Constructing a Tailor-made Performance Management System Supported by Knowledge Elicitation Tools and Dynamic Modeling

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Abstract

For constructing a causality-based performance management system (PMS), the consideration of expert knowledge is indispensable. As this knowledge is usually not transparent or explicitly available, the process of tacit knowledge elicitation (TKE) plays an important role for a tailor-made construction of PMS, as does its operationalization in the form of a company-specific scorecard or a dynamic model. Owing to this importance, this paper develops a holistic, step by step approach for constructing and operationalizing an effective PMS using TKE such as interview techniques, as well as System Dynamics (SD) and the interaction of organization's personnel (experts) and Management Accounting (MA). The framework is structured by a phase model in matrix form, whereby the three main steps data generation, assessment and construction are further divided by functional responsibilities on company and MA levels. For demonstration purposes, the framework is subsequently applied to a case study within the automotive industry.

Keywords: Cause-and-effect Relationships, Expert Knowledge, Performance Management, Tacit Knowledge, Causal Maps, Strategy Maps, System Dynamics, Interview Techniques, Case Study.

1. INTRODUCTION

A necessary condition for the construction of an effective and efficient performance management system (PMS) is the consideration of company-individual cause-and-effect-relationships as well as the subsequent corresponding chain of value generation with its leading and lagging indicators in the form of a strategy map. Consequently, Management Accounting (MA) which supports the management in the construction of a PMS is faced with the task of identifying the relevant causes of performance which are mostly not financially dimensioned.

Having identified a company-specific strategy map and its controllable measures, the strategy map can be dynamically extended in order to model and simulate the impact of management decisions on the PMS, especially on the system behavior of leading financial indicators within the causally-oriented framework. As relevant, temporarily delaying cause-and-effect-relationships are usually not transparent or explicitly available, the process of knowledge elicitation in the form of tacit expert knowledge plays an important role for tailor-made construction of PMS and its operationalization in the form of a dynamic model. Owing to this role, this research paper follows a case-study based framework to demonstrate how an efficient PMS can be constructed by the support of tacit knowledge and dynamic modeling tools such as the System Dynamics (SD) methodology.

After having pointed out the importance of causal mapping for MA and its responsibility towards Performance Management (PM) in a literature review in section 2 this research focuses on the therefore necessary process and techniques for generating such expert knowledge that is only implicitly available (section 3). The subsequent section 4 deals with the importance of dynamic modeling for PM and combines all previous aspects within a holistic framework, followed by the application of the entire approach to a case study within the automotive industry in section 5. A final section 6 summarizes the results and points out areas for further accounting research.

2. LITERATURE REVIEW: CONSTRUCTION OF PMS AND CAUSAL MAPS IN MA

MA is an academic discipline that concentrates on the support of planning, decision making and control by defining performance measures, providing relevant performance data and practicing continuous improvement by systematic performance management. Moreover, the Association for Accountants and Financial Professionals in Business (IMA) defines MA as “a profession that involves partnering in management decision making, devising planning and performance management systems, and providing expertise in financial reporting and control to assist management in the formulation and implementation of an organization’s strategy” [1]. Thus, a fundamental function of MA, in addition to allocating costs and providing information for planning, control and decision support, is the responsibility towards managers for the construction, the implementation and the continuous improvement of efficient PMS.

A PMS can be seen as a network of related key success factors of which the aim is to improve organizational effectiveness by explicit consideration of linked-to-strategy cause-and-effect relationships as well as continuous control activities (compare [2], [3]). Hence, the entire value chain between the overall organization’s strategy and single key success factors is focused on. Compared to previous decades, contemporary Management Accountants act as strategists and internal consultants whereby the analysis of corporate strategies as well as their implementation is of particular importance [4], [5]. The responsibility that all activities ensuring business strategies are consistently being met in an efficient and effective way, can be assigned to the field of PM.

Based on the criticism of quantitative approaches (i.e. traditionally and financially focused key performance indicators (KPI) as well as their combinations in ratio systems), the development and use of non-financial measures have been of great interest for the last three decades. A logical decomposition of financial measures, such as the DuPont-System of Financial Control, measures the realization of value, whereas the value-creation process is disregarded. Therefore, MA must also consider the development of modern PM and extend its view to the non-financial aspects [6], [7], [8]. An efficient PMS requires acknowledgment and understanding of the cause-and-effect relationships, so that strategies for ensuring satisfactory future performance can be implemented [9]. A PMS should be based primarily on causal relationships, as indicated by the concept of the balanced scorecard (BSC), and not exclusively on logical relationships [10]. Otherwise, the real causes of financial performance remain concealed. Within a performance management framework, non-financial as well as financial measures are leading indicators of financial performance. The relevance of detecting, displaying and understanding causal relationships is supported by various empirical studies (see e.g. [11], [12] for a review).

Hence it is rare that one effect is only influenced by one cause, cause-and-effect relationships in the complex reality are linked to each other in various forms (compare [13] for different types of causal structures). In general, it can be differentiated between unidirectional cause-and-effect relationships, whereby a cause exclusively influences the effect, and bidirectional relationships, whereby two or more factors cause an effect. Moreover, it is possible that the cause variables may influence each other. In addition, time lags between cause and effect can occur so that the inter-temporal structure has to be explicitly considered.

The combination of relevant cause-and-effect relationships leads to an integrated model, a *causal map* [14], [15]. In a PM context, which is focused on all cause-and-effect relationships and their function as leading and lagging indicators of corporate strategy, the term '*strategy map*' is used [16], [17].

Strategy maps as specific types of causal maps are designed to illustrate and support the execution of an organization's strategy by linking KPIs according to determined cause-and-effect relationships. In brief, strategy maps can be seen as diagrams to visualize the strategic goals being pursued by organizations as well as the mental models of the participating experts [18]. Apart from facilitating the translation of a strategy into operational terms, another purpose of a strategy map is to communicate to the members of an organization how their tasks are related to the overall objectives [19].

An efficient strategy map as part of a PMS is not a standard product and consequently has to be constructed tailor-made to capture the individual cause-and-effect relationships and KPIs of the specific field and business.

Due to the importance of a company-specific strategy map as well as the identification of relevant individual cause-and-effect relationships the construction of efficient PMS is an often discussed subject in the literature [20], [21]. Apart from the application of tacit knowledge elicitation (TKE) techniques such as expert interviews for creating causal models (see e.g. [15], [18], [22], [23]) TKE is also used to improve the performance of a company [24]. The idea of enhancing the strategy map by dynamical extensions is shown by Bianchi and Montemaggiore [25] who indicate that the integration of the PMS approach with dynamic modeling tools such as the SD methodology (for the extension of the BSC with SD see also [26], [27], [28], [29]) facilitates the analysis of cause-and-effect relationships between key variables of the company. The hypothesis that the use of dynamic strategy maps can significantly improve the PMS is also described by Liang and Hou [30], who try to provide empirical evidence on the dynamic connection of BSC.

Despite of the variety of publications which integrate single elements of knowledge elicitation or dynamic aspects in the development of PMS there is a lack of approaches which combine the construction of efficient PMS with the process of knowledge elicitation and dynamic modeling in a holistic framework. Thus, this article provides a step by step approach for constructing and operationalizing an efficient PMS using TKE such as interview techniques as well as SD and the interaction of organization's personnel. In order to create a realistic construction of a strategy map – as an illustration of an organization's strategy – the following section will explore different tacit knowledge based approaches.

3. KNOWLEDGE ELICITATION FOR CONSTRUCTING TAILOR-MADE STRATEGY MAPS

3.1 Tacit Knowledge as a Vital Source of Corporate Data

Due to the fact that an efficient strategy map based on PMS has to be constructed individually for each organization, comprehensive knowledge about the domain of interest is necessary. Cause-and-effect relationships and their representation within strategy maps require the formalization of knowledge. The knowledge inherent in an organization can be available explicitly (objective, formal or explicit knowledge) or implicitly (tacit knowledge). Moreover, often it can be useful not to focus on the assessment of only one person but to allow the participation of several company members in the construction process of the strategy map. Therefore, the MA is additionally faced with a group decision problem of knowledge elicitation (see e.g. [31] for advantages and disadvantages of group decision making). Hence, a holistic PMS-concept is required which incorporates not only the relevant leading and lagging indicators but also provides a broad and interdisciplinary information base of the respective company. *Figure 1* illustrates the interaction and the process of constructing a tailor-made strategy map using tacit knowledge and interdisciplinary expert teams.

