Towards a Modeling Method for Supporting the Management of Organizational Decision Processes

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Abstract: Today's business environments necessitate effective and well-informed organizational decision processes. To establish adequate environments for decision processes in organizations, methods are advisable that promote the coordination of these processes, facilitate the implementation and maintenance of supporting information systems, and foster accountability as well as traceability of organizational decisions. We investigate the potentials of an enterprise modeling-based approach for supporting the management of organizational decision processes and propose conceptualizations for modeling constructs as enhancements to existing enterprise modeling methods.

1 Introduction

Dynamic global markets, heterogeneous and quickly changing customer demands, and short technology life cycles, among other economic challenges, increase the need for decision support in organizations [TALS07, pp. 6–8]. Addressing this need, research areas such as prescriptive decision theory and decision analysis as well as other quantitatively oriented fields of business administration provide sophisticated formal methods for analyzing particular decision situations [Ra70; BCK08]. Various technological approaches and information systems (IS), such as business intelligence (BI) systems, data warehouses (DW), and decision support systems (DSS), have been developed for supporting business stakeholders in making decisions. DSS are primarily built to support selected problem areas. BI systems are intended to provide condensed information based on data gathered in data warehouses [TALS07, p. 90]. Supporting and preparing managerial decisions through the provision of information, furthermore, is also an aim of the business functions and research areas of controlling and management accounting [Kü08, pp. 20, 48-49].

Organizational decisions in enterprises take place in a social, technological, informational, and environmental context [Ra77, pp. 20–33]. Consequently, improving the circumstances of organizational decision processes demands for multifaceted measures "addressing technology, information, organizational structure, methods, and personnel" [Da09, p. 120]. For example, from a technological perspective, it is necessary to design DSS and BI systems in a manner that is actually oriented towards organizational decisions and problems [MH07, pp. 1034–1035]. From an organizational perspective, it is necessary to specify organizational regulations to determine which actors have the authority for making certain kinds of decisions [FGT12, pp. 147-148,

157-159]. From an informational perspective, it is necessary to satisfy information needs arising from decision problems in different units of an enterprise [Kü08, p. 189]. As an additional challenge, implementing these measures requires collaboration and communication between stakeholders with different professional backgrounds and with different perspectives on decisions. This demands for a common understanding of central concepts. However, especially the term 'decision' is characterized by a broad and diverse understanding in everyday language [Be96, pp. 201–202] and, notably, even in wide parts of dedicated literature on decisions [Th74, pp. 9–21].

Against this background, a methodical approach for supporting the management of organizational decision processes is advisable. This includes the identification, documentation, coordination, and analysis of organizational decision processes. Such support is not provided by the aforementioned approaches and tools. A promising foundation for the development of a corresponding method, however, can be found in the area of *enterprise modeling*. This is mainly for four reasons. First, enterprise modeling approaches, such as ARIS [Sc01], MEMO [Fr12], and ArchiMate [Th12], provide (domain-specific) modeling languages (DSML) for describing various aspects of an enterprise. Among these aspects are organizational structures, business processes, goal systems, and IT landscapes. Second, these modeling languages are integrated to enable expressing and analyzing relations between different areas of an organization [Fr10, pp. 8–9]. Third, enterprise modeling methods typically offer illustrative graphical notations to foster an intuitive understanding of the models. Fourth, approaches such as MEMO [Fr12] are multi-perspective in that they provide different groups of stakeholders with specific abstractions and views on their areas of concern within an enterprise. We therefore argue that a domain-specific modeling method that is integrated with an existing enterprise modeling method represents a suitable foundation for describing, communicating, and analyzing organizational decision processes from multiple perspectives. An enterprise model-based approach thus promises to contribute to the long term management of organizational decision processes. At the same time, it enriches the current state of the art in enterprise modeling. To the best of our knowledge, present enterprise modeling approaches do not provide dedicated modeling concepts for describing organizational decision processes.

The contribution of this paper is threefold: (1) We present the results of a terminological analysis and reconstruction of the domain of organizational decision processes, (2) we investigate the potentials of an enterprise modeling-based method to support managing organizational decision processes, and (3) we present the outline of such a method. In this paper, we focus particularly on requirements and language design issues. This represents a first step towards a comprehensive method for the dedicated management of organizational decision processes. A process model, as the second constituent part of the intended modeling method, is part of future research. In Section 2, we present results of a domain analysis. Section 3 elaborates on the purpose of the method and introduces requirements it should satisfy. General prospects of an enterprise modeling approach for the given purpose are envisioned in Section 4. In Section 5, we discuss issues and decisions pertaining corresponding language concepts. A review of related work, which builds on concepts and relations outlined before, is given in Section 6. Section 7 provides concluding remarks and an overview of future research.

