Formal Modelling of Goals in Organizations

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Abstract. Each organization exists or is created for the achievement of one or more goals. To ensure continued success, the organization should monitor its performance with respect to the formulated goals. In practice the performance of an organization is often evaluated by estimating its performance indicators. In most existing approaches on organization modelling the relation between performance indicators and goals remains implicit. This paper proposes a formal framework for modelling goals based on performance indicators and defines mechanisms for establishing goal satisfaction, which enable evaluation of organizational performance. Methodological and analysis issues related to goals are discussed in the paper. The described framework is a part of a general framework for organization modelling and analysis.

1. Introduction

Organizations exist for achieving certain goals by coordinating the execution of appropriate activities among actors and by handling the complexity of interactions with the environment. Therefore, the viability and success of an organization depend on how effectively the organization manages its internal activities and how well its behaviour fits with the environmental conditions. The behaviour of an organization is usually guided by its strategic and tactical goals that depend on the professional orientation (i.e., domain, types of activities) and specific characteristics of the organization, interests of concerned stakeholders and on the type of the environment (e.g., a market) in which the organization is situated.

The performance of an organization is often evaluated by estimating the values of its qualitative and quantitative performance indicators (e.g., profits, number of clients). Therefore, to ensure the effectiveness of an organization, all the principal performance indicators (PIs) should be reflected in its goals. While in most existing approaches on organization modelling the relation between PIs and goals remains implicit, this paper defines a clear and general mechanism for specifying goals based on PIs. Then, the performance of an organization can be evaluated by estimating the (level of) satisfaction of its goals.

Different types of goals can be identified in organizations. The satisfaction of some of them can be determined in a clear-cut way by evaluating conditions in goal expressions (e.g., “ensure that an order is processed within 24 hours”). Such goals are sometimes called hard goals. The satisfaction of other
goals is difficult to assess (e.g., “maximize the customer satisfaction”), since they refer to not directly measurable quantities. Such goals are often called soft goals. In this paper both hard and soft goals are described and the corresponding mechanisms for establishing the goal satisfaction are specified.

The individuals (agents) assigned to certain positions (roles) in an organization have personal goals based on individual PIs that may comply with, be disjoint or conflict with organizational goals. The performance of individuals can be determined in the same way as the performance of an organization.

Furthermore, the satisfaction of goals often can only be established in a framework, in which goals are related to other concepts (such as tasks, roles and agents). Such a framework for the performance-oriented modelling is considered in this paper with the main focus on goal modelling. An elaborated description of PIs and the related techniques relevant to the framework are given in [17].

The framework for the performance-oriented modelling constitutes a part of a general framework for organization modelling and analysis. In the general framework, organizations are considered from other perspectives (or views) as well. In particular, the process-oriented view describes static hierarchies of tasks and resources, flows of control (or workflows), relations between processes and resources. Within the organization-oriented view organizational roles, their authority, responsibility and power relations are defined. In the agent-oriented view different types of agents with their capabilities are identified and principles for allocating agents to roles are formulated. The framework considers the actual execution of organization scenarios as well, providing tools for analysis of the recoded data on the functioning of the organization.

Note that the identified views are linked to each other by means of sets of relations. For example, relations between goals (from the performance-oriented view) and roles (from the organization-oriented view) are introduced. Further these relations are used in the organization-oriented view to describe mechanisms of goal assignment and delegation to roles, in which also power and authority relations from the organization-oriented view are used.

In all these views environmental conditions, in which the organization is functioning, are taken into account: they influence the specification of organizational concepts and relations between them (e.g., the formulation of goals and the specification of tasks), thus, affecting the structure and behaviour of a particular organization model. Furthermore, the type of the environment determines a part of the domain knowledge, which is represented by unconditionally valid facts and rules about the environment that directly influence all the activities within the organization. Another part of the domain knowledge is defined by intrinsic properties of the organization itself.

Concepts and relations within every view are formally described using dedicated languages expressive enough to convey structures and processes of organizations of most types. To provide the formal meaning for the concepts and to enable different specific (for a view) and general (across different views) formal types of analysis of organization models (e.g., by simulations and verification), an axiomatic basis is defined that establishes formal relations between concepts within one view and across different views. Furthermore, the formal definition of organizational models and the axiomatic
basis enable semantic integration of different ontologies for enterprise modelling, implemented in information systems of organizations aiming at cooperation or integration.

The formal language and the set of axioms and constraints specific for modelling goals within the performance-oriented view are described in this paper. Furthermore, some of the verification techniques specific for performance-oriented organization models are described as well as some methodological issues related to creating and revising goal structures, and the process of organizational performance evaluation based on a goal hierarchy. Other views of the general framework will be considered elsewhere.

The presentation is organised as follows. Section 2 introduces the case study used to illustrate modelling and analysis techniques. In Section 3 the main concepts for the goal modelling framework are specified. The relationships between them are described and formalized using the dedicated logic-based language in Section 4. Section 5 discusses how the performance of the organization is evaluated in the introduced framework. Some design principles are given in Section 6. In Section 7 the related work on goal-oriented modelling is discussed. Finally, Section 8 concludes the paper.

2. Introduction to the Case Study

The proposed approach was applied for modelling and analyzing an organization from the security domain within the project CIM (Cybernetic Incident Management, see http://www.almende.com/cim/). The main purpose of the organization is to deliver security services to different types of customers. The organization has well-defined multi-level structure that comprises several areas divided into locations with predefined (to a varying degree) job descriptions for employees (approx. 230,000 persons). The global management of the organization (e.g., for making strategic decisions) is performed by the board of directors, which includes among others the directors of the different divisions (regions). Within each region a number of areas exist controlled by area managers. An area is divided into several units, supervised by unit managers. Within each unit a number of locations are served, for which the contracts with customers are signed and security officers are allocated. The allocation of employees is performed based on plans created by planning groups.

The examples given in this paper will be related to the part of the organization concerned with the planning of the allocation of security officers to different locations of customers. The planning process consists of the forward (or long-term) planning and the short-term planning. The forward planning is the process of creation, analysis and optimization of forward plans for the allocation of security officers within the organization for a long term (4 weeks) based on customer contracts. It is performed by forward planners from the forward planning group, managed by the manager of planning. During the short-term planning, plans that describe the allocation of security officers to locations within a certain area for a short term (a week) are created and updated based on the forward plan and up-to-date infor-
mation about the security employees. Based on short term plans, daily plans are created. For each area the short-term planning is performed by the area planning team that consists of planners and is guided by a team leader. During the planning process short-term planners interact actively with forward planners (e.g., for consultations, problem solving). Furthermore, forward planners have a number of supervision functions with respect to short-term planners.

3. Concepts for Goal Modelling

Each organization exists for the achievement of one or more goals. This varies depending on the type of organization and the environmental conditions, in which the organization is situated, e.g. the main goal of a manufacturing company can be the realization of maximal amount of profit, whereas the goal of a non-profit organization for animal protection can be to rescue maximal number of wild animals. Being aware of these goals is a prerequisite to taking measures for their satisfaction. To ensure continued success, the organization should monitor its performance with respect to the formulated goals. To enable the goal-based performance evaluation, organizational goals should be formulated over performance measures (indicators).