Regarding the tacitness of knowledge, Ambrosini and Bowman [32] point out different degrees of tacitness. The two boundary points are 'explicit knowledge' which can be communicated, codified, explained and shared easily, and 'tacit knowledge' which is totally inaccessible because it is too deeply ingrained in the members of an organization. In between we can find 'tacit knowledge that could be articulated' and 'tacit knowledge that can be imperfectly articulated'. Within the exploration process towards causal relationships, explicit knowledge is merely necessary for the identification of KPIs, e.g. by support of a literature analysis. However, in order to reveal company specific cause-and-effect relationships and to achieve further information about relevant measures in form of leading and lagging indicators in greater depth, intuitive subject-related tacit knowledge ([33], [34], [35]) of experts has to be considered.

In contrast to explicit knowledge, tacit knowledge is difficult to write down or to formalize. Furthermore, it is personal knowledge and its possessor cannot communicate it to another person easily [36]. In other words tacit knowledge includes cognitive images of reality as well as technical skills and capabilities. It is furthermore personalized and so it is difficult to elucidate and share it in a formalized framework of communication [37]. The higher the degree of tacitness, the more complicated is the disclosure and usage of tacit expert knowledge for constructing a PMS. Nevertheless, the necessary condition for using a PMS is that organizations' strategy as well as related cause-and-effect relationships can be articulated clearly and communicable. In order to achieve information which can support the formulation of causal relations between leading and lagging indicators in the process of the model construction process the elicitation of tacit knowledge is of high importance whereby the formalization and application of qualitative data is further necessary [38].

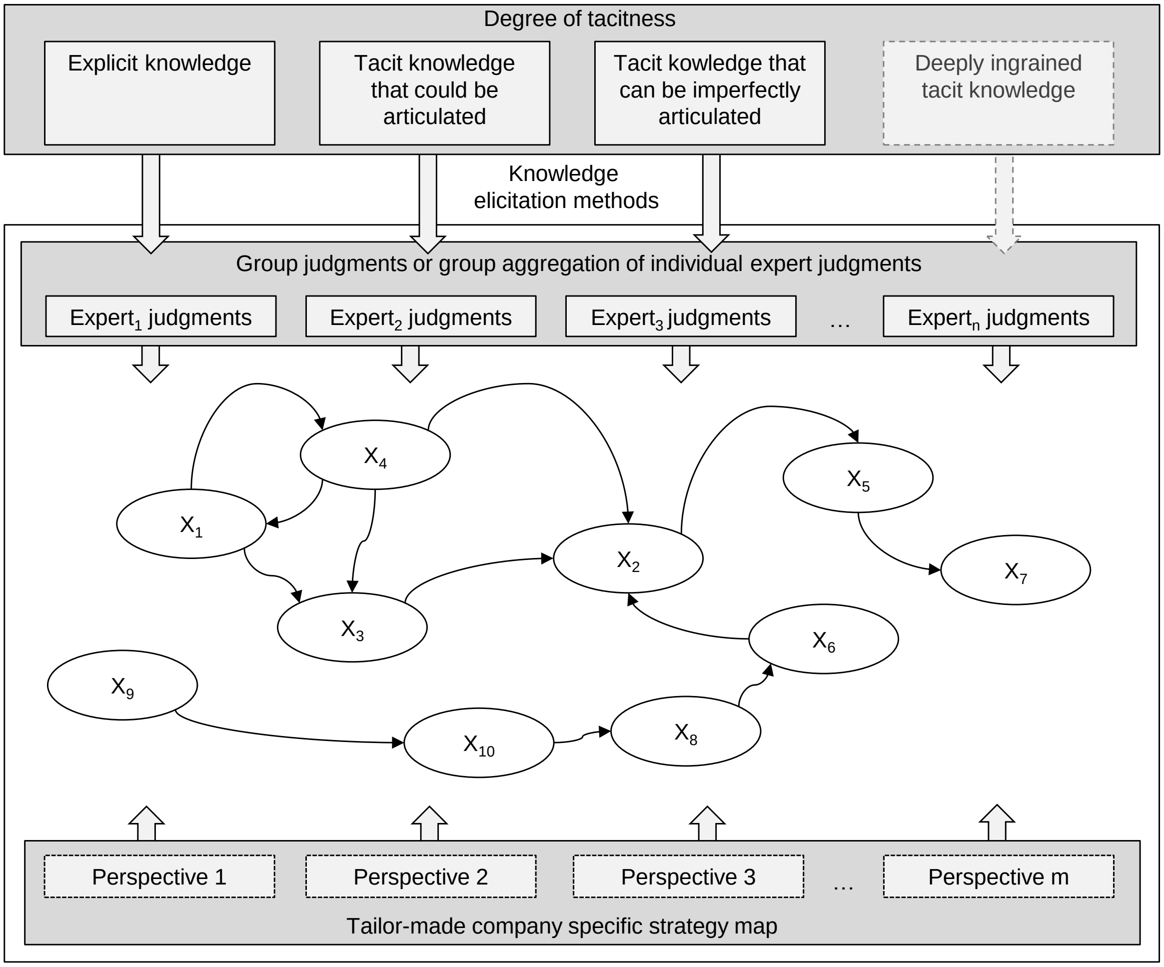

FIGURE 1: Individuals' interaction and process of constructing a tailor-made strategy map by support of tacit knowledge.

Apart from the necessity to elicit tacit knowledge, the participation of experts from various departments and functions of the company is very important (see e.g. [23], [39]). Experts may be employees, executives or managers from different hierarchical levels or areas of the organization, provided they have relevant knowledge. Compared to individual interviews, the quantity and quality of the information collected can be increased significantly by interviewing groups. These provide a much larger, fuller information base and one of a higher quality than an individual can reach (see e.g. [40], [41]).

3.2 Compilation of Existing TKE Methods

In order to identify tacit knowledge about KPI-measures and their causal links as a basis for constructing a strategy map, numerous different knowledge elicitation methods are available. Knowledge elicitation methods can be classified in various ways (see e.g. [42], [43], [44], [45]). Based on the earlier research of Cooke [46] and Burge [47], *Table 1* shows a more extensive presentation of a possible classification in the three different groups A, B and C.

Knowledge elicitation techniques		
Group A: Interviews and Observations	**Group B:** Process Tracing	**Group C:** Conceptual techniques

Observations
▪ Active participation
▪ Focused observation
▪ Structured observation
	Verbal reports
	▪ Verbal on-line
	  ▪ Self-report
	  ▪ Shadowing
	▪ Verbal off-line/ stimulated recall
	  ▪ Retrospective/aided recall
	  ▪ Interruption analysis
	  ▪ Critical retrospective
		Concept elicitation methods
		▪ Structured interviews for concept elicitation
		  ▪ Concept-/ Step-/ Chapterlisting
		  ▪ Interview transcription
		▪ Concept elicitation associated with repertory grid
		  ▪ Laddering
		  ▪ Triad comparison/ Triadic elicitation

Interviews
▪ Interviewing (structured, un-/ semi-structured)
▪ Concept mapping
▪ Interruption analysis
▪ ARK (ACT-based representation of knowledge)
▪ Cognitive structure analysis (CSA)
▪ Problem discussion/ Focused discussion
▪ Uncertain information elicitation
▪ Data flow modeling
▪ Entity-relationship/ Entity life modeling
▪ Object oriented modeling
▪ Semantic nets
▪ IDEF modeling
▪ Petri nets
▪ Questionnaire/ Question answering protocols
▪ Task action mapping
▪ User needs analysis (decision process diagrams)
▪ Teachback
▪ Role play
▪ Cloze experiment/ minimal scenario technique
▪ Likert scale items
▪ Group interview techniques
▪ Automated interviewing tools
	Protocol analysis
	▪ Content analysis
	▪ Discourse/ conversation/ interaction analysis
	▪ Grounded theory
	▪ Automated protocol analysis tools
		Data collection methods
		▪ Rating and ranking
		  ▪ Paired comparisons
		  ▪ Magnitude estimation
		  ▪ Controlled association
		  ▪ Reference ranking
		▪ Repertory grid
		▪ Sorting
		  ▪ Q sort/ P sort
		  ▪ Repeated sort/ multiple Q sort
		  ▪ Hierarchical sort
		  ▪ Multidimensional card sorting
		▪ Event co-occurrence/ transition probabilities
		▪ Correlations/ covariance

Task analysis
▪ Functional flow analysis
▪ Operational sequence analysis
▪ Information flow analysis
▪ Interaction analysis
▪ Job analysis
▪ Time line analysis
▪ Cognitive task analysis
	Decision Analysis
	▪ Eliciting estimations of probability and utility
	▪ Statistical modeling/ policy capturing
		Structural analysis
		▪ Multidimensional scaling
		▪ Discrete techniques
		  ▪ Clustering routines
		  ▪ Network scaling
		▪ Direct elicitation of structure
		  ▪ Drawing closed curves
		  ▪ Free association
		  ▪ Graph construction
		  ▪ Question-answering
		▪ Interpretation of the structure
		  ▪ Guided interview
		  ▪ Identifying aspects of the representation
		  ▪ Comparing two or more representations

	Non-verbal reports	**Conceptual techniques automation**

TABLE 1: Groups of Knowledge Elicitation Techniques.