2 Domain Analysis

The development of a modeling method, and in particular the design of a domain-specific modeling language, requires to reconstruct key terms and semantics of the targeted domain. For this purpose, pertinent literature in the field of *organizational decision processes* has been reviewed, analyzed, and interpreted. This section summarizes key findings from a reconstruction of the terminology concerning the fundamental understanding of a decision (Section 2.1), decisions and decision processes in organizations (Section 2.2), as well as the relation to information systems and organizational decision support (Section 2.3). The research fields considered in the following analysis include business administration, organizational studies, psychology, prescriptive decision theory, and information systems (management).

2.1 Fundamental Understanding of the Concept of a Decision

The term 'decision' undergoes a highly varied use both in everyday language and in literature. Remarkably, even a large number of publications specifically dealing with decisions hardly elaborate on the underlying understanding of this term [Lu06, p. 123]. Often, the term is introduced en passant and only in a rather concise manner [Be96, pp. 201–202]. To develop a more comprehensive understanding, different aspects related to the concept of a decision are discussed below.

The most common definition of a decision is that of a *choice* among *alternatives* [e.g., Gä63, p. 22; Ra77, p. 1, Sc04, p. 54]. In wide parts of literature, and particularly in economics, business administration, and prescriptive decision theory, decisions are exclusively understood as choices [Ma99, p. 14]. Following this conception, a decision consequently presupposes the availability of at least two options to choose from. As another central characteristic of decisions, it is commonly suggested that decisions relate to subsequent *courses of action* of an individual [e.g., Si76, p. 4; MRT76, p. 246]. That is, a decision is considered to imply an act of *commitment* to perform a particular course of action [Ki71, pp. 54; MRT76, p. 246]. Both the conception of a decision as a choice and as a commitment portray a decision as an isolated mental act taking place at a specific point in time. It is abstracted from how individuals arrive at this act. In this regard, it is generally suggested that decisions are the result of dedicated *decision processes* [e.g., Ki70, pp. 70–75; Si76, p. 4; Be96, pp. 200–207]. Despite its common use in literature of different research fields, only very few distinct definitions of the term 'decision process' can be found. Synthesizing various proposals in the literature, a decision process can be regarded as an abstraction of a number of different and potentially temporally dispersed cognitive processes and activities of an individual, which eventually result in a decision. A remarkable diversity of prototypical descriptions of decision processes are suggested in the literature [see Ki70, pp. 70–75]. Four commonly noted key elements have been identified. First, a decision process is ordinarily assumed to be initiated by the perception of a *stimulus*, such as the perception or recognition of a problem, a specific situation, or a certain condition. A stimulus will hereinafter be understood as an individual's initial perception of a *problem* [PB81,

p. 119]. If a number of possible courses of action are already available, and only one alternative may be realized, this is usually defined as a *decision problem* [GK05, p. 7].

Second, a decision process suggests some kind of pre-decision behavior in the course of which an individual searches for, identifies, develops, and evaluates possible courses of action. It is often suggested that these activities primarily represent activities of *information* processing. Many authors with both descriptive and prescriptive claims suggest a specific sequence of these activities [e.g., PB81, p. 119; GK05, p. 66]. However, empirical research stresses that the phases taking place in decision processes cannot be assumed to occur in any strict order [Wi72; MRT76]. The assumption that courses of action are evaluated implies the existence of mental concepts of valuation. In this connection, concepts such as values or, most commonly, *goals* are invoked [e.g., Ki70, p. 26; Si76, pp. 4–8]. Additionally, *environmental factors* are considered, which may result in different future states [e.g., BCK08, pp. 18–22]. According to traditional conceptions in economic theories, 'rational' individuals have perfect knowledge of available courses of action and their outcomes, and they pursue consistent goals [Si76, pp. 79ff.]. Contrarily, most recent descriptive theories of human decision making acknowledge that there are limits to human knowledge and rationality [Ma99, p. 33]. Third, a decision process involves a *decision* at one point. If different courses of action have been identified or developed, it is suggested that one of these alternative courses of action is chosen in this phase. However, it is also possible that only one potential problem solution is accepted without considering other alternatives [Br80, pp. 37–38; Ki70, p. 71]. Thus, in contrast to common definitions, a decision does not necessarily have to represent a choice. Fourth, and lastly, some authors suggest post-decision behavior, e.g., activities of assessment, feedback, learning, legitimation, or revision with respect to the decision and the accepted course of action [e.g., Si77, p. 41]. In summary, it can be concluded that decisions are not isolated acts or choices, but rather result from dynamic and iterative processes of assessing and developing possible courses of action.

2.2 Organizational Decisions

Organizational decisions and decision processes exhibit specific particularities. First, not every individual or group of individuals as part of an organization is permitted to make any kind of decision. Instead, certain organizational positions or units are assigned the authorization to make organizational decisions that have internally or externally binding implications [e.g., FGT12, pp. 147, 157]. In case individuals involved in an organizational decision process do not have the authority to legitimately or bindingly make a decision, this decision may have to be *authorized* by a different organizational unit, typically up in the organizational hierarchy [MRT76, pp. 259–260; Ki71, pp. 54–55]. Second, major parts of literature on business administration advocate the notion that organizational decisions are to be oriented towards goals, and that organizations define and maintain organizational *goal systems* [e.g., He66; Sc04, p. 57]. Organizational goal systems comprise a number of interrelated organizational goals, which are pursued in the long term or for a certain period of time. It is argued that organizational goal systems can and should serve as a key orientation for decisions in enterprises [e.g., He66, pp. 22, 24]. Third, decisions in business firms are typically decisions on the use and commitment of scarce resources [e.g., Sc04, p. 57].