**Definition 1. (Performance indicator (PI))** A performance indicator is defined as a measure, quantitative or qualitative, that can be used to give a view on the state or progress of the company, a unit within the company or an individual (e.g., time to produce a short-term plan, efficiency of allocation of security officers).

The set of relevant PIs is company-specific. Furthermore, causal and other relationships may exist between different PIs.

Expressions can be formulated over PIs containing >, = or <, for example for defining target values: an expression over the PI $P_1$: “efficiency of allocation of security officers” is defined as $P_1 = \text{high}$. PI expressions are used to define goal patterns.

**Definition 2. (Goal pattern)** A goal pattern is a property over one or more PI expressions that can be checked for a given state/time point or interval for the company or an individual agent.

Goal patterns are characterized by: (1) name; (2) definition; and (3) type. 
*Type* determines the way the property will be checked:

(a) achieved (ceased) – it should be checked whether the property is true (false) for a specific time point;
(b) maintained (avoided) – it should be checked whether the property is true (false) for the duration of a specific time interval;
(c) optimized (maximized, minimized, approximated) – it should be checked if the value of the PI expression has increased, decreased or approached a given target value for the duration of a given time interval.

Achieved, ceased, maintained and avoided are used on PI expressions that are evaluated to a Boolean value; optimised is defined over PI expressions that are evaluated to value of any type that is ordered (for maximized, minimized) or for which a distance measure is defined (approximated).

Consider the following examples of goals patterns: “maintained efficiency of allocation of security officers to objects = high” based on the maintained pattern type and “achieved that time to produce a short-term plan given operational data ≤ 48” based on the achieved pattern type.

Goals are formulated by adding to goal patterns information such as desirability and priority.

Definition 3. (Goal) is an objective to be satisfied describing a desired state or development of the company or an individual.

For example “it is required to maintain high efficiency of allocation of security officers”. A goal is characterized by: (1) name; (2) definition, (3) priority; (4) evaluation type; (5) horizon; (6) ownership; (7) perspective; (8) hardness; and (9) negotiability.

Priority is defined by a numerical estimation between 0 and 1; alternatively {very high, high, medium, low, very low}. When less information about goal priorities is available, a (partial) ordering on goals may be defined.

Evaluation type determines if a goal is based on goal pattern with type achieved or ceased (achievement goal), i.e., it is evaluated for a given state/time point, or if a goal is based on goal pattern of type maintained, avoided or optimized (development goal), i.e., it is evaluated for a given time interval.

Horizon specifies within which time interval (for development goals) or at which time point (for achievement goals) is the goal supposed to be satisfied: (a) long-term goal; (b) mid-long term goal; (c) short-term goal.

Ownership can be organizational, i.e., belongs to an organization/unit/role, follows from the highest level goals of the company, and individual, i.e., belongs to an agent. Normally, organizational goals have a high level of priority. Goals of agents may comply with organizational goals to a varying degree. The priority of individual goals might depend on the company policy: some companies might assign lower priority to individual goals than to organizational ones; others might decide to involve and motivate the agents by taking into account their goals and avoiding some conflicts that might exist between individual and organizational goals.

Perspective (for organizational goals) defines, which point of view is described by the goal: of management; of a supplier; of a customer; or of the society. Even though all organizational goals belong to the organization itself, they can reflect the point of view of an external party which desires the organization to perform in a certain way. For example the society wants the organization to obey society’s
norms and values. It is sometimes beneficial for the company to adopt goals desired by other parties e.g. to conform to the relevant laws.

It is also important to note that the different points of view will often be conflicting, for example while customers might want low prices, the management wants high profits, however if the prices are lowered that will decrease the profits. Such conflicts should be recognised during the design phase and made explicit in order to deal with them. For example priorities can be defined in order to specify which goal is more important to satisfy.

**Hardness** distinguishes soft and hard goals. The satisfaction of a soft goal cannot be clearly established. We use the term *satisficing* to indicate an acceptable degree of satisfaction of a soft goal. Soft goals are given labels that correspond to their degrees of satisficing/denial with a natural order between the labels: *satisfied > weakly_satisfied > undetermined > weakly_denied > denied*. Satisfaction of a hard goal can be established quantitatively. Hard goals also have labels ordered as follows: *satisfied > undetermined > failed*. In the example below goal G3.2 (this and the following goals are named by labels from the goal tree constructed for the considered case study) is soft, PI “efficiency of allocation of security officers” cannot be objectively established to be maintained high or not, instead we use a subjective estimation of degree of satisficing. Goal G3.1.1.1 is hard – it can be seen if PI “time to update a short-term plan given operational data” is at most 48 hours.

By negotiability goals are divided into non-negotiable (i.e., need to be satisfied, no compromise is possible) and negotiable (negotiation is possible in case of conflicts with other goals). This can be used for conflict resolution at the design phase.

**Examples:**

<table>
<thead>
<tr>
<th>Goal name: G3.2</th>
<th>Goal name: G3.1.1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informal definition: It is required to maintain high efficiency of allocation of security officers to objects</td>
<td>Informal definition: It is required to achieve that the time to update a short-term plan given operational data is at most 48 hours.</td>
</tr>
<tr>
<td>Priority: high</td>
<td>Priority: high</td>
</tr>
<tr>
<td>Horizon: long-term</td>
<td>Horizon: short-term</td>
</tr>
<tr>
<td>Evaluation type: development goal (maintain goal pattern)</td>
<td>Evaluation type: achievement goal (achieve goal pattern)</td>
</tr>
<tr>
<td>Ownership: organizational</td>
<td>Ownership: organizational</td>
</tr>
<tr>
<td>Perspective: management, customer</td>
<td>Perspective: management</td>
</tr>
<tr>
<td>Hardness: soft</td>
<td>Hardness: hard</td>
</tr>
<tr>
<td>Negotiability: negotiable</td>
<td>Negotiability: negotiable</td>
</tr>
</tbody>
</table>

Goals are realizable by tasks in an organization. A **task** represents a function performed in an organization by its role(s). A role is characterized by a set of functionalities performed by it. Roles are characterized by sets of competences, which are required to perform a certain task. Roles are allocated to agents to perform tasks in an organization. Each agent has specific capabilities (skills, knowledge or traits) and can only play a particular role if it has the capabilities that match the competences required
in the role description. Roles and agents are committed to certain goals. In addition to organizational goals, an agent may pursue its own individual goals that comply or conflict with organizational goals. These and other concepts will only briefly be discussed in this paper and are extensively considered in the descriptions of other views.

4. Formal Goal Modelling

In this Section first the concepts and relations introduced previously in Section 3 will be formalized using the first-order sorted predicate language (Section 4.1). After that, goal structures that comprise both soft and hard goals will be introduced in Section 4.2. In particular, this Section includes the formal description of relations between goals and goal satisfaction principles in goal structures.