Group A (interviews and observations) consists of direct elicitation methods whereby watching and talking to domain experts plays an important role. The techniques are particularly suitable when there is a need for constructing an initial conceptualization of the problem domain [46]. This is of importance for the needs of MA, where experts must develop a comprehensive insight of the surrounding problem. Techniques in *group B (process tracing)* are related to special tasks, for example different methods of verbal and non-verbal reports or tools of statistical modeling for decision analysis. The tasks' underlying inferences about the cognitive processes are thereby included in the field of interest. *Group C (conceptual techniques)* consists of indirect techniques which need less verbalization and introspection. Because they cover a full range of knowledge, they can be combined with techniques from other groups in order to achieve more precise results [46].

Within MA literature there are different approaches for constructing strategy maps by support of tacit knowledge (see e.g. [15], [18], [22]). Comparing these approaches regarding to different criteria (for example complexity, limitation of indicators, software support or possibility of using formalized group decision rules), there cannot be made a consistent recommendation of one technique as the best method. Depending on the intended use, each approach shows specific advantages and disadvantages which have to be evaluated individually for each organization. However, all approaches point out the various interview techniques as an integral part of constructing a strategy map in MA context. Due to their specific characteristics both *group B: process tracin*g and *group C: conceptual techniques* as well as observations cannot provide enough information about company-specific coherences relevant to the construction of strategy maps, therefore interview techniques should be focused on.

3.3 Interview Techniques as Appropriate TKE Methods

In order to ensure the participation of various experts in the process of constructing a PMS, we recommend the use of mixed interview techniques (unstructured, semi-structured and structured) for knowledge elicitation. In contrast to structured surveys, unstructured interviews are formless and do not follow a predetermined format. While in highly-structured interviews the content as well as the order of questions is fixed, the sequencing in semi-structured interviews may vary [46], [48]. Furthermore, in the semi-structured form of knowledge elicitation the interviewer gets the opportunity to ask open-ended questions and to interact with the interviewed experts in a more flexible way than in predetermined questionnaires.

The success of an interview session depends on the questions asked (it is difficult to know which questions should be asked, particularly if the interviewer is not familiar with the domain) and the ability of the experts to articulate their knowledge [46]. However, in order to elicit both explicit and implicit knowledge of various experts, the interview method as a selected knowledge elicitation technique provides significant advantages.

A first unstructured expert survey enables the MA professionals to acquire a first impression of the company as well as of potential problem areas. Even without any prior knowledge, the interview technique makes it possible for the elicitors to identify the company's requirements and expectations [46]. Moreover, the application of multi-personal expert interviews increases the interaction of the group members, who are supposed to elicit knowledge reciprocally from each other, and therefore the broadness and quantity of shared information [46].

Although the purpose and structure of the interview are predetermined by the systematic survey, the participants get the opportunity to present their views on the drivers of success [32]. "Through storytelling, participants can express what is done in the organization, and hence some tacit skills may be uncovered" [32, p. 820].

The combination of the interview technique with the construction of strategy maps increases the mentioned advantages. The mapping process forces the participants to reflect their behavior and thus revealing aspects that have been tacit until then. In order to improve the quality of the strategy maps and to reduce the time required the interview techniques are advantageous and allow not only the collection of explicit and tacit knowledge even with the participation of groups but also support and facilitate the mapping process [15], [46].

3.4 Need for Aggregation of Group Judgments

In addition to the determination of a knowledge elicitation technique, a method for constructing the group strategy map needs to be selected. A multi-personal strategy map can be fundamentally established in two ways: by a group of experts [49], [50] or by aggregating the individual maps of the members of a group [51]. Whether a strategy map should be constructed all at once by a group or by aggregating individual strategy maps of the members of the experts' team depends on organizations' specifics (e.g. simultaneous availability of all experts) as well as on advantages and disadvantages of each interaction type. Based on the identified expert knowledge the elicitation process should lead to a company-specific strategy map. The relevant cause-and-effect-relationships may then be allocated to the typical BSC perspectives (in *Figure 1*: perspective A to D, whereby each KPI is denoted by X_i).

In addition to the consideration of explicit and tacit knowledge a holistic orientated PMS is of fundamental importance to ensure the long-term success of the company. The described importance of tacit knowledge and the advantages of interview techniques create the base of a holistic framework for the construction and operationalization of efficient PMS.

4. HOLISTIC FRAMEWORK FOR THE CONSTRUCTION AND OPERATIONALIZATION OF EFFICIENT PERFORMANCE MANAGEMENT SYSTEMS

4.1 Concept for a Holistic Framework

Based on the theoretical aspects of the previous sections, this chapter introduces a holistic framework for the tailor-made construction of causal-oriented PMS by support of TKE and SD. The framework is structured by a phase model in matrix form (see *Figure 2*). This complex but transparent structure is useful as there is a substantial interaction of tasks and participating groups.