2.3 Information Systems and Organizational Decision Support

In recent decades, a variety of *information system* types have been developed and propagated by academia and practice with the aim of supporting organizational decision making. Business intelligence systems and decision support systems are two of the most notable types of IS in this context. BI systems are aimed at gathering business data from different sources such as internal information systems or external information providers, consolidating these data in specific centralized databases, and providing business stakeholders with diverse means of observing, accessing, and analyzing these data [MH07]. The databases underlying BI systems are commonly referred to as data warehouses. BI systems intend to provide information in terms of general business figures such as product sales structured by regions and periods. In contrast, DSS are tailored towards supporting specific problem areas [TALS07, p. 90]. For example, DSS may offer information and implement analytical models for supporting problem areas such as assessing investment options. In addition to IS (management), supplying stakeholders in enterprises with information is of concern in research areas such as information management, controlling, and management accounting. A concept that is utilized in all these research areas is the concept of *information need*. Information need is commonly understood as a specification of type, amount, and quality of informational resources, which are required to accomplish a task [Ho09, p. 309]. Küpper states that information needs for a decision problem can be obtained by assessing given alternatives, goals, and relations between them [Kü08, p. 183]. Diverse methods for identifying business information needs have been developed [SWW11]. Information needs are relevant in the area of controlling to supply business stakeholders with appropriate information [Kü08, p. 189ff.; Ho09, p. 309ff.] as well as in the area of IS management to design adequate IS, in particular BI systems [SWW11, pp. 37–38]. The concept of information need, hence, represents a link between decision processes and both technological and organizational measures aimed at information provision. To recapitulate, the semantic net in Figure 1 summarizes the key concepts and relations pointed out in this section.

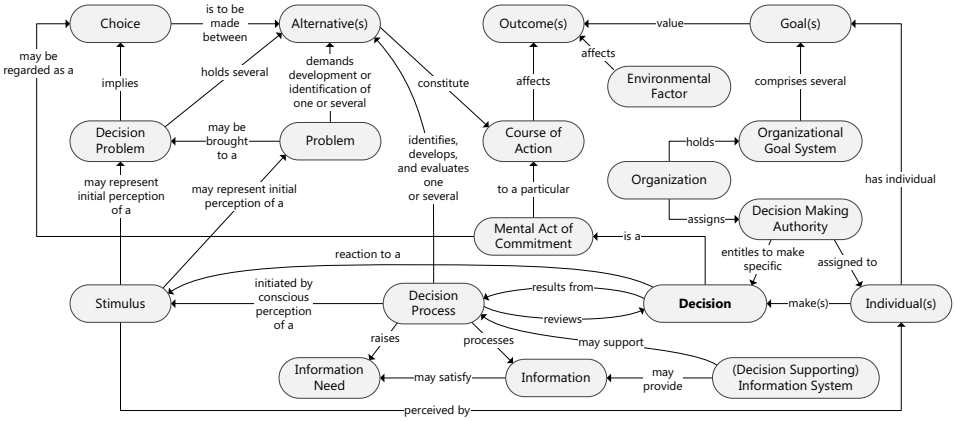

Figure 1: Semantic net of key concepts related to (organizational) decisions

3 Design Goals and Requirements

The modeling method presented in this paper is intended to be an instrument for supporting the identification, documentation, coordination, and analysis of organizational decision processes. It is supposed to stimulate and foster the implementation of suitable organizational and technological measures for improving the basis of decision making. In particular, models created with the prospective modeling language should provide multiple perspectives on decision processes, such as an organizational, a technological, and an informational perspective. Accordingly, the overall design goal is to enhance present enterprise modeling approaches with constructs for modeling organizational decision processes to enable a model-based and multi-perspective management of organizational decision processes.

The design of a modeling language demands to identify requirements for guiding the specification of language concepts. Hence, based on the domain analysis presented in Section 2, we refine the stated goal by establishing domain-specific requirements the method should satisfy. General requirements that a DSML should fullfill are discussed in, e.g., [Fr10]. At first, requirements relating to the particularities of conceptually modeling decision processes are discussed. Subsequently, requirements concerning the integration of decision process models in the context of an enterprise (model) are specified.