4.1 Formalizing concepts for goal modelling

The formal language used for specifying the meta-model for the performance-oriented view is the first order sorted predicate language [15]. In this language, for each type of a concept a special sort is introduced, which contains all the names of concept instances (e.g., sort GOAL contains all the names of goals). The semantics for this language is defined in a standard way, by interpretation of sorts, constants, functions and predicates, and a variable assignment. The characteristics (or attributes) of the concepts are represented by corresponding relations (predicates) with arguments: a concept name, an attribute name and a value for the attribute (e.g., has_attribute_value: GOAL x ATTRIBUTE x VALUE). In the following for better readability such predicates will be used in the more compact form: concept.attribute=value. Using this dedicated language a number of relations between goals and other concepts are defined that are included into the meta-model for the performance-oriented view (the graphical representation of the meta-model is given in Figure 1). To provide the formal meaning for the introduced relations and to enable formal verification of organization models (e.g., consistency and integrity checking), the set of axioms is defined along the definitions or relations.

Goals are constructed based on PIs using the relations introduced below.

*is_based_on*: GOAL_PATTERN x PI: The goal pattern in the first argument is defined over the PI in the second argument.

*uses*: GOAL_PATTERN x PI_EXPRESSION: Goal pattern defined over PI expression.

In goal patterns the symbols <, >, and = from PI expressions are interpreted as functions: PI x (NUM_VALUE, QUALIT_VALUE) → PI_EXPRESSION, where NUM_VALUE is a sort containing all numerical values, and QUALIT_VALUE contains all qualitative values.

For example, the goal pattern GP1 “maintained efficiency of allocation of security officers to objects = high” is based on the PI P2 “efficiency of allocation of security officers to objects” and uses the PI expression PE1 formulated over P2 (P2=high): is_based_on(GP1,P2); uses(GP1,PE1).
**is_formulated_over:** GOAL × GOAL_PATTERN: The goal in the first argument is defined over the goal pattern in the second argument.

For example, the goal G3.2 defined earlier is formulated over the goal pattern GP1.

Goals are related to tasks, roles and agents by the following relations:

**Figure 1.** A Meta-model for the performance-oriented view.

**is_realizable_by:** GOAL × TASK_LIST: The goal in the first argument is realizable by the list of tasks in the second argument.

**is_committed_to:** ROLE × GOAL: The goal is an organizational goal and the role is committed to the satisfaction of this goal.

**wishes:** AGENT × GOAL: The goal is an individual goal of the agent.

For example, role Planner is committed to goal G3.1.1.1, which is realizable by task T4.4.1 “update short-term plan”, i.e., is_committed_to(Planner, G3.1.1.1) & is_realizable_by(G3.1.1.1, L41) & is_in_task_list(L41, T4.4.1), where is_in_task_list: TASK_LIST x TASK.
4.2 Modelling of Goal Structures

A goal structure can be built by refining high level goals (top-down approach) and aggregating lower level goals into higher level goals (bottom-up approach). Since goals in the modelling framework can be of two types: hard and soft, different types of refinement relations should be considered.

First consider refinement of hard goals. Hard goals are refined into and-lists of hard goals (sort AND_GOAL_LIST), in which the goals are connected by AND relation.

\( \text{is\_refined\_to} \): \( \text{GOAL} \times \text{AND\_GOAL\_LIST} \): Defines a refinement of a hard goal into a list of hard goals, which contribute to its satisfaction. The refinement means that when all the goals in the list are satisfied then the goal in the first argument will be satisfied as well. If one or more goals in the list fail and no other refinement exists where all goals are satisfied, then the goal in the first argument will fail too. More formally, we introduce the predicates satisfied: \( \text{GOAL} \) and failed: \( \text{GOAL} \) to express the satisfaction state of a goal and these predicates can then be used to formulate the following axioms:

\[
\forall l: \text{AND\_GOAL\_LIST} \text{ is\_refined\_to}(g, l) \& (\forall gi:\text{GOAL} \text{ is\_in\_goal\_list}(gi,l) \Rightarrow \text{satisfied}(gi)) \\
\Rightarrow \text{satisfied}(g)
\]

\[
\forall l: \text{AND\_GOAL\_LIST} (\text{is\_refined\_to}(g, l) \Rightarrow \exists gi: \text{GOAL} \text{ is\_in\_goal\_list}(gi, l) \& \text{failed}(gi)) \\
\Rightarrow \text{failed}(g)
\]

where \( \text{is\_in\_goal\_list} \): \( \text{GOAL} \times \text{GOAL\_LIST} \) expresses that a goal is in a goal list. Sort \( \text{AND\_GOAL\_LIST} \) is a subsort of \( \text{GOAL\_LIST} \), which contains names of all goal lists.

\( \text{is\_subgoal\_of} \): \( \text{GOAL} \times \text{GOAL} \): The first argument is a goal which is a subgoal of the goal in the second argument, i.e., it takes part in a refinement list of the second goal.

The relation between \( \text{is\_in\_goal\_list} \) and \( \text{is\_subgoal\_of} \) is established by the following axiom expressing that if the goal \( G2 \) is refined into the list \( L \), and \( G1 \) is one of the goals in the list \( L \), then \( G1 \) is a subgoal of \( G2 \):

\[
\forall G1, G2: \text{GOAL}, \forall L:\text{GOAL\_LIST} : \text{is\_in\_goal\_list}(G1, L) \& \text{is\_refined\_to}(G2, L) \\
\Rightarrow \text{is\_subgoal\_of}(G1, G2)
\]

When more than one refinements are defined, they are considered as alternatives connected by OR, i.e., they allow a choice, which measures to take to satisfy the goal.

The refinement of hard and soft goals will be illustrated in the context of the goal structure given in Figure 2. This structure is constructed from the most important and relevant goals related to the planning process of the company considered in the case study. The detailed description for the goals of this structure is given in Appendix A.

**Example:**

In Figure 2 the hard goal G3.1.1 “It is required to achieve that the number of times the planning activities (creating and updating of a plan) exceed the allowed durations is equal to 0” is refined into the and-list that consists of goals G3.1.1.1 “It is required to achieve that the time to update a short-term plan given operational
data is at most 48 hours”, G3.1.1.2 “It is required to achieve that the time to create a daily plan given operational data is at most 24 hours”, G3.1.1.3 “It is required to achieve that the time to create a short-term plan after all operational data is received is at most a week”, and G3.1.1.4 “It is required to achieve that the time to create a forward plan after all operational data is received is at most a week”. This refinement is formally defined by the following relations:

\[
\begin{align*}
&\text{is\_in\_goal\_list}(G3.1.1.1, L) \\
&\text{is\_in\_goal\_list}(G3.1.1.2, L) \\
&\text{is\_in\_goal\_list}(G3.1.1.3, L) \\
&\text{is\_in\_goal\_list}(G3.1.1.4, L) \\
&\text{is\_refined\_to}(G3.1.1, L) \\
&\text{is\_subgoal\_of}(G3.1.1.1, G3.1.1) \\
&\text{is\_subgoal\_of}(G3.1.1.2, G3.1.1)
\end{align*}
\]