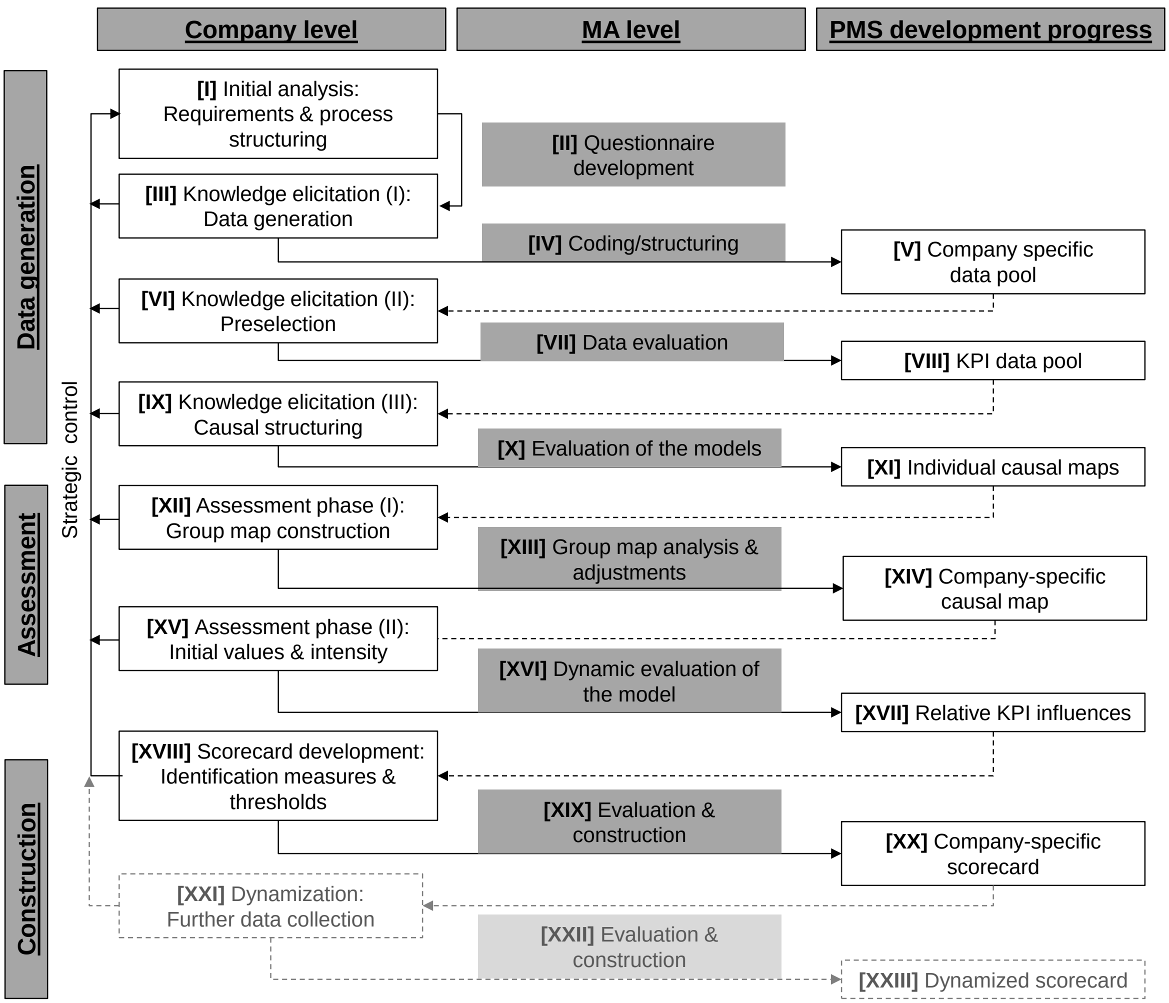

FIGURE 2: Holistic Framework for PMS Construction and Operationalization.

The entire PMS development process is classified into the three main steps *data generation*, *assessment* and *construction*. The main steps are functionally divided according to the responsibilities on a *company level* and on a *MA level* which interactively lead to a certain object of the *development progress of the PMS*. *Strategic control* [52] accompanies the whole framework.

4.2 General Description of the Procedure

Within the **data generation** phase the starting point is an [I] *initial analysis* about company's individual requirements towards a PMS. *Requirements* are the aim of the PMS development and the scope of the construction (entire company, division, business unit or department). Subsequently, it is helpful to structure the construction process chronologically and functionally. The initial analysis should be conducted by MA professionals and top management.

Next, an interdisciplinary and cross-functional expert team (organization's personnel) has to be compiled in order to cope with a holistic construction perspective. Having multiple personalities within the units of an organization, a group can enhance the generation of relevant information as well as the identification and selection of performance relevant factors that are crucial for the construction of a strategy map. Considering a problem from different points of view, discussing several opinions among the members of the group, these interactions lead to an elicitation of information that may not have been regarded until then. Such group-dynamic processes help to ensure that fewer errors of judgments occur. In addition, the participation of employees in the development of the PMS facilitates their acceptance and engagement in the subsequent implementation [40], [41], [53].

A further important aspect within the initial analysis is the determination of the overall strategic goal the PMS has to be connected to. The overall goal is then directly transferred to a general reference point for further interviewing. If no consensus about the overall strategic goal can be reached by the top management, the question towards the overall strategic goal will be the first question for all participants (experts). Based on the assumption that the determination of an overall goal can be realized, an interdisciplinary expert team, associated with this goal has to be compiled. In our framework experts have to participate six times within the construction process. MA has to ensure that experts, who can either directly or indirectly influence the outcome and who have special interest or knowledge about the field of interest, are included. In order to cope with further arising complexity, we suggest a team size which is not too small and not too large, for instance a team size of five to eight members (for relationships between team task, team size and processes see e.g. [54]). Additionally, by including a strategy related expert team in the construction process, it is easier to gain higher acceptance for the PMS as well as a facilitated implementation.

The initial analysis is followed by the [II] *development of questionnaires*. The MA professionals have to prepare appropriate interviews for the first meeting of knowledge elicitation.

Within the knowledge elicitation at first basic company information has to be collected ([III] *Knowledge Elicitation (I): Data generation*). The data generation (in form of an open questionnaire) includes necessary information about corporate structures and second level goals. The aim is to map the entire value chain including internal processes, areas of concern, possible improvements and corresponding potential measures. By using semi-structured individual interviews for all participating experts, a cross-functional holistic view of the company can be reached. Interviews should be recorded (by notes or dictation machine). Owing to the fact that the information can be very personal and sensitive as well as contain criticism, MA professionals have to act as neutral and non-influencing interviewers and have to guarantee absolute confidentiality and ensure experts' anonymity, especially with the top management. In case an obligation of secrecy does not exist, it is possible that experts won't answer completely or concisely, because they are afraid of potential consequences from the top management. In order to ensure anonymity, at no stage in the construction process is MA allowed to communicate data which can be clearly traced to single experts.

After having executed the first interviews, MA professionals have to systematically analyze the recorded interviews by [IV] *coding/structuring* in order to build a [V] *company specific data pool* as a first step stone of a PMS construction. Coding can be done manually or by support of appropriate software solutions (e.g. atlas.ti). Manual coding has the advantage that MA professionals can obtain a better understanding of the situation. Although manual coding causes more effort than software solutions the MA professionals get a deeper view inside the answers and the information provided by the interviewed experts. The company specific data pool which has to be generated must contain a comprehensive and as complete as possible set of strategy related factors of corporate success on the one hand as well as actions which affect the success factors on the other hand.

In the next step, the company specific data pool has to be reduced by less relevant success factors and actions. Therefore, the experts are asked in a second step [VI] *Knowledge Elicitation (II): Preselection* to select the 15 most important success factors and the 5 most important actions from the entire data pool from their individual perspective. This preselection and [VII] *data evaluation* on the part of MA makes it possible to compile a [VIII] *KPI data pool* by using threshold values. To improve the preselection, scoring methods can be used, where e.g. each expert has to prioritize his personally chosen success factors from 1 to 3. Another possibility would be a complete ranking of the selected success factors with regard to their importance (score 1 to 15).

In order to receive more detailed additional information (before constructing a group causal map (GCM)) the experts should be asked to link their personal 15 KPIs according to the belonging cause-and-effect relationships ([IX] *Knowledge Elicitation (III): Causal structuring*). With the provided information, MA professionals can undertake an [X] *evaluation of the models* for constructing [XI] *individual causal maps* as a final step within the data generation phase.

After having collected all relevant data, the start within the **assessment** phase is [XII] *Assessment Phase (I): Group map construction*, whereby the experts are asked to agree on a company-specific group map. MA professionals should support this step strongly as a strategic partner. They have to ensure that the most relevant (high scores) KPIs out of the [VIII] KPI data pool are included. A further support for the determination of causality within the group map is the information provided by individual causal maps. The entire process should be supervised and moderated by the MA professionals. Simultaneously they have to [XIII] *analyze the group map* (e.g. ensure that no KPI is unconnected and that there is a top KPI) and secure necessary adjustments until an adequate [XIV] *company-specific causal map* is constructed.

In order to achieve an evaluation of single KPIs' importance within the GCM a comprehensive assessment of all model parameters is necessary. For this reason, in [XV] *Assessment Phase (II): Initial values & Intensity* all experts are separately asked at first to give an assessment about the current values of the KPIs. The purpose is on the one hand to receive an overview of experts' estimation on corporate matters and on the other hand to create initial values for further modeling. For estimating the current stages of KPIs we suggest an ordinal scale from "1 = very low" to "7 = very high". In a second estimation the experts are asked to assess the intensity of the identified cause-and-effect relationships between the KPIs. Therefore, we recommend an ordinal scale from "0 = no causal influence" to "5 = very strong causal influence". Additionally, the experts should set a time delay in months (if applicable). Furthermore there is a need for evaluating the before identified actions by connecting the actions to one or more KPIs from the group model. Hereby the intensity should be given by an ordinal scale from "1 = very low influence" to "5 = very strong influence".

With this collected data a [XVI] *dynamic evaluation of the model* should be accomplished by MA. For this purpose Forrester's [55] System Dynamics (SD) approach can be used. Using SD, it is possible to simulate the impact of management decisions on the system structure and the system behavior (e.g. on top financial indicators). This approach can be seen as an operationalization of a strategy map. Based on the dynamic character of PMS, the use of SD is furthermore necessary to take into account temporarily delaying and retroactive influences. In order to enable the company to predict financial results, the dynamic structures of the cause-and-effect relationships must be considered explicitly [26].