3.1 Requirements Concerning the Conceptualization of Decision Processes

The domain analysis has revealed several particularities of decisions and decision processes that a corresponding modeling method has to consider. Conceptual modeling languages ordinarily focus on the *type* level, which abstracts from particular instances [e.g., Fr10]. A decision process *instance* may be regarded as a particular decision process taking place in an organization, while a decision process *type* may be regarded as an abstraction of several similar decision process instances. Constructing an appropriate abstraction at the type level faces various challenges, though. First, a decision is characterized by the very fact that it is a reaction to a ’new‘ or partly ’unknown‘ situation (see Section 2.1). The idea of aggregating several decision processes to a type, hence, may compromise the very essence of the concept. Second, decision processes are characterized by the fact that their problem definitions are neither fixed, nor entirely predictable over the course of a decision process. For example, decision processes initiated by similar problem perceptions might result in highly heterogeneous decisions. At the same time, decisions that relate to similar courses of action might be the result of decision processes that are initiated by entirely different problem perceptions. Also, a decision process may often start with little more than a vague perception of a problem. These observations indicate that different conceptions of decision process types are conceivable. A method for managing organizational decision processes should thus provide a conception that is adequate to its purpose.

Req. 1 – Decision processes: The method should provide a purposeful specification of the semantics of decision process types as abstractions of substantially similar past, present, and possible future decision processes. The method should provide clear guidelines for constructing meaningful decision process types.

Decisions and decision processes are always the reaction to specific stimuli, i.e., initial perceptions of problems.

Req. 2 – Stimuli: The method should provide a concept for modeling *stimuli*, which initiate decision processes. It should be possible to link stimuli to concepts that represent potential sources or triggers of stimuli, e.g., business performance indicators or other kinds of incentives, threats, or opportunities.

Various studies have shown that both individual and organizational decision processes are iterative and also incremental in nature [e.g. Wi72; MRT76]. Activities in decision processes do not follow strict schemes of phases.

Req. 3 – Iterativeness: The method should neither presume nor convey the impression that decision processes in organizations can be approached by following a strict scheme of phases or activities.

It is widely recognized that a traditional conception of rationality is neither suitable for describing human behavior, nor appropriate to human cognitive capabilities [Si76].

Req. 4 – Bounded rationality: The method should not build on unrealistic assumptions on human rationality and cognitive capabilities. It should neither be assumed that individuals in a decision process are generally aware of all possible courses of action and their outcomes, nor that individuals have consistent goal and preference systems with respect to these outcomes.

Different individuals in the social system of an enterprise may pursue different goals, which neither need to be congruent with each other, nor necessarily be conducive to organizational goals [PB81, pp. 426ff.].

Req. 5 – Social systems: The method should take into account the fact that organizational decisions are made in social systems. To mitigate possible detrimental effects of opportunistic behavior and to promote the reflective use of the method, it should stimulate deliberate *justifications* of decisions, and it should foster *traceability* as well as *accountability* of decisions, e.g., with regard to possible negative side-effects.

The domain analysis has revealed a number of key concepts for describing formalized decision problems (see Section 2.1 and 2.3). To foster differentiated communication about key determinants of decision problems and to provide a basis for the specification of formal decision models, these concepts should be considered by the modeling method.

Req. 6 – Key determinants: The method should provide concepts for modeling *courses of actions*, *goals*, *environmental states*, and *outcomes*.

3.2 Requirements Concerning the Context of Organizational Decision Processes

To foster communication about decision processes and to support corresponding analyses concerning, e.g., the personnel involved in decision processes or the support provided by IS, it is necessary to account for the organizational context.

Req. 7 – Organizational context: The method should allow for integrating decision processes and related concepts in the context of an enterprise. This demands for integration with other modeling languages, specifically languages for modeling organizational structures, information systems, and goal systems.

Decision processes may result in measures that affect specific parts or elements of an organization. For example, an organizational decision process may be concerned with restructuring business processes, or it may be concerned with redefining its IT strategy. To enable analyses of presumable impacts and interrelations of decisions within an enterprise, it should be possible to model these relations.

Req. 8 – Decision impact: The method should allow for denoting those organizational aspects or elements of an organization, e.g., business processes, IT resources, or strategies, which are targeted or expected to be influenced by a decision process type.

Information has been found to be a key resource of decision processes, i.e., decision processes raise information needs. Different technological approaches and business functions aim at providing stakeholders with information (see Section 2.3). To support these business functions, there is need to align provided and needed information.

Req. 9 – Information needs: The method should allow for modeling information needs associated with decision processes. It should be possible to link information needs to information provided by existing IS.

The method is aimed at supplying stakeholders in enterprises with references to decision supporting resources that are relevant to specific decision process types. Also, it is intended to support analyses on the appropriateness and possible expansions of these supportive means.

Req. 10 – Decision support: The method should allow for linking different supportive means, e.g., specific decision support systems, diagram types of modeling methods, or formal decision modeling approaches to a decision process.

The prospective application of a method that addresses these identified requirements is illustrated below.