\[\text{Figure 2.} \text{ A partial goal structure for the considered case study (for a detailed description of goals see Appendix A).}\]
Goal and PIs structures are closely related to each other. In particular, if goals are related by the refinement relation, then the corresponding PIs are related by a causality relation. This is expressed by the following axiom, where $\text{EFFECT} = \{\text{very_negative, negative, positive, very_positive}\}$:

$$\forall G_1, G_2: \text{GOAL}, \forall L: \text{GOAL}\_\text{LIST} \forall \text{GP}_1, \text{GP}_2: \text{GOAL}\_\text{PATTERN} \forall \text{P}_1, \text{P}_2: \text{PI}:$$

$$\text{is\_in\_goal\_list}(G_1, L) \land \text{is\_refined\_to}(G_2, L) \land \text{is\_based\_on}(	ext{GP}_1, \text{P}_1) \land \text{is\_formulated\_over}(G_1, \text{GP}_1) \land \text{is\_based\_on}(	ext{GP}_2, \text{P}_2) \land \text{is\_formulated\_over}(G_2, \text{GP}_2) \Rightarrow \exists \text{pn}: \text{EFFECT causing}(	ext{P}_1, \text{P}_2, \text{pn}).$$

Now let us consider the refinement of soft goals. Since the satisfaction of soft goals cannot be established in a clear-cut way, the process of refinement of soft goals also differs from the refinement of hard goals. It is more difficult to clearly define decomposition for soft goals. Instead we talk about positive contribution from other goals in the satisfaction of the goal to be refined. Such contribution can vary in its degree (i.e. strength) which is expressed by the following relations, in which the goal in the second argument is soft and the goal in the first argument can be soft or hard:

$satisfies$: $\text{GOAL} \times \text{GOAL}$: The first goal strongly contributes in a positive way to the satisficing of the second goal. If the first goal is satisfi(ed) and any other influences are ignored then the second goal is considered satisficed.

$contributes\_to$: $\text{GOAL} \times \text{GOAL}$: The first goal contributes positively to the satisficing of the second goal, however might not be enough to satisfice it.

The precise meaning of these relations is defined through the propagation rules defined for goals related by refinement. These rules are used to determine the degree of satisfaction/satisficing of a higher level goal (specified by a label) based on the available information about the degrees of satisfaction/satisficing of lower level goals in its refinement. To determine the label of a higher level goal, first the propagated labels from lower level goals of the refinement list are determined using Table 1. Then, the propagated labels are combined depending on the type of the refinement list to determine the label of the higher level goal.

**Table 1.** The table for determining the propagated labels for a higher level goal based on the satisfaction/satisficing labels of lower level contributing goals and types of contributing links.

<table>
<thead>
<tr>
<th>Label of contributing goal \ Type of link</th>
<th>satisfies</th>
<th>contributes_to</th>
</tr>
</thead>
<tbody>
<tr>
<td>satisfied / satisfied</td>
<td>satisfied</td>
<td>weakly_satisfied</td>
</tr>
<tr>
<td>weakly_satisfied</td>
<td>weakly_satisfied</td>
<td>undetermined</td>
</tr>
<tr>
<td>undetermined</td>
<td>undetermined</td>
<td>undetermined</td>
</tr>
<tr>
<td>weakly_denied</td>
<td>weakly_denied</td>
<td>undetermined</td>
</tr>
<tr>
<td>denied / failed</td>
<td>denied</td>
<td>weakly_denied</td>
</tr>
</tbody>
</table>

Lower level goals can be combined using *and*- and *balanced contribution* relations in lists which contribute positively to the satisficing of the higher level soft goal.
**has_influence_from**: `GOAL \times GOAL_LIST`: The goals in the list contribute positively to the satisfying of the soft goal in the first argument. For each goal in the list it is defined separately what the level is of its contribution (the type of the link) using the above defined relations satisfies and contributes_to.

The combination of goals in an and-list implies that if all goals in the list are satisfied then the higher level goal will also be satisfied. In order to ensure this the following constraint is enforced: at least one of the goals in an and-list is connected with a link of the type satisfies to the higher level goal. When lower level goals are combined in an and-list, the label of a higher level goal is defined by the minimal label propagated from the goals in this list using the defined order between the labels.

**Example**

Consider the refinement of the goal G1 “It is required to maintain that the level of correctness of plans with respect to the contracts of the employees, CAO, de Arbeidstijdenwet (Dutch labor legislation), the general company policy /the policy of the business unit Security is very high” in the goal structure (Figure 2). G1 is refined into the and-list L that consists of three soft goals G1.1, G1.2 and G1.3. All goals in the list L are connected to G1 through a satisfies-link. It means that all subgoals of G1 are equally important for the satisfaction of G1. Note that all contribution relations of soft goals in the goal structure in Figure 2 are of type satisfies. This is because for this case study only the most essential goals, satisfaction of which considerably influences the productivity of the organization, have been chosen. The refinement of G1 is formalized by the following relations:

- `is_in_goal_list(G1.1, L)`
- `is_in_goal_list(G1.2, L)`
- `is_in_goal_list(G1.3, L)`
- `has_influence_from(G1, L)`
- `satisfies(G1.1, G1)`
- `satisfies(G1.2, G1)`
- `satisfies(G1.3, G1)`

Furthermore, let us have the levels of satisfying of G1.1, G1.2 and G1.3 based on measurement and observation. They are assessed to be as follows: G1.1 is satisfied, G1.2 is weakly satisfied, G1.3 is weakly denied. We can now propagate this knowledge taking into account the type of the links using the Table 1 in order to find out the level of satisfying of G1. The propagation for G1.1 results in the label satisfied, for G1.2 – the label weakly_satisfied, and for G1.3 – the label weakly_denied. Taking the minimal label we conclude that goal list L propagates weakly_denied.

Another kind of relation between goals represents balanced contribution which gives us the possibility to describe more fine-tuned ways of contributing which favour the majority influence. The rule that is used to calculate the exact effect first quantifies the propagated labels of lower level goals and then takes the (weighted) average which is subsequently discretized again to the closest label, resulting in the sought label for the higher level soft goal. The quantification scale for the propagated labels may
look as follows: $satisfied = 2$, $weakly\_satisfied = 1$, $undetermined = 0$, $weakly\_denied = -1$, $denied = -2$.
Then, to fine-tune influences that the lower level goals from the balanced list (and thus, the propagated labels) have on the determination of the label for the higher level goal, weights can be assigned for the lower level goals in the list. Let the quantified propagated labels from the goals in the balanced list be $g_i$ and the weights defined for each goal in the list are $w_i$. Then the influence of the balanced list on the higher level goal is calculated using a formula of the type: $\Sigma w_i g_i / \Sigma w_i$.

To specify the weight of a goal in a balanced list the relation $has\_weight\_in\_list$: \text{GOAL} \times \text{INTEGER} \times \text{BAL\_GOAL\_LIST}$ is defined.