A particular strength of SD is the possibility to formulate forecasts. As a strategy map is a limited static model, dynamic SD models are able to evaluate and test alternative assumptions and dynamic influences of different strategic actions [14], [56].

Through the SD support it is possible to simulate the [XVII] *relative influence of each KPI* on other KPIs, e.g. on the top KPI. In this way the most important KPIs can be revealed. Outgoing from the results of the performed SD simulation (depending on the influence intensity) a priority score has to be given to all KPIs instantly. The priority domain could be divided into “1 = low impact (priority level 1)”, “2 = medium impact (priority level 2)” and “3 = high impact (priority level 3)”. The priorities have to be used later on for monitoring and control actions. High priority KPIs are having a stronger impact e.g. on the top KPI. Therefore, special attention has to be paid to these KPIs in the case of threshold values’ deviations.

Out of this information a [XVIII] *scorecard development with relating measures and thresholds* is subsequently possible as a first step in the **construction** phase. Within this step top management, experts and MA professionals should be included. After having reached consensus about adequate measures and belonging thresholds, a final [XIX] *evaluation & construction* step on behalf of MA professionals is necessary to develop a ready-for-use [XX] *company-specific scorecard*, which should underlie a strategic control (like all other mentioned steps). Strategic control hereby consists of implementation control, premise control and strategic surveillance [51].

As an extension of the framework (which is not further regarded here as we only focus on the construction process), a next step would be the [XXI] *dynamization* process whereby *further data collection* is necessary for completely transforming the company-specific scorecard by additional [XXII] *evaluation and construction* (e.g. stock and flow identification, generation of model equations) into a [XXIII] *dynamized scorecard*. A quantitative dynamized model would have the advantage of a possible use of statistical methods to validate the model (long-term data required). The dynamization process can be an important issue (see e.g. [57], [58]) but is not a key matter in this contribution.

This PMS construction framework closes a gap in the existing literature as it shows transparently without any black box how it is possible to synthesize TKE methods, causality and dynamic modeling in a tailor-made and practice-oriented PMS. Furthermore it is unique in the way it shows the interaction between MA and the participating interdisciplinary expert group regarding to the tasks which have to be mastered in all stages of the design process. Moreover a positive impact on the acceptance and the maintenance of the PMS can be assumed, since all experts take an active part in the entire construction process.

The importance of TKE in form of interview techniques, the necessity of considering causality aspects and the benefits that can occur from the support of SD within the PMS construction process are essential components that concur with many important research contributions within the field of designing a PMS (see e.g. [15], [18], [22], [28]). Even though other research contributions suggest a broader and more sophisticated range of methods for analyzing and mapping KPIs (see e.g. [15], [18]), this can also be disadvantageous, however: Rising complexity due to the combination of several methods induces less transparency and a more demanding implementation and calculation process from a practical point of view.

There is an elusive number of contributions to the field of PMS design, therein many research frameworks are highly academic and presented on a more abstract level (see e.g. [59], [60]) which could erect barriers for practitioners.

With respect to the fact that a PMS has to be designed tailor-made our aim is to highlight this individual construction process but not to generate or statistically validate a generalized KPI list for companies in the same business sector (see e.g. [61], [62] for this way of proceeding). For a better understanding of our research contribution as well as for a practical validation the framework is applied to a case study in the automotive sector within the next section.

5. APPLICATION OF THE FRAMEWORK TO A CASE STUDY IN THE AUTOMOTIVE SECTOR

The framework presented within the previous section is now applied to a small sized company in the automotive sector in Germany. The orientation of the company has a very strong focus on customer satisfaction (corporate mission) which is seen as the driving force for any financial performance influencing the long-term business success. In order to improve this long-term business success, the purpose of the study is to apply various interview techniques to identify the company-specific success factors and their relationships to each other. In particular, the investigation should enable the company to determine the factors which influence the customer loyalty (as the predetermined top goal). Therefore the financial indicators are indirectly represented by the top goal customer loyalty. On account of this, cause-and-effect-relationships relevant to the performance of customer loyalty are to be identified, analyzed and assessed in the course of this case study. In addition, the framework shall facilitate the development of conceptual recommendations for the design and implementation of a company-specific PMS. A SD model is constructed to cope with dynamic effects within the PMS and to provide a quantitative tool, which is able to facilitate the development of the scorecard.

The first **data generation** step of the framework application starts with an [I] *initial analysis* (compare again *Figure 2*) of the individual requirements towards the PMS. As mentioned above, the aim of the company is the identification and operationalization of cause-and-effect-relationships relevant to the performance in order to ensure and improve the long-term business success. Due to company's strong focus on customer satisfaction (see Figure 6 for the results of the impact analysis using SD), the specific purpose of the PMS is to increase customer loyalty and should be reached by an optimization of all related processes. Therefore, all relevant processes are to be depicted by controllable measures in a company specific scorecard.

In order to consider a wide range of knowledge an interdisciplinary team of experts consisting of members through all parts of the company which are directly or indirectly connected to the financial performance, the overall strategic goal (customer loyalty) is now compiled. The expert group consists of six employees from different organizational levels: two Chief Executive Officers (expert 1 and expert 2), an Operations Manager (expert 3), a Key Account Manager (expert 4) as well as two Service Employees (expert 5 and expert 6).

As a result of the [II] *development of questionnaires* we applied individual semi-structured interviews in the first meeting of [III] *Knowledge Elicitation (I): Data generation*. Subsequently, we systematically analyzed the recorded interviews in a [IV] *coding/structuring* process particularly with regard to mentioned KPIs in order to generate a comprehensive [V] *company specific data pool (see Table 2)*. Instead of an automated coding with software support we perform a manual coding. Although manual coding requires a higher effort for MA it is advantageous to obtain a better understanding of the situation (due to the intensive reading/listening process) and the company which is desirable in our context.

Compilation of key performance indicators	
Dependency on insurers	HR development (trainees)
Job rotation (employees)	Incentive system
Accuracy of invoices	Initial training employees
Acquisition of new customers (insurers)	IT
Acquisition of new customers (private sector)	Jour-Fix-Dates
Bottlenecks (caused by staff)	Lack of time
Claims management	Maintenance customer data
Communication between departments	Market leadership
Communication within departments	Market share
Competitors	Marketing events
Complaints	Ongoing process controls
Coordination (departments)	Overflow
Coordination (time limits)	Personnel management (management)
Corporate flexibility	Personnel management (top management)
Corporate growth	Processes between departments
Corporate image	Processes within departments
Corporate structure	Product quality
Cost rates	Quality of employees
Customer loyalty	Quality of insurer relationship
Customer satisfaction	Selection suppliers
Customer structure	Selection trainees
Delivery quality	Service quality
Earned income (employees)	Service range
Employee loyalty (specialized personnel)	Team buildings
Employee loyalty (trainees)	Teamwork
Employee motivation	Training employees
Employee satisfaction	Volume of sales
Employees error rate	Willingness for responsibility (employees)
External recruiting	Willingness for responsibility (managers)
Final check (products)	Working atmosphere
Fixed responsibilities	Working time

TABLE 2: Company Specific Data Pool.

In a second step in [VI] *Knowledge Elicitation (II): Preselection,* the experts are asked to select the 15 most important success factors and the 5 most important actions from the before compiled data pool. With regard to further steps it is additionally necessary to assess all selected items with a score (1 = “important”, 2 = “very important” and 3 = “extremely important”). Based on this expert-individual preselection and a [VII] *data evaluation* which combines selection and scoring via threshold values to a [VIII] *KPI data pool*, a subsequent prioritization of these individually selected success factors leads to the third step of [IX] *Knowledge Elicitation (III): Causal Structuring*. This is performed to receive more detailed additional information before constructing a GCM. In order to construct graphical representations of the company-specific success factors, the experts are asked to link their personal 15 KPIs according to the individually relevant cause-and-effect relationships.

A final step within the data generation phase is the [X] *evaluation of the model*s which is task of the MA professionals to enable construction of the [XI] *individual causal maps*.

The following **assessment** phase ([XII] *Assessment Phase (I): Group map construction*) starts with an expert survey (structured interviews) about their agreement or improvements on a company-specific group map. At the MA level, we have to [XIII] *analyze the group map* as well as the construction process to ensure that all relevant KPIs are included, no KPI remains unconnected and a top KPI is selected.