4 Prospects of an Enterprise Modeling Approach

In this section, prospects of extending an enterprise modeling method with modeling constructs for describing organizational decision processes are outlined. On the basis of an exemplary application scenario, it is envisioned how conceptual models of

organizational decision processes could be integrated into existing enterprise models and which benefits are associated with such an approach. Considerations on the design of modelling concepts are discussed in the following section. Figure 2 presents an excerpt of an enterprise model, which is augmented by a model of organizational decision process types. The enterprise model describes selected aspects of a fictitious medium-sized mail order company that focuses on consumer products and operates on the basis of an online shop. The enterprise model is created using several DSML and notations provided by the enterprise modeling method MEMO [Fra12]. The shown excerpts do not predetermine a specific enterprise modeling approach, though. New concepts can equally be introduced to enterprise modelling approaches other than MEMO.

The scenario shows five partial models, all of which are located at the *type* level. First, a goal model is pictured in the top left part of the diagram. This model represents selected goals of the enterprise. Second, a model of the organizational structure is depicted in the top right part of the diagram. Third, certain business process types that are selected from a business process map are shown in the second layer. Fourth, a model that depicts a set of decision process types along with corresponding stimuli and a detailed view on a particular decision process type is part of the third layer. Fifth, and finally, a model of selected information systems, the information they provide, and an exemplary model showing hardware and software used to realise the IS is part of the bottom layer of the diagram. Not every prospective analysis scenario needs to consider all aspects depicted in the given example simultaneously. As such comprehensive diagrams can reach a remarkable degree of complexity, common enterprise modeling methods often provide mechanisms for fading in and out details in diagrams according to the user's needs.

Selected relationships between elements of the enterprise model are explicitly modeled using associations. These associations are found between, e.g., organizational units and business processes. In particular, the augmented enterprise model points out how models of decision processes can be integrated with other models in the context of an enterprise. The given application scenario focuses on analyzing the context of the decision process type 'Define Temporary Promotional Offer' (see ❶ in Figure 2). Prior to specific analyses, stakeholders with different professional backgrounds can gain an initial understanding of this decision process type by assessing its attributes and linked concepts. The attribute 'General Aim' points out that this decision process is generally concerned with specifying a promotional offer in terms of a product and a promotional price. As is expressed by the corresponding stimulus type (see ❷), this process is initiated whenever need is perceived for attracting additional visitors to the online shop in the short term. Stimuli of this type occur 'occasionally', hence, the decision process is initiated rather frequently. It is important to note here that the model describes abstractions of these occurences at type level, while particular stimuli perceived at specific dates would be located at the instance level. Furthermore, it can be found that this decision process is to be oriented towards the goal to 'Maximize Shop Awareness' (see ❸) in the organizational goal system. With respect to this relationship, it is also noteworthy that the decision process should target the goal 'Attract at least 300 Unique New Visitors' (see ❹). This represents a decision-specific goal, which is too specific to be considered in the general organizational goal system. Yet, on the basis of decision process models, even such goals can be managed and documented.