When a goal is refined in one list only then the influence calculated using the described above rules defines the satisficing label of the goal. Sometimes a goal is refined into alternative influence lists related by OR. This reflects the knowledge that these lists are in conflict or competition and if one is satisficed then the probability that the rest will also be satisficed is lower. In such situations we use the following strategy: first the influences of the and- and balanced lists are calculated separately and then the highest among them label is assigned to the higher level goal.

**Example**

Consider the refinement of the goal G2 “It is required to maintain high effectiveness of allocation of security officers” (see Figure 2). G2 is refined into the balanced list L of three soft goals G2.1 “It is required to maintain high average correctness of produced plans”, G2.2 “It is required to maintain high level of correctness of administrative processing of all planning data in the system”, and G2.3 “It is required to maintain low average level of deviation from daily plans in their application”. All goals in the list L are connected to G2 through a satisfices link. Furthermore, weights for goals in L are defined: 2 for both G2.1 and G2.3, and 1 for G2.2. Formally:

- is\_in\_goal\_list(G2.1, L)
- is\_in\_goal\_list(G2.2, L)
- is\_in\_goal\_list(G2.3, L)
- satisfices(G2.1, G2)
- satisfices(G2.2, G2)
- satisfices(G2.3, G2)
- has\_influence\_from(G2, L)
- has\_weight\_in\_list(G2.1, 2, L)
- has\_weight\_in\_list(G2.2, 1, L)
- has\_weight\_in\_list(G2.3, 2, L)

Let us assume that the degrees of satisficing of the lower-level goals G2.1, G2.2 and G2.3 are known. Let G2.1 be $satisfied$ and G2.2 and G2.3 be $weakly\_satisfied$. Then, using the Table 1 the propagated labels are obtained: $satisfied$ for G2.1 and $weakly\_satisfied$ for both G2.2 and G2.3. The la-
bels are quantified so that the degree of satisficing of G2.1 is considered 2 and the degree of satisficing of G2.2 and G2.3 is considered 1.

Then, the degree of satisficing of G2 is calculated as $(2*2+1+1*2)/5 = 1.4$ which we round up to 1 (which corresponds to weakly satisfied in our scale).

Apart from the refinement links discussed so far, we can also define conflicts, which represent negative relations between (hard or soft) goals or lists of goals.

**conflicts with:** AND_GOAL_LIST × AND_GOAL_LIST: Represents joint negative effect between lists of goals, i.e., the goals in both lists cannot be satisfi(c)ed or weakly satisficed at the same time. More precisely, if all goals in one list are satisfi(c)ed then at least one goal in the other is failed or denied; if all goals in one list are at least weakly satisficed, at least one goal in the other is at most weakly denied.

**weakly conflicts with:** AND_GOAL_LIST × AND_GOAL_LIST: Represents weak joint negative effect between lists of goals, i.e., the goals in both lists cannot be satisfi(c)ed at the same time. More precisely, if all goals in one list are satisfi(c)ed then at least one goal in the other is at most weakly denied; if all goals in one list are at least weakly satisficed then at least one goal in the other is at most weakly satisficed.

Conflicts can be defined at each two levels of the goal structure, however if the hierarchy is sufficiently complete then these conflicts should be propagated through the goal refinement to the lowest level at which the sources of these conflict can be found. Conflicts can also be used at the analysis and evaluation phases by propagating satisfaction labels bottom-up when only partial information is available. For example let goals $g_1$ and $g_2$ be in conflict at the lowest level of the goals structure and let $g_1$ be known to be satisfied. Then if the satisfaction label of $g_2$ is not known it can be assumed to be at most weakly denied if $g_2$ is soft and failed if $g_2$ is a hard goal. If however it is known that $g_2$ is satisfi(c)ed then that points at an inconsistency in the model.

In the goal structure given in Figure 2 no conflicts between goals are present. However, in the past the considered in the case study organization contained conflicts between its general company goals and low level goals of its subdivisions, which caused the inefficient operation of the company. For example, the high-level goal of the company “It is required to maintain high effectiveness of allocation of security officers within the organization” was in conflict with the goal “It is required to maintain high level of independency (autonomy) of all area planning teams from each other”. The conflict was identified in the refinement of these goals: it is often the case that in order to create an effective plan in one area, data about the available and scheduled employees from other areas were needed. Without cooperation the autonomous area planning teams often created inefficient plans, which suffered from the shortage of information. For example, plans for a certain area were created on the basis of the shortage of security officers in this area, whereas in other areas available (not scheduled) employees were in plenty.
5. Goal-based Performance evaluation

The explicit identification of PIs in the structure of goal expressions and the satisfaction propagation mechanisms in goal hierarchies described in the previous Section 4 provide means for the evaluation of organizational performance, which are described in this Section.

Consider the process of goal-based performance evaluation in detail. Every task performed in an organization contributes to the satisfaction of a certain organizational goal(s). Each goal is formed based on a PI(s). This PI(s) can be measured (directly or indirectly) during or after the task execution depending on the goal evaluation type, in the end or during a certain period of time (an evaluation period defined as a goal horizon). Then, by comparing the measured value(s) with the goal expression(s), the satisfaction (degree of satisficing) of the goal(s) is determined. Further, the obtained goal satisfaction (satisficing) measure is propagated by applying the rules defined in Section 4, upwards in the goal hierarchy for determining the satisfaction (degree of satisficing) of higher level goals. Thus, the organizational performance is evaluated by determining the satisfaction (degree of satisficing) of key organizational goals. The same principles can be applied for evaluation of agent performance.

As illustration of the proposed performance evaluation procedure consider the evaluation of satisfaction of one of the most important organizational goals from the case study – goal G3.1 “It is required to maintain high efficiency of the planning process”. Figure 2 shows the refinement of G3.1 into a balanced list of more specific goals: the hard goal G3.1.1 and the soft goal G3.1.2. Goal G3.1.1 has the weight 3 in the list and G3.1.2 has the weight 2. Furthermore, the goal G3.1.1 is refined into an and-list that consists of four hard goals and G3.1.2 is refined into an and-list of two soft goals and one hard goal. The lowest level goals (goals corresponding to the leaves) of this structure are related to tasks from the task structure created for the organization from the case study. Since task modelling is out of scope of this paper, only names of some tasks from the task structure will be used here. The lowest level goals, their PIs and the corresponding tasks for the considered example are given in Table 2.