From the aggregation of individually explicated cause-and-effect relationships, the [XIV] *company specific GCM* results are illustrated in *Figure 3*.

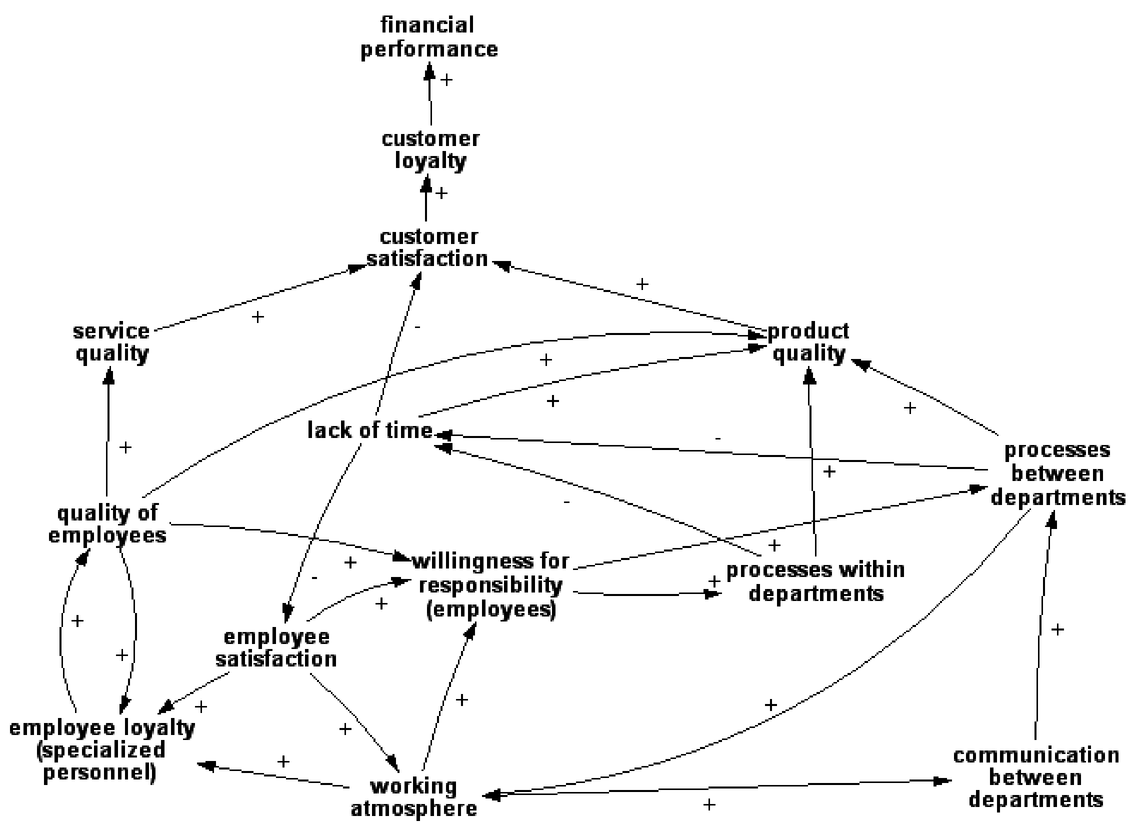

FIGURE 3: Company Specific GCM.

Before the GCM is analyzed in detail, the actual states of the corresponding variables should be determined for achieving a comparable starting point. Therefore, in the following [XV] *Assessment Phase (II): Initial values & Intensity,* the experts are invited to estimate the current values of the selected KPIs. As mentioned above, we used an ordinal scale from “1 = very low” to “7 = very high” to gain an overview of the experts’ estimations of the current key success factors. These judgments can also be used as initial values for further modeling. In addition, the members of the company have to assess the intensity of the identified cause-and-effect-relationships. For this purpose an ordinal scale from “0 = no causal influence” to “5 = very strong causal influence” is used.

In order to enable an initial feedback as well as to identify areas for performance improvement further model evaluations are recommended. Visualizations can thereby support the evaluation process, for instance network-like representations of the assessments as shown in *Figure 4*. The figure illustrates the individual assessments of the current situation. The higher the scale value, the better is the current status of the relevant KPI. Similarities and differences in individual perceptions can be visualized by the network-like representation to facilitate the evaluation of the surveys.

The further analysis of the GCM and the visualization of the experts’ assessments in our case study show that the experts focus on the working atmosphere and the processes within and between the departments as relevant KPIs. The identification of KPIs reveals that the experts point out a demand to improve the processes and the communication within and between the departments and the working atmosphere. Regarding to "willingness to take responsibility", experts' perceptions diverge strongly. Relevant factors to improve company performance are indicated to be the reduction of the lack of time and the augmentation of employees' satisfaction and qualification. Not surprisingly, "customer loyalty" is selected as the top non-financial KPI.

In order to operationalize these individual statements and to enable objective feedback to all participants, *Figure 5* shows the average values of the assessments of the interdisciplinary expert team.

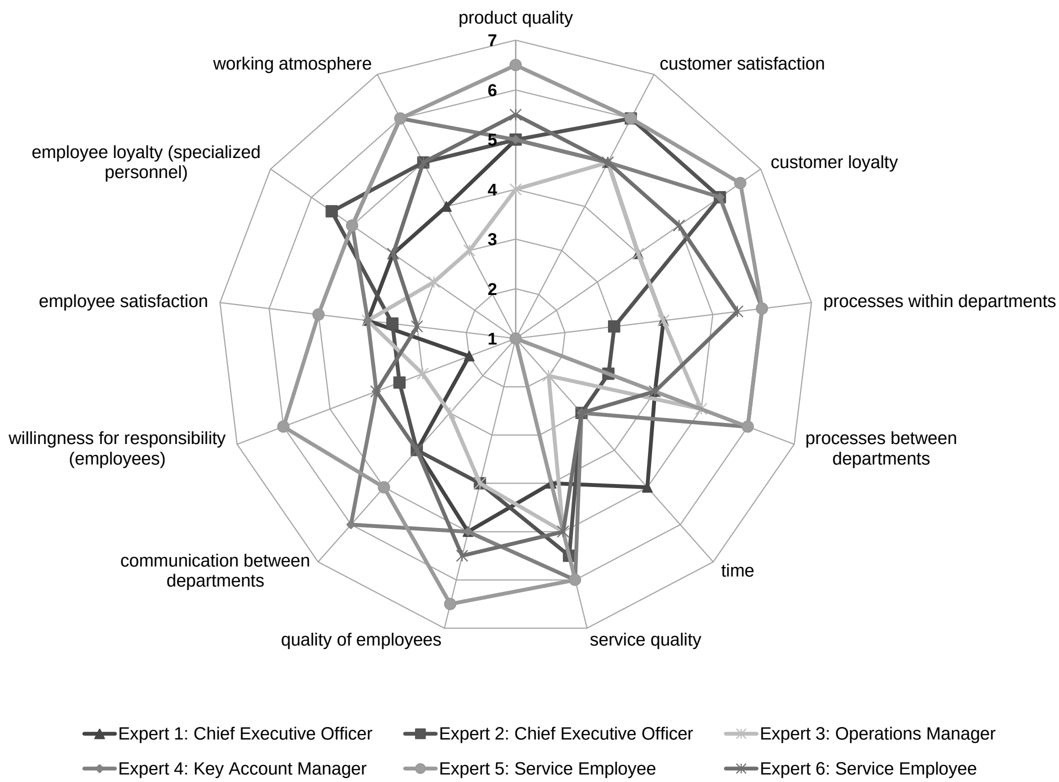

FIGURE 4: Individual Assessment of the Current Situation.