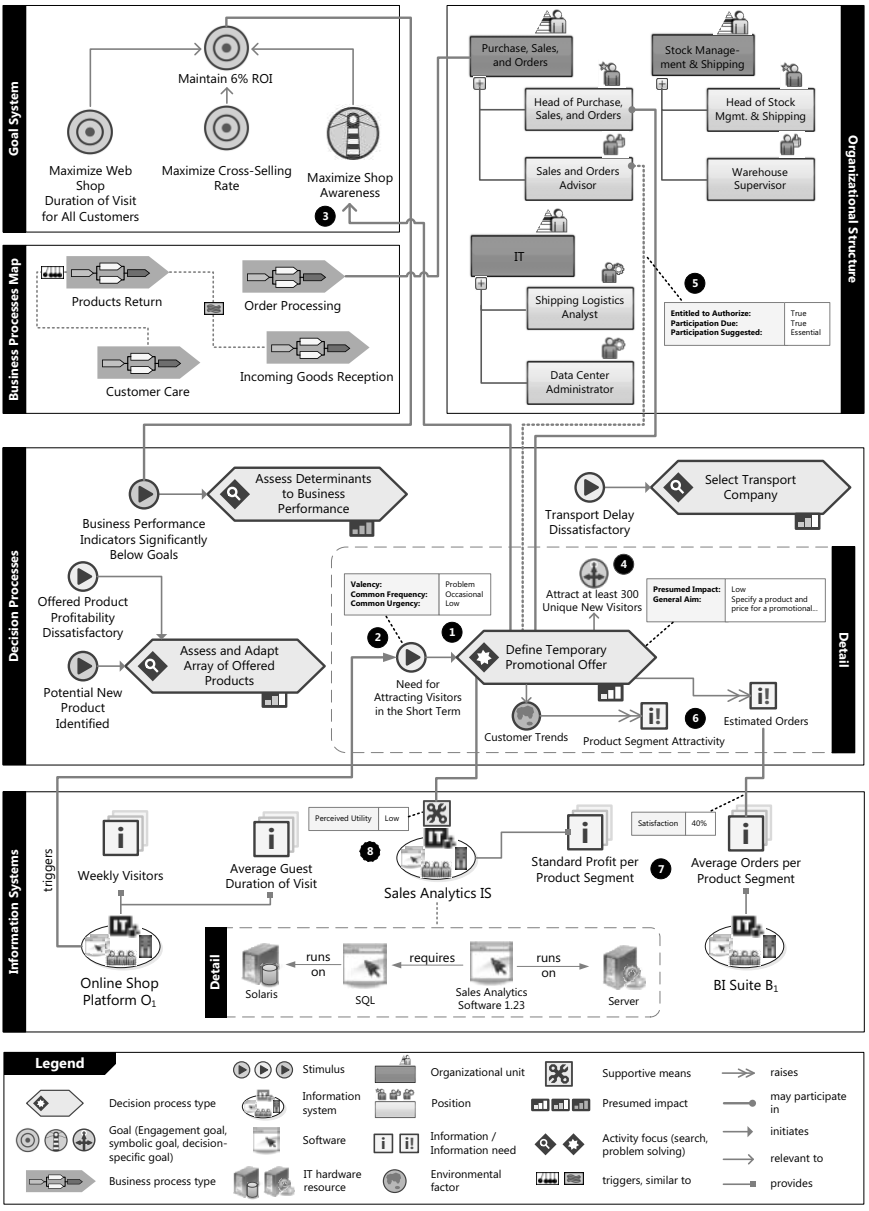

Figure 2: Illustration of an enterprise modeling approach to decision process modeling

Building on a general understanding of the decision process, an enterprise model provides the foundation for supporting various specific analyses. For example, a manager responsible for a certain organizational unit can analyse who is involved—and who *should* be involved—in certain decision processes by analysing relationships from decision process types to organizational positions and roles (see ❺). In the scenario, it can be found that the 'head of purchase, sales, and orders' as well as 'sales and orders

advisors' are commonly involved in the given decision process type. A responsible manager may find that the decision process lacks particular competencies and suggest that a shipping logistics analyst should participate in the process as well. Also, it may be assessed to be inappropriate that sales and order advisors are entitled to authorize the final decision. Consequently, decision making authorities might be reassigned more strictly, e.g., by demanding authorization by the head of the department. Taking a different perspective, IT experts can assess information needs raised by the decision process type (see ❻) as well as information and support provided by existing information systems (see ❼). By tracing connections between information needs and information provided by IS, the appropriateness of supplied information can be assessed and deficits may be identified. For instance, it may be noted that the environmental factor 'customer trends' raises the need for information on current product segment attractivities. Apparently, this demand is not addressed by any existing IS. This might stimulate measures for adapting IS or establishing new IS meeting this demand. Also, IT experts can assess whether information systems provide information that is not pivotal to any decision process type by identifying information that is not linked to any decision process type. This supports evaluating costs and benefits of providing this information. Finally, it can be assessed whether it might make sense to establish additional decision supporting systems by comparing existing decision process types and available DSS. For example, it can be detected that the 'sales analytics IS' is regarded as a supportive means for the given decision process type. Its perceived utility, however, remains low (see ❽). In addition to these examples, various analyses taking further perspectives are conceivable. For example, a top level board of managers may assess whether the right set of goals is targeted in different decision process types.

5 Considerations on Language Design

Based on the requirements analysis and the outlined vision of an enterprise modeling approach, this section provides considerations on modeling concepts for describing organizational decision processes. We present preliminary specifications of modeling constructs as meta model excerpts using the MEMO meta modeling language (MML) [Fra11]. The specifications are intended as working drafts for the following discussion with and discursive evaluation by peers and domain experts. To improve readability, the meta model excerpts are split into several figures.

Based on the domain analysis, we suggest to clearly distinguish between language concepts for describing *decision processes* and *decisions.* Decision processes embrace all activities of treating detected problems, while decisions represent the final acts of commitment resulting from these processes. Consequently, decision processes are regarded as the prime concepts of interest for most prospective analyses. To conceptually model decision processes, a purposeful conception of decision process *types* (Req. 1) is necessary. Various options are conceivable. First, it would be possible to define decision process types as abstractions of decision processes that relate to *similar problem areas*. Second, it would be possible to specify them as abstractions of decision processes, which result in decisions on *similar subjects*. Third, it would be possible to define decision process types as abstractions of decision processes, which are

initiated by *similar stimuli* (i.e., by similar initial problem perceptions). This conception refines the first one. We propose to employ the third conception as a basis of abstraction. The first alternative remains unpractically vague, as it does not provide clear criteria for specifying decision process types. The second alternative neither allows for modeling decision process types that are initiated by vague stimuli, nor for modeling decision process types that deal with heterogeneous decision subjects. For instance, consider the stimulus "business performance indicators significantly below goals". This stimulus might result in different decisions such as cutting of operations costs or investing into new product developments. The third alternative, in contrast to the second one, allows for capturing decision process types that deal with such different decision subjects, since it focuses on the inital stimulus. Thereby, in contrast to the first conception, it also provides a clear reference point for the construction of abstractions at the type level.