<table>
<thead>
<tr>
<th>Goal name</th>
<th>Goal definition</th>
<th>PI</th>
<th>Related task</th>
<th>Level of goal satisfaction/satisficing</th>
</tr>
</thead>
<tbody>
<tr>
<td>G3.1.1.1 (hard)</td>
<td>It is required to achieve that the time to update a short-term plan given operational data is at most 48 hours</td>
<td>The time to update a short-term plan given operational data</td>
<td>update_shortterm_plan</td>
<td>satisfied</td>
</tr>
<tr>
<td>G3.1.1.2 (hard)</td>
<td>It is required to achieve that the time to create a daily plan given operational data is at most 24</td>
<td>The time to create a daily plan given operational data</td>
<td>create_daily_plan</td>
<td>satisfied</td>
</tr>
<tr>
<td>Goal</td>
<td>Description</td>
<td>PI</td>
<td>Satisfaction</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>----</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>G 3.1.1.3</td>
<td>It is required to achieve that the time to create a short-term plan after all operational data is received is at most a week</td>
<td>The time to create a short-term plan after all operational data is received</td>
<td>create_shortterm_plan</td>
<td>satisfied</td>
</tr>
<tr>
<td>G 3.1.1.4</td>
<td>It is required to achieve that the time to create a forward plan after all operational data is received is at most a week</td>
<td>The time to create a forward plan after all operational data is received</td>
<td>create_forward_plan</td>
<td>satisfied</td>
</tr>
<tr>
<td>G 3.1.2.1</td>
<td>It is required to achieve high level of promptness of communication of every produced forward plan to all concerned employees</td>
<td>The level of promptness of communication of every produced forward plan to all concerned employees</td>
<td>inform_all_concerned_about_forward_plan</td>
<td>weakly_satisfied</td>
</tr>
<tr>
<td>G 3.1.2.2</td>
<td>It is required to achieve high level of promptness of communication of every produced short-term plan to all concerned employees</td>
<td>The level of promptness of communication of every produced short-term plan to all concerned employees</td>
<td>inform_all_concerned_about_shortterm_plan</td>
<td>weakly_satisfied</td>
</tr>
<tr>
<td>G 3.1.2.3</td>
<td>It is required to achieve that the number of concerned security officers not informed on time about the produced daily plan is zero</td>
<td>The number of concerned security officers not informed on time about the produced daily plan</td>
<td>inform_all_concerned_about_daily_plan</td>
<td>satisfied</td>
</tr>
</tbody>
</table>

Furthermore, for each goal in this table the level of satisfaction is identified. This is done by measuring the values of the PIs, on which these goals are based, during or after the task execution. For most of the hard goals these data can be extracted from the log-files and databases of the enterprise management system, and thus the satisfaction of the goals can be directly determined. On the contrary, the level of satisficing of soft goals is often difficult to identify, since they are based on soft PIs. In order to evaluate a soft PI it is usually beneficial to find a closely related hard indicator that can be measured instead and that can give an impression on the state of the soft one. For example, to estimate the soft PI “The level of promptness of communication of every produced forward plan to all concerned employees”, on which the goal G 3.1.3.1 is based, for every forward plan the time interval between the moment when the plan is created and the moment when it is communicated to all concerned employees is measured. In
10-15% of all cases, this interval was longer than it is allowed by company’s regulations. By the choice of the designer, this corresponds to the weakly_satisfied label for the goal G 3.1.3.1.

By applying the propagation rules, the label for the goal G3.1.1 is determined as satisfied, and for the goal G3.1.2 – as weakly_satisfied. For the calculation of the propagated label for the goal G3.1 resulted from the balanced list, the following quantification scale is used: satisfied/satisfied = 3, weakly_satisfied = 1, undetermined = 0, weakly_denied = -1, denied/failed = -3. Then, the degree of satisficing of G3.1 is calculated as (3*3 + 1*2)/5=2.2, which corresponds more closely to the label satisfied, which gives a strong positive evaluation of the overall organizational performance.

6. Methodological issues in the Design of Goal Structures

In this Section some techniques for building a consistent goal hierarchy are described. Since in the proposed framework goals are based on PIs and are related to other concepts (e.g., roles and tasks), many of the methodological issues with respect to goals will be considered in relation to these concepts.

Usually, high level goals of a company are of a strategic (long-term) type. Such goals are often made operational by refining them into lower level tactical (short-term) goals. In such a way a goal-structure is created by a top-down design process. The refinement of goals may proceed until subgoals are found, which could be realized by (possibly single) lowest-level tasks from the task hierarchy. In practice, the top-down design approach is often combined with the bottom-up approach, which is performed by aggregation of goals. For example, in the goal elicitation approach described in [4] sub-goals are identified by asking “how” questions about the goals already determined, and parent goals are identified by asking “why” questions.

To fine-tune goal and task structures, and relations between them at the design phase, backwards reasoning approaches on a goal structure [10] can be used. These approaches are particularly useful for the analysis of cases of a soft goal refinement. More specifically, given that a higher level soft goal is required to be satisfied to a certain degree, and provided the type of a list into which this goal is refined (i.e., and or balanced) and types of refinement links between goals, it is possible to determine the least degree of satisfaction of the lower level goals from the refinement list. This information constitutes constrains on lower-level goals that can be used for the revision or (re)formulation of goals and corresponding tasks, and relations between them.

Furthermore, relations between goals can be identified by using relations in the corresponding PIs structures [17]. In PIs structures different types of relationships between PIs are identified: e.g., causality, correlation and aggregation. A refinement relation between goals often corresponds to a causality relation between the corresponding PIs on which these goals are based. For example, in the goal structure in Figure 2 goals G2.3.1 and G2.3.1.4 are related by refinement, whereas the corresponding
PIs “the level of deviation from the produced daily plan in its application” (for G2.3.1) and “the level of correctness of data change forms delivered to the planners” (for G2.3.1.4) are related by a negative causality relation in the PI structure developed for this case study. This means that the higher is the level of correctness of data change forms delivered to the planners, the less is the level of deviation from the produced daily plan in its application. Furthermore, a goal refinement relation may also correspond to an aggregation relation in a PI structure. For example, goals G2.1 and G2.1.1 are related by refinement and their corresponding PIs are related by aggregation. Note that an aggregation relation also assumes a positive correlation.

Since goal and PI structures are closely related, it is important to guarantee consistency and correspondence of these structures to each other. For this a dedicated consistency check can be performed, based on the following principle. If goals are related by the refinement relation, then the PIs corresponding to these goals are related by a certain (positive or negative) causality relation. To determine the exact type of causality, goal expressions should be analyzed. If the PI expressions for goals related by refinement, contain an equality relation (“=”) over comparable (or opposite) measures of degrees (i.e., high/low, maximal/minimal) of some variables, then the corresponding PIs are most probably related by positive (or negative) causality relation. Comparison functions (i.e., ‘>’, ‘<’) or change functions (i.e., ‘increased’, ‘decreased’) in PI expressions can be treated in a similar way. Furthermore, if a precise (mathematical) functional relation between PIs, on which goals in a refinement are based, is known, then the type of the causality relation can be easily determined and used for identifying inconsistencies in the goal structure. Note that since the designer has much of freedom in specifying goal expressions, there is no guarantee that inconsistencies identified in a PI structure are valid. Therefore, all automatically identified inconsistencies in goal and PI structures still need to be confirmed by the designer.

For example, in the case study both goal expressions for G3.1 and for G3.1.2 contain the equality relation to “high”. According to the principles explained above, this corresponds to the positive causality relation between the PIs “efficiency of the planning process” and “level of promptness of communication of forward and short-term planning data to all concerned employees”, which indeed the case in the PI structure.