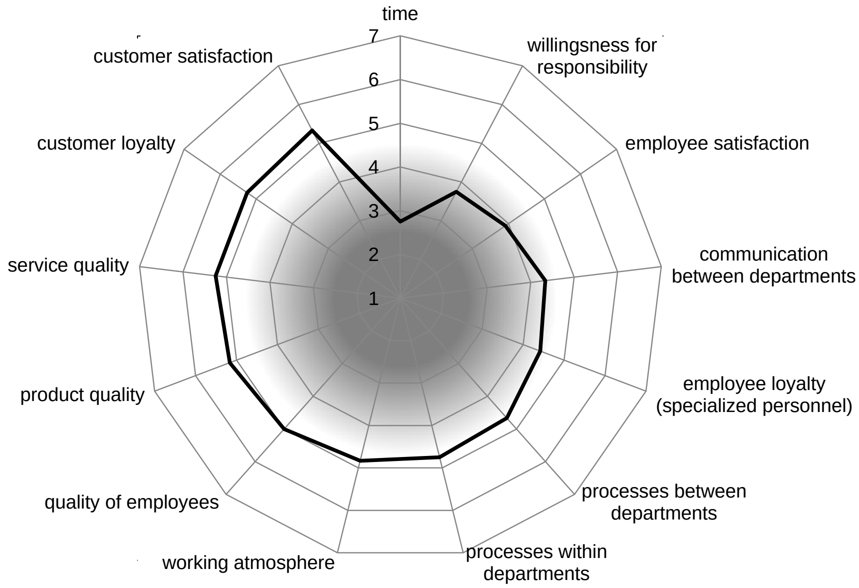

FIGURE 5: Assessment Current Situation.

The greater the distance of the average line to the center point, the better is the actual state of the KPI. In the assessments of the expert team, customer loyalty, service and product quality as well as customer satisfaction all reach already scale values bigger than five. Hence, the potential for improvement of these variables is low. This visualization also confirms that there is a need for actions and improvements in the areas of internal processes, inter-divisional communication, the increase of time (decrease of lack of time) and the increase of employee satisfaction.

Apart from these analysis options, the collected data constitute the base for the [XVI] *dynamic evaluation of the model*. The purpose of this step in the application of our holistic framework is to simulate the [XVII] *relative influence of each KPI* on the top (non-financial) KPI customer loyalty using SD techniques. In order to identify the most important KPIs, SD is used for impact analysis. The quantification of the previous qualitative GCM to a SD model leads to a priority ranking of the KPIs. After a single-period simulation, the variables of the model are arranged according to the intensity of their impact on the customer loyalty. *Figure 6* shows the relative impact of the KPIs on customer loyalty subdivided in three priority areas from “1 = low impact (priority level 1)” to “3 = high impact (priority level 3)”.

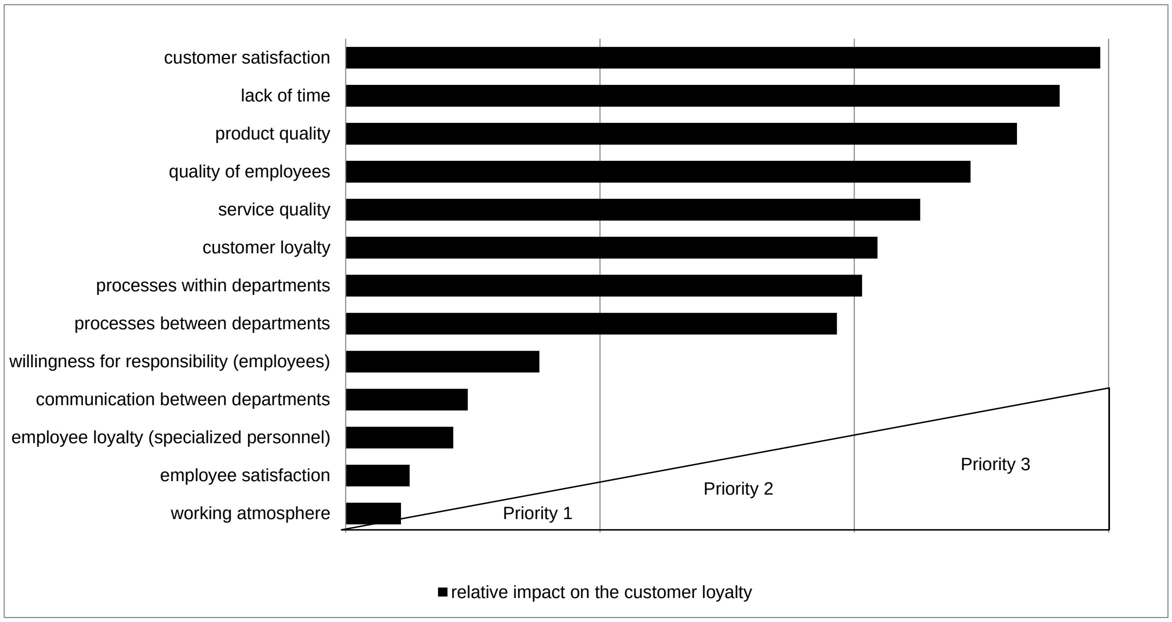

FIGURE 6: Relative Impact on Customer Loyalty.

The impact analysis using SD confirms that customer loyalty is highly influenced by customer satisfaction, lack of time as well as product and service quality (priority 3). In contrast, the impact of willingness to accept responsibility, communication between departments, employee loyalty and satisfaction and working atmosphere is perceived as rather low (priority 1).

On completion of the assessment phase, *Figure 7* illustrates the combination of the qualitative GCM and the BSC perspectives.

The following **construction** phase starts with further interviews on the topic [XVIII] *scorecard development with relating measures and thresholds.* The purpose of this step is the identification of measures for the most import KPIs. Furthermore, the expert team is asked to reach a consensus about adequate thresholds to ensure a continuous monitoring and control of the relevant KPIs. The result of this task in our case study is shown in *Figure 8*. During the process of monitoring and control particular attention must be paid to high priority KPIs and belonging measures (compare again *Figure 6*). In case of threshold deviations of high priority KPIs the case study company has to intervene promptly and effectively as the SD simulation results show that high priority KPIs are having a stronger impact on customer loyalty.

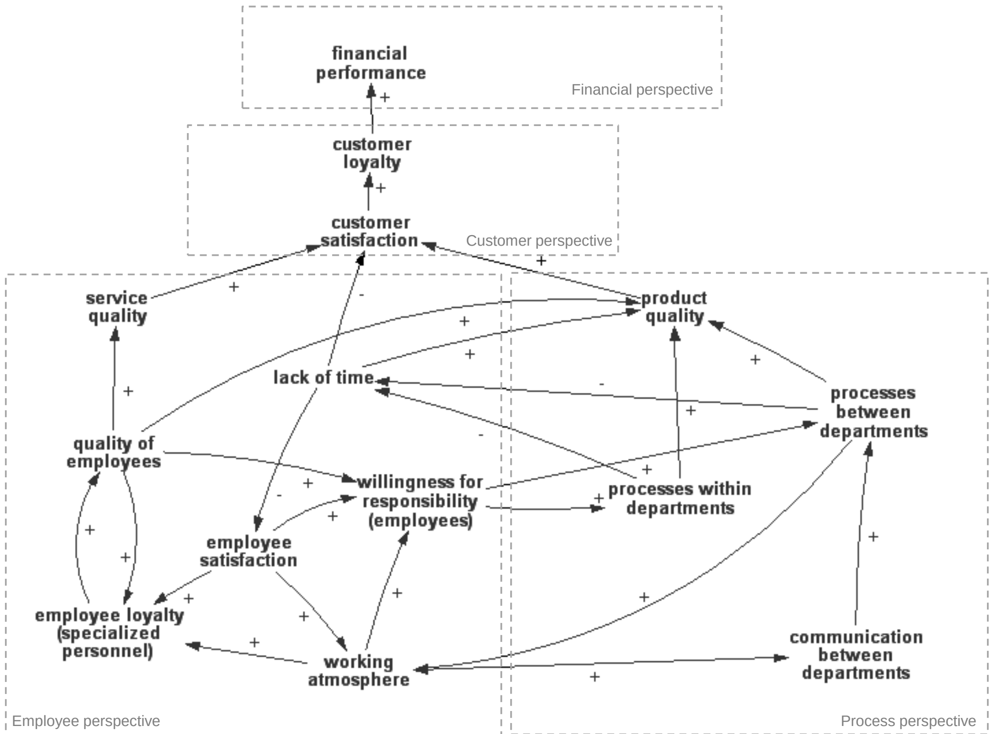

FIGURE 7: GCM with Perspectives.