Building on this conception of decision process types, we suggest to describe a decision process type in terms of a *name* and a *generalAim* (see Figure 3). The general aim should briefly characterize the intent of a given decision process type. Different decision processes may emphasize different activities, which can be specified using the attribute *commonActivityFocus*. Based on the domain analysis, we suggest that the auxiliary type *DecisionProcessFocusType* can take the values ‚Problem Analysis', ‚Problem Solving', ‚Search', and ‚Evaluation and Choice'. The attribute *presumedImpact* of a decision process type may be used to express the expected influence on business performance.

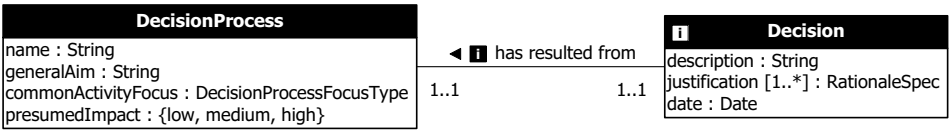

Figure 3: Conceptualization of 'decision process' and 'decision'

With respect to the established design goals and requirements (see Section 3), modeling *decisions* as final acts of commitment is primarily relevant for purposes of justification, and accountability (Req. 5). Therefore, it is suggested to specify 'decision' as an *intrinsic*[1] concept (as expressed by the white ‚i' on the meta type in Figure 3). The purpose of this concept is to describe particular decisions (instances of a decision type). Attributes for specifying a general description, a justification for the respective decision (the auxiliary type ‚RationaleSpec' for modeling rationales is developed by [SFHK12]), as well as an attribute expressing the date that a particular decision has been made have been included. As decisions are solely modeled at the instance level, the association between 'Decision' and 'DecisionProcess' is marked as being intrinsic as well. At instance level, one particular decision results from exactly one decision process instance.

A 'stimulus' represents a further key concept of the prospective language (Req. 2), especially since it is employed as a basis for the construction of decision process types. In addition to the generic attributes *name* and *description* and in accordance with, e.g., [MRT76], it is propose that a stimulus can be characterized in terms of a *valency*. A

[1] Intrinsic concepts, attributes, and associations are not instantiated at type level, but only at instance level (see [Fr11] for further discussion).

stimulus valency expresses the degree to which it is regarded as voluntary (an ‚opportunity') or enforced by external pressure (a ‚crisis') to respond to a stimulus (see Figure 4). Intermediate stimuli are regarded as an ordinary ‚problem'. The degree to which an immediate reaction is necessary can be expressed using the attribute *commonUrgency*, while the rate of its occurence may be specified using the attribute *commonFrequency*. At the instance level, the date a particular stimulus has been noted can be documented (*recorded*). It is proposed that at type level each stimulus type initiates exactly one decision process type, while a decision process type may be initiated by different stimuli (*initiates*). At the instance level, a decision process can only be initiated by exactly one specific stimulus (intrinsic association 'has initiated'). Hence, while the former association describes, which stimulus types can initiate which decision process types, the latter can be instantiated only at instance level to document which particular stimulus has initiated which specific decision process. Furthermore, it is argued that a decision process may potentially trigger further stimuli. This relation is purely optional. With respect to requirement 3, it has been chosen to deliberately refrain permitting to model strict sequential relations within or between decision process types.

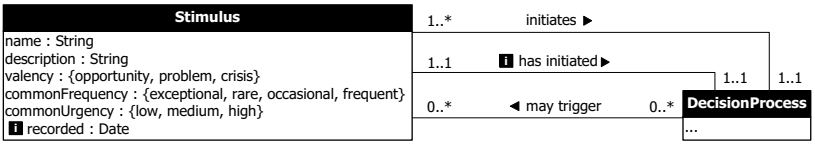

Figure 4: Conceptualization of 'stimulus'

To enable multi-perspective analyses of organizational decision processes, it is necessary to integrate the concepts of a decision and a decision process in the context of an enterprise (Req. 7). Figure 5 presents an initial integration with existing modeling languages of MEMO and it introduces further domain-specific concepts. Reused modeling concepts from existing modeling languages are marked by a colored rectangle attached to the meta type (as suggested in [Fra08]). Decision processes can be related to various organizational units (e.g., single units such as positions, boards, or committees) by means of the association *ParticipationRelation*. This relationship offers attributes for documenting and managing desired charactistics of this participation. It can be specified whether a specific organizational unit may authorize the final decision (*entitledToAuthorizeFinalDecision*), and whether participation of a specific unit is regarded as mandatory or advisable (*participationDue*, *participationSuggested*). For purposes of documentation, at the instance level, it can be recorded that a specific organizational unit has participated in a particular decision process (*participatedIn*). Similarly, the concept 'decision' can be linked to organizational units at instance level to document the stakeholders who have authorized a particular decision (*AuthorizationRelation*). To enable analyses as outlined in Section 4, IS can be linked with decision processes in two different ways. First, the concept *InformationNeed* is offered (Req. 9). Information needs can be raised by decision process types. The association *InformationNeedSatisfactionRelation* can be used to express the degree to which IS satisfy these needs. Second, the association *SupportiveMeansRelation* enables to model that an IS represents a supportive means for a decision processes type (Req. 10). Furthermore, key determinants for describing decision problems (Req. 6) can be

modeled using the concepts *AbstractGoal* (and its specializations), *EnvironmentalFactor* and *CourseOfAction*. It is suggested to relate these concepts to decision processes through a specific *RelevanceRelation*. The conceptualization of this relationship is intended to be augmented in future work.