The identification of conflict relations between goals is of particular importance for the design and the evaluation of organizations. In order to create an effective organization, it is often advised at the early design phase to take into consideration interests and concerns (expressed as goals) of different stakeholders, who will eventually play a role within the organization and will interact with the organization. The stakeholders may have conflicting goals that should be reflected in an organization model being constructed. Furthermore, conflicts may exist in a goal set of a stakeholder. To identify conflicts between goals, the goal patterns and the PIs structure can be used: by knowing the type of a causality relation between PIs and the types of goal patterns, the presence of a conflict between goals can be determined. The goal structure created for the case study does not contain conflicts; therefore, we shall illustrate the principle of conflict identification by assuming hypothetical goals for the company from
the case study: The goal “It is required to maximize the time spent on examining the plan proposal for correctness” and the goal “It is required to minimize the time spent on producing a correct plan” are in conflict, since the corresponding PIs “the time spent on examining the plan proposal for correctness” and “the time spent on producing a correct plan” are related by the positive causality relation, and the corresponding goal patterns are based on the opposite types of functions: maximize and minimize.

If during the design phase a conflict between high level goals is determined, then through the refinement a more precise cause of the conflict can be found at the lowest level of a goal structure. For this the relations between performance indicators and the available domain knowledge are exploited.

For those organization models that do not allow conflicts, the consistency of a model can be achieved by applying different conflict resolution techniques [12, 19]. The common strategy for conflict resolution is based on weakening of goal expressions (e.g., by weakening boundary conditions in the PI expressions; by introducing so-called ‘organizational slacks’). For example, a Planner may have an individual goal to minimize his/her overwork, which is in conflict with the organizational goal G3.1.1.2 “it is required to achieve that the time to create a daily plan given operational data is at most 24 hours”. To be able to create a daily plan within 24 working hours, planners often need to work overtime (due to some other daily occupations), which contradicts his/her own goal. If the company recognizes the importance (i.e., gives a high level of priority) of the individual goal of the Planner, the organizational goal G3.1.1.2 could be weakened by allowing 28 hours for the accomplishment of a daily plan.

This example shows the importance of the goal priority attribute for the process of conflict resolution. For example, it can be used to determine which goal can be modified to a greater degree or even deleted from a model. In general organization goals have the higher priority than individual goals of agents. Therefore, in order to fit into the organization, an agent sometimes needs to adjust her/his own goals to the organizational ones. On the other hand, sometimes priorities of goals of an agent (e.g., important customer, government) can be so high that the organization decides to revise its goal structure to ensure the satisfiability of agent goals.

For negotiable goals conflicts can be solved by negotiations among the stakeholders, to whom the goals are related [19].

7. Related Work on Goal-Oriented Modelling

Goal-oriented modelling is given a special place in the area of enterprise engineering. Often both organizational and individual goals of the involved actors are considered and distinctions are made between the goals originating from different stakeholders.

Some aspects of our definition of a goal are inspired and come close to existing state-of-the-art approaches in enterprise modelling and requirement engineering [4, 6, 9, 11, 20]. There are however sig-
nificant differences as well which will be pointed out here. Our analysis pinpointed the following approaches as most relevant – CIMOSA [2], TOVE [5], i* [20], Tropos [1, 7], goal-oriented agent-based models [8], KAOS [4], the NFR framework [16] ordered roughly in an increasing degree of relevance to this discussion.

In CIMOSA the notion of objectives is used to represent business goals for a particular domain (i.e. a part of the enterprise). No relationships between the objectives are defined therefore no hierarchy of objectives is built. No distinction is made between hard and soft goals. Also in the TOVE model no distinction is made between hard and soft goals. Goals can be decomposed in AND/OR subgoal trees.

The i* approach focuses on the dependency relationships between the actors. A Strategic Rationale model is built on the level of each actor where its internal reasoning on the relationships between goals, tasks and resources can be modelled. The approach recognises both hard and soft goals and defines a (soft)goal dependency relationships between actors w.r.t. (soft)goals expressing that one actor depends on another to make a condition in the world come true. The goals are only informally specified; no format and unified representation is enforced. The goals hierarchy is coupled to the tasks hierarchy as tasks can be decomposed to goals and tasks. Positive and negative contribution to a different degree of tasks/goals to soft goals are modelled using contribution links. Tropos is a methodology for agent-oriented software development based on i* thus goals are treated in the similar way as in i*. The extension Formal Tropos [7] uses a temporal specification language inspired by KAOS.

The agent-oriented enterprise meta-model presented in [8] defines a goal as a desired or undesired state of the environment which is described by states of objects (beliefs, authorisations, resources, etc.). Goals can be refined into alternative sets of other goals using AND/OR relationships. Distinction is made between operational and soft goals – plans can fulfil operational goals but can only contribute positively or negatively to soft goals. Goals can also be organizational or personal. A dependency relationship between organizational roles for the fulfilment of organizational goals is defined.

Moreover, the motivational concept of a goal has been often used for specifying attitudes of agents in multi-agent systems [3, 13]. Usually agent goals are specified as declarative concepts in (modal) logical specifications that describe states of the agent system, which are desirable and could be realized (achieved) by the agent. Often goals are related to other motivational attitudes of agents, such as beliefs, desires and intentions [18]. Moreover, declarative goals are often operationalized in agent programming languages by sequences of actions or plans [13]. Then, the distinction between goals and tasks, essential for the framework proposed in this paper, is not tangible any more.

The KAOS methodology focuses on requirements elaboration and provides support in connecting high-level goals to operations, objects and constraints to be implemented by the software. A goal is defined as an objective to be achieved by the system while an operational objective is called a constraint. Goals and constraints are defined formally using the patterns achieve, cease, maintain, avoid and optimize which are reused in our approach in the notion of a goal pattern. A difference is that the goal pattern in our approach is based on a PI expression. Soft goals are not considered in KAOS. Goals are
structured and operationalized to constraints in AND/OR graphs. Temporal logic is used to define the goals and their relationships. In our approach a wider set of goals is considered, some of which cannot be expressed as temporal logic formulae. This reflects the way organizations define their goals in practice.

The NFR framework focuses on the representation of non-functional requirements on the designed software system through interrelated goals. Three types of goals are defined: NFR, satisficing and argumentation goals. The last two model design decisions and arguments resp. and are hence irrelevant for this discussion. The NFR goals are soft goals which can be refined using different types of relationships describing how the satisficing of the offspring relates to the satisficing of the parent goal. A labelling procedure is defined for determining the degree of satisficing of each node in the goal structure. The label propagation procedure used in our approach is inspired by but different from the one used in the NFR framework. We consider only positive refinement links. The negative links are modelled using conflict links. Furthermore, we enrich the refinement structure with one more relation in addition to AND and OR representing balanced contribution and providing tools for finer definition of how a set of goals together contributes to the satisficing of the higher-level goal.