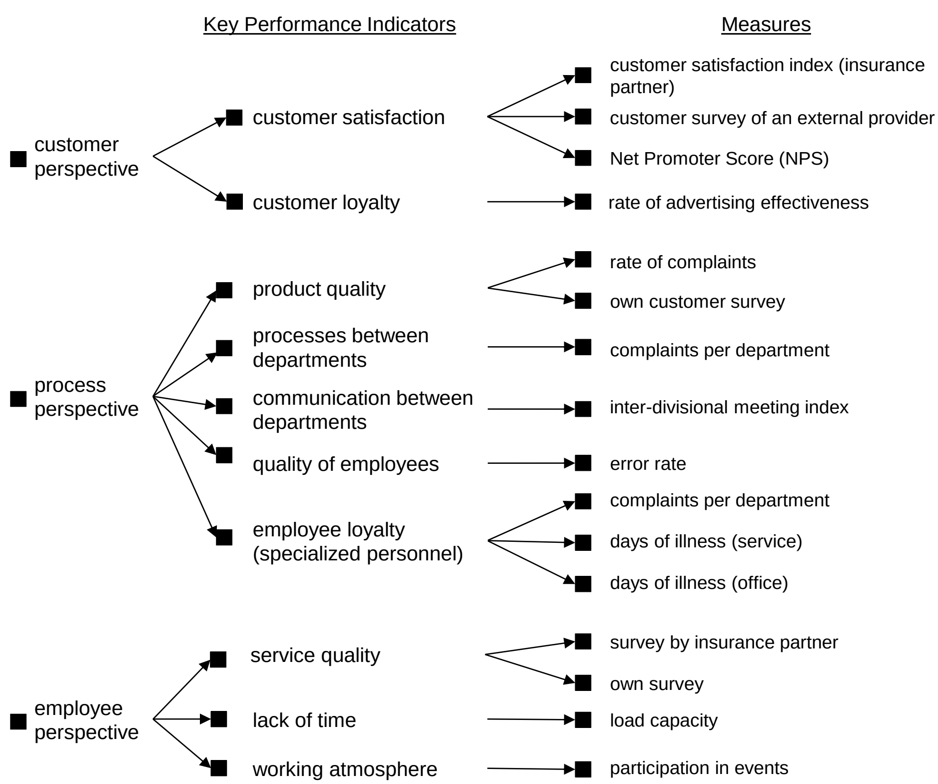

FIGURE 8: Company specific scorecard: KPIs and Measures.

A final [XIX] *evaluation & construction* on the MA level leads to a [XX] *company-specific scorecard*. It classifies the KPIs into perspectives (customer, process and employee). Each KPI is furthermore accompanied by relevant measures as well as belonging threshold values for achieving controllability within the scorecard.

In order to improve the previous static representation of the company-specific cause-and-effect relationships, further data collection as well as a long-term measurement of the KPIs and its measures can lead to possibilities of SD modeling in a [XXI] *dynamization* process. For this purpose, further data collection and an additional [XXII] *evaluation and construction* is necessary. Next, Management Accountants and company's expert team would have to estimate the dynamic effects to identify the stocks and flows in the GCM and to generate SD model equations. Based on these additional investigations the static strategy map can then be transformed into a [XXIII] *dynamized scorecard*. A further dynamic modeling is not considered within this case study, as the possibility of a framework is mentioned for future research. See for example [28] or [29] for SD modeling in a PM context.

With respect to the practical impacts it can be stated that the company could achieve an improvement of its control system which is from now on enhanced by further KPIs which are seen to be performance-relevant. As a result the company has to cope with new tasks on strategic and operational level. During the transparent procedure it was possible to give a reality check to the top management level. Especially the assessment of the current situation (see again *Figure 5*) was considered to be extremely revealing as it points out potential weaknesses. In general the communication inside the company could be improved. Furthermore tacit knowledge and causal relations have been elicitated and transported bottom-up to the top management. This enabled the identification and the usage of important KPIs and their presumed impacts on companies' performance within a causal model as a part of the control system. Since customer loyalty is a KPI which cannot be controlled in the short or medium term in this case one can be eager towards the long-term development and companies' experience with the constructed PMS.

There are some potential limitations to this study. On the one hand, we used a limited number of experts to develop the PMS. It is thus possible that the PMS is not truly representative as it only reflects the views of the six participating experts. With respect to the transferability, on the other hand, the developed PMS and its KPIs should be only used with caution for other companies. Instead companies should use the process itself to design their own KPIs. Our aim is to show transparently how an efficient PMS can be constructed tailor-made and not to present a universally valid list of KPIs which influence customer loyalty. Results haven't been validated statistically yet for the case company.

6. CONCLUSION AND FURTHER RESEARCH

The task of constructing, implementing and maintaining PMS is clearly assigned to the functional range of MA. It is fundamental for a PMS to be tailor-made for each organization. Accordingly, the consideration of company-specific cause-and-effect relationships is of particular importance, so that the organizations' strategy for ensuring satisfactory future performance can be implemented. Strategy maps as a specific type of causal maps are designed to illustrate and support the execution of an organization's strategy by linking KPIs according to determined cause-and-effect relationships in the form of leading and lagging (financial) indicators. Non-financial indicators play an important role in this context. In order to construct a strategy map according to the greatest possible extent to reality it is inevitable to refer to a broad information basis which should be derived from expert knowledge. As this knowledge is mostly not expressly available, the process of TKE is important for a tailor-made construction of PMS and its operationalization in the form of a company-specific scorecard or a dynamic model. Within this research, the variety of TKE methods were classified into three groups (interviews and observations, process tracing and conceptual techniques). From a MA perspective, the interview techniques turned out to be the most adequate TKE method since the other techniques are not expedient in a PM mapping context when there is a need for handling groups and a vast number of qualitative assessments.

Based on the relevance of tacit expert knowledge and because up to now a coherent framework does not exist, a holistic step by step approach for constructing and operationalizing efficient PMS was pointed out in this paper. The framework is supported by TKE in the form of interview techniques, SD and the interaction of organizations experts and MA. The approach fundamentally consists of the three main steps of data generation and assessment and construction are further divided by functional responsibilities on company and MA level. Additionally, the current stage of PMS development is transparent after each interaction step. Apart from interview and group aggregation techniques, the approach applies SD for the preliminary assessment of determined KPIs towards the organizational top goals.

In a further section the applicability of the approach was demonstrated with a case study within the automotive industry. As qualitative factors were playing an important role, the use of interview techniques with non-metric scaling turned out to be helpful and facilitating for the experts during the two interview rounds in the assessment step as well as for the following group aggregation. Moreover, the case study showed that the intermediate steps of the PMS development progress (especially the visualization of the individual assessment of the current situation) are highly appreciated by top management level as they are very helpful to facilitate the creation of an objective and anonymous view on the current organizational situation from an interdisciplinary employee perspective. Thus, it was directly possible to perceive a need for action.

A final step within the approach was not supported by the case study. Therefore it is necessary to create a long-term database in order to perform a more comprehensive dynamic modeling of the PMS. At least 30 data points are recommended. However, in this case it has to be reemphasized that the entire presented framework should be embedded into appropriate strategic control activities which can reveal changes within strategy, assumptions or external factors. These changes again require an adjustment of the entire model. Despite this, a further SD modeling would offer the possibility for verifying the validity of experts' tacit knowledge and could be an interesting aspect for further research.

Owing to the fact that the PMS construction process is permanently confronted by multiple conflicting goals which are further influenced by various indicators, the use of appropriate multi-criteria decision aid methods could be an additional possibility for improving and facilitating the PMS design and implementation process. As partnering in decision making ranks among the fundamental tasks of MA [63] the support of multi-criteria decision problems in the context of PM such as selection, priorization or evaluation of strategic goals, KPIs, measures and possible actions likewise belongs to the responsibility of MA. Despite of attempts to combine methods of multi-criteria decision aid with single steps of the PMS construction process (see e.g. [64] and [65] for selecting BSC metrics with Analytic Hierarchy Process (AHP), [66] for an evaluation of AHP-software support from a MA perspective and [67] for evaluating and determining the most important BSC's indicators and European Foundation for Quality Management (EFQM) criteria with TOPSIS) there is still a lack of sufficient consideration of causal models and dynamics in strategic decision making. Therefore, a future research direction can be seen in the improvement of PM frameworks concerning the integration of multi-criteria decision making techniques in order to facilitate a transparent and systematic process of constructing and implementing PMS in a multi-personal decision environment.

Acknowledgements: We would like to thank the participants from our case study for their support and collaboration. Furthermore, we would like to thank the referees for their helpful comments.

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