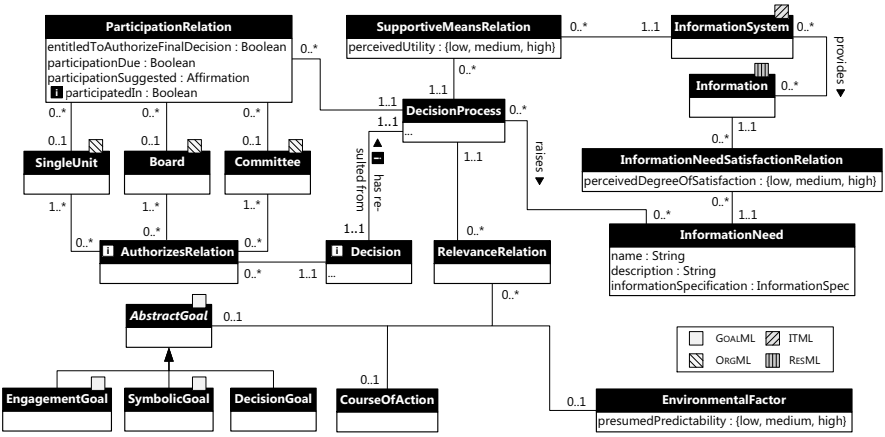

Figure 5: Further key concepts and integration in the context of an enterprise[2]

6 Related Work

Related work can roughly be categorized into two categories: Research on modeling languages for processes and research on formal decision modeling. The former focuses on dynamic abstractions, such as modeling languages for describing business processes or workflows. These languages typically offer branch elements, which divide a path of execution into several paths. Branch elements, in which only a subset of outgoing paths may be selected for further execution, are often directly or indirectly labeled as decisions [e.g., Ob11, p. 37]. The prime purpose of branching decisions is to serve as control flow elements. They are not intended to enable management of organizational decision processes, since they neither model decisions as social processes involving different actors, nor integrate these processes in the organizational and technological environment of an enterprise. The latter category of related work, formal decision modeling approaches, are proposed in the fields of prescriptive decision theory, applied mathematics, and business administration. These approaches conceive a decision as a choice among given alternatives and develop mathematical-statistical means of identifying an 'optimal' alternative [Ra70; BCK08]. To this end, these approaches mathematically describe particular decision situations in terms of alternatives, goals, environmental states, and outcomes. Building on these formalizations, they provide methods for maximizing quantitative figures such as expected values or risk utility values [Ra70; Ma99]. These approaches do not intend to support the documentation and analysis of organizational decision processes beyond the scope of particular decision situations. They largely abstract from the organizational system decisions are embedded

[2] Note that constraints such as 'a ParticipationRelation must be linked to exactly one SingleUnit, Board, or Committee' are omitted in the meta model. They are part of the full language specification as OCL statements.

in [Be96, p.212]. In particular, these proposals do not support assessing decision processes in relation to, e.g., organizational units and IS. Overall, to the best of our knowledge, there is no method directly comparable to the one elaborated in this paper.

7 Conclusions and Future Research

This paper investigates the potentials of an enterprise modeling approach to support the management of organizational decision processes and proposes corresponding modeling constructs as enhancements to existing enterprise modeling methods. The assessment indicates that enterprise models provide a suitable foundation for establishing and supporting the dedicated management of organizational decision processes. For example, enterprise models allow for describing key determinants (Req. 6), represent the organizational context (Req. 7), and provide the foundation to model information needs and supportive means (Req. 9 and 10). Extending the modeling language and providing a process model will be subject of future research. Also, as the targeted level of detail in modeling is rather thorough, attention must be directed to assessing costs and benefits of applying the method. To tweak method economy, the set of used modeling concepts could be reduced or the targeted level of detail could be adapted according to an organization's needs. Developing respective guidelines is part of future work as well.

In addition, the proposed approach promises to support at least two more advanced application areas. First, enterprise models enriched with details about decision processes can be used as the foundation for advanced management of decision process instances. On the basis of a suitable modeling tool, decision process instances could be monitored and documented in real time. Second, a modeling environment may be used to enhance existing methods for identifying and managing information needs, because it allows to document information needs beyond the scope of particular IS implementation projects—which has been found to be a shortcoming of existing methods [SWW11].

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