8. Conclusions

This paper presents a formal goal-oriented modelling approach in the context of the performance-oriented view on organizations. The proposed approach is based on the essential idea that goals expressions should be explicitly defined over performance indicators of an organization. In such a way, a clear-cut relation between organizational objectives and performance measurements is established. The proposed approach includes a diverse vocabulary to express goal-related concepts and relations. Goals are classified along different dimensions: in particular, hardness (hard and soft) and ownership (organizational and individual). Furthermore, the mechanisms for identifying (the level of) satisfaction/satisficing of goals are defined in the paper, where a special attention is given to the propagation of satisficing labels for soft goals. Often the estimation (evaluation) of soft goals is not straightforward. The paper proposes various means for fine-tuned modelling and evaluation of soft goals, among which the possibility to define different degrees of satisficing of goals and contributions in goal structures (including a balanced list), a variable quantification scale used for the performance evaluation. The potential downside of such expressivity and design freedom is that some organizational models may suffer from the subjectivity of the designer with respect to the choice of scales and types of influences. Because of the high domain dependency, it is difficult to formulate general design principles to specify soft parts of a model and to verify the correctness of certain design choices afterwards. However, some work has been done [14] to apply probabilistic reasoning and statistics based on accumulated data about organizational processes from the past to justify the correctness of the designed
model. However, such information is not always available or cannot be used, e.g., when new (or modified) organizational structure and processes are considered. One reasonable suggestion to decrease the level of subjectivity of a designed model is to involve different organizational stakeholders (modellers, domain experts) in the process of determining quantitative measures and degrees of influence for soft parts of the model. Furthermore, performing simulations based on an organizational model with different parameters related to soft goals is helpful for identifying an acceptable design.

Further, the paper presents some guidelines and techniques for building consistent goal structures. For this relations to other concepts from the related views (such as PIs, tasks) are used. To create a consistent and correct model for an organization for any view, interdependencies with other related views should be identified and employed already at the early design stage. For example, organizational goals often have a great impact on the form of an organizational structure (i.e., choice of roles and relations between them), thus this should be reflected in an organization-oriented model for an organization. A detailed description of other views as well as design and analysis issues that concern relations between views are not considered in this paper and will be described elsewhere.

References

Appendix A. A specification of goals for the case study

name: G1
informal definition: It is required to maintain that the level of correctness of plans with respect to the contracts of the employees, CAO, de Arbeidstijdenwet, the general company policy, the policy of the business unit Security is very high.
priority: very high
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: non-negotiable
perspective: society

name: G1.1
informal definition: It is required to maintain that the level of knowledge of employees involved in (forward) planning about the current contracts of the employees, CAO, de Arbeidstijdenwet, the general company policy, the policy of business unit Security is very high.
priority: very high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: non-negotiable
perspective: society

name: G1.2
informal definition: It is required to maintain that the level of up-to-dateness of the software system used in (forward and daily) planning with respect to the contracts of the employees, CAO, de Arbeidstijdenwet, the general policy of Falck/the policy of BU Security is very high.
priority: very high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: non-negotiable
perspective: society

G1.3 = G2.2
name: G2
informal definition: It is required to maintain high effectiveness of allocation of security officers
priority: high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management, customer

name: G 2.1
informal definition: It is required to maintain high average correctness of produced plans.
priority: high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 2.1.1
informal definition: It is required to achieve high level of correctness of every produced plan.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 2.1.1.1
informal definition: It is required to achieve high level of correctness of every produced forward plan.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management
name: G 2.1.1.2
informal definition: It is required to achieve high level of correctness of every produced daily plan.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 2.1.1.3
informal definition: It is required to achieve high level of correctness of every produced short-term plan.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 2.2
informal definition: It is required to maintain high level of correctness of administrative processing of all planning data in the system.
priority: high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 2.2.1
informal definition: It is required to maintain high level of correctness of administrative processing of forward planning data in the system.
priority: high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: negotiable
name: G 2.2.2
informal definition: It is required to maintain high level of correctness of administrative processing of short-term and daily planning data in the system.
priority: high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 2.3
informal definition: It is required to maintain low average level of deviation from daily plans in their application.
priority: high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G2.3.1
informal definition: It is required to achieve low level of deviation from the produced daily plan in its application.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 2.3.1.1
informal definition: It is required to achieve that the number of concerned security officers not informed on time about the produced daily plan is zero.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: hard
negotiability: negotiable
perspective: management

name: G 2.3.1.2
informal definition: It is required to achieve that the promptness of data change forms delivery by security officers is very high
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 2.3.1.3
informal definition: It is required to achieve that the promptness of data change forms delivery to the planners is very high
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 2.3.1.4
informal definition: It is required to achieve that the level of correctness of data change forms delivered to the planners is very high
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 3
informal definition: It is required to maintain high efficiency of planning and allocation of security officers
name: **G 3.1**
informal definition: It is required to maintain high efficiency of the planning process.
priority: high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: **G 3.1.1**
informal definition: It is required to achieve that the number of times the planning activities (creating and updating of a plan) exceed the allowed durations is equal to 0.
priority: high
horizon: long-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: hard
negotiability: negotiable
perspective: management

name: **G 3.1.1.1**
informal definition: It is required to achieve that the time to update a short-term plan given operational data is at most 48 hours.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: hard
negotiability: negotiable
perspective: management
name: **G 3.1.1.2**
informal definition: It is required to achieve that the time to create a daily plan given operational data is at most 24 hours.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: hard
negotiability: negotiable
perspective: management

name: **G 3.1.1.3**
informal definition: It is required to achieve that the time to create a short-term plan after all operational data is received is at most a week.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: hard
negotiability: negotiable
perspective: management

name: **G 3.1.1.4**
informal definition: It is required to achieve that the time to create a forward plan after all operational data is received is at most a week.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: hard
negotiability: negotiable
perspective: management

name: **G 3.1.2**
informal definition: It is required to maintain high level of promptness of communication of forward, short-term and daily planning data to all concerned employees.
priority: high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
name: G 3.1.2.1
informal definition: It is required to achieve high level of promptness of communication of every produced forward plan to all concerned employees.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 3.1.2.2
informal definition: It is required to achieve high level of promptness of communication of every produced short-term plan to all concerned employees.
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

G 3.1.2.3 = G 2.3.1.1

name: G 3.2
informal definition: It is required to maintain high efficiency of allocation of security officers
priority: high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 3.2.1
informal definition: It is required to maintain high average level of optimality of forward, short-term and daily planning for efficient allocation of security officers
priority: high
horizon: long-term
evaluation type: development goal (maintain)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 3.2.1.1
informal definition: It is required to achieve high level of optimality of every daily plan for efficient allocation of security officers
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 3.2.1.2
informal definition: It is required to achieve high level of optimality of every forward plan for efficient allocation of security officers
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management

name: G 3.2.1.3
informal definition: It is required to achieve high level of optimality of every short-term plan for efficient allocation of security officers
priority: high
horizon: short-term
evaluation type: achievement goal (achieve)
ownership: organisational
hardness: soft
negotiability: negotiable
perspective: management