69% of the objective), so the manager of *on-time delivery* tracked the status of the children of that business value. Thus, the manager of *the business* values *granted quick delivery* and *accuracy of delivery* 



Fig.7 Dashboard for on-time delivery and its corresponding KPIs.



Fig. 8 Dashboard for accuracy of delivery estimate and its assigned processes.

*estimate* was asked to report on the status and obstacles of achievement.

After reviewing the dashboard of the children of *accuracy of delivery estimate*, the manager of *accuracy of delivery estimate* found that the major obstacle was the put-away management process. The dashboard in Fig. 8 illustrates the achievement level of the atomic business value *accuracy of delivery estimate* as well as the achievement levels of its cascaded processes, which are put-away management, shipping management, and delivery management. The achievement of each process is calculated by integrating the achievement results of predefined KPIs. Through this dashboard, the manager of *accuracy of delivery estimate* can monitor the status of the assigned responsibility and respond immediately to a request for the manager of the parent business value *on-time delivery*.

Figure 9 displays the achievement of the shipping management process and its KPIs, which are shown in Table 1 as *adherence rate of ATP date (from the shipping viewpoint)* and *average shipping cycle time*. The two bars indicate the achievement of the two KPIs, respectively, and their integration results are marked with the solid line, which indicates the level of achievement for the shipping management process. The dashboard in Fig. 9 reveals that the cause of the low value achievement is the delay of the ATP date at the shipping time.



Fig. 9 Dashboard for the shipping management process and its KPIs.

 Table 3
 Comparison with the existing practice.

The H-company's current practice	The BVMMT
Step H1. Analyzing processes and activities of	Hierarchical business process definition
fulfillment work	
Step H2. Deriving the	Mapping-to-process dimension (partially
monitoring and controlling	related but quite different in its approach)
process performance	
	Measures derivation dimension
	Step 1. Identify business values
	Step 2. Derive atomic business values by
	decomposing the identified business values
Step H3. Deciding KPIs and	Measures derivation almension Step 2 Select and define VPIs for monitoring
cascading them to	(each atomic value)
organizational units	Step 4. Cascade KPIs to define tactical goals
	Measures derivation dimension
	Step 5. Derive measures
	Mapping-to-process dimension
	Performance management dimension

#### 4.3 Comparison with the Current Practice of H-Shopping

To illustrate how the BVMMT makes differences from the current practice we compare them side-by-side. Table 3 summarizes the differences between the current practice and the BVMMT. Some of the steps of the measures derivation dimension are implemented in the current practice but most of the steps are not. Notably, the mapping-to-process dimension and the performance management dimension are not implemented in the current practice.

Our BVMMT derives indicators by recursively decomposing a business value into subvalues until atomic business values are reached. This process provides rationales that direct atomic business values to the primary indicators. Whenever a business value or subvalue is decomposed, the R&Rs of value achievement need to be determined. To that end, the relationships between the business value being decomposed and its subvalues should be defined and the subvalues should be mapped to the relevant parts of the process hierarchy. Our method overcomes the problems P1-P5 mentioned in Sect. 4.1 in the following ways:

· Because indicators are derived from business values through decomposition, their rationales are straightfor-

ward. Moreover, the BSC perspectives and the alignment technique of the GQM approach enhance the correctness of the indicators (resolving P1).

- The expected contribution and level of achievement from each component of the business value hierarchy can be traced by cascading the results and integration functions, respectively (resolving P2).
- The business value hierarchy provides trace links from the top-level business value through data collection points, enabling the relationships to be managed effectively (resolving P3).
- The importance of each divided element is decided whenever decomposition occurs. The integration function reflects the importance of each of the decomposed subvalues. In addition, the size of the business value hierarchy can be adjusted by considering its complexity (resolving P4).
- The opinions of stakeholders are reflected in the decomposition results through the GQM, and the decomposition results are mapped to the appropriate components of the business process hierarchy. If processes are already assigned to the relevant organization units, there is no need to cascade the business values to the organization units. Stakeholders need to reach a consensus only for an associated deadline and the assignment of tactical goals (resolving P5).

Our BVMMT helps define meaningful KPIs, particularly for achieving business values, gaining consensus on KPIs, and their assigned tactical goals. It also allows an organization to manage the process performance in accordance with the R&Rs assigned to each element of the business value hierarchy. Furthermore, while the existing method monitors process agents and takes corrective actions at the agent level, the BVMMT monitor processes in accordance with the R&Rs. Hence, corrective steps can be implemented to promote the achievement of the assigned business value in the processes pertaining to their R&Rs.

#### 5. Conclusion

To increase business value achievement capability, an organization should be able to measure the level of achievement. In this paper, we proposed the BVMMT, a set of related techniques for monitoring business processes on the basis of the organization's business values. Organizations implement business processes to achieve their pursued business values but most of their current methods of monitoring business activities only focus on the task performer level.

Our BVMMT provides information that makes it possible to monitor an organization's processes not only at the task performer level but also at each management level; it does so by defining the business value hierarchy, the enterprise's business process hierarchy, and the trace links between the two different hierarchies. The measurement results provide a dashboard for the task performer; the KPIs and atomic values provide a status report on the business value achievement at the middle management level; and the integration of the achievement of subvalues at the highest business value provides a dashboard at the higher management level, including executive management.

In this paper, we also compared the differences between the results of applying the BVMMT and the results of applying the current practices of fulfillment work at Hshopping. The existing techniques of H-shopping focus on deriving and achieving individual performance indicators but not on tracking the rationale of how much each indicator contributes to the whole performance of the organization. Moreover, it is difficult to decide which performance indicators are critical for accomplishing the objectives of an organization. In contrast, the BVMMT explicitly deals with business values, which are abstract concepts, and we can judge which processes or tasks are related to the achievement of the business value and which processes or tasks are crucial for its achievement. Furthermore, we can decide how the processes and tasks are integrated for the purpose of presenting the level of achievement.

With the BVMMT, the traceability must be maintained among business values, subvalues, tactical goals, KPIs, and measures. This requirement complicates the monitoring and control task. Establishing trace links between the business value hierarchy and the business process hierarchy requires an organization to have well-defined business processes. In spite of these extra works, the BVMMT provide managers with a dashboard which is suitable for their R&Rs and which helps them identify the root causes in cases of low value achievement.

The current BVMMT addresses internal measures that gauge the effectiveness of a process. However, internal measures must be linked to external measures that a customer deems important; thus, the external measures should be directly controllable by the process manager. Our future work will improve the current BVMMT to resolve this limitation. In addition, we are conceiving an experimental plan for validating our predictions.

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