

Defining and Monitoring Strategically Aligned Software Improvement Goals

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Abstract. Software engineers are always aiming at improving software processes and products. However, the adoption of these improvements on software organizations must be aligned to their strategic goals. Otherwise, these improvements may not improve the organization. However, to guarantee this alignment can be complex, since improvement initiatives would have to be planned and monitored considering aspects starting from strategic level and going all the way to the organization daily operations. Thus, this work presents an approach to define and monitor software improvement goals, which are decompositions of strategic goals and are related to software products or processes. Our approach comprises strategic, tactical and operational planning activities, always aiming at strategic alignment. As important tools to monitor the goals defined, software measurement and statistical process control are also considered. An infrastructure to monitor the goals is described, and also an experience of use of the approach at a Brazilian software development organization.

Keywords: Software Improvement Goal, Strategic Planning, Software Process.

1 Introduction

The increase of demand for high quality software products has forced organizations to find out alternatives to improve their products, including the improvement of their software processes. However, the search for better software processes and products without aligning them to business goals can be insufficient. Software process improvement initiatives have to be consistent with business goals of an organization and also with its business strategy [1].

Although the literature highlights the need for strategic alignment in software process improvement [2], [3], [4], [5], [6], achieving this alignment may be difficult. Even existent software reference models, such as CMMI-DEV [5], do not provide proper guidance on how organizations should define their processes based on their strategic priorities. As a result, although the practices suggested by the models may be successfully deployed in an organization, there is no guarantee that they will satisfy business goals [2]. Moreover, translating business goals into actions and more specific plans that can be enacted in projects can be difficult, mainly when there is no specification of the steps to be followed.

In this context, we define a software improvement goal as a decomposition of a business goal (i.e., it is strategically aligned) which is related to software products or processes and that can guide software process improvement.

One of the ways an organization can control its processes is through the use of statistical process control – SPC. Applying SPC means using statistical methods to analyze processes and provide subsidies for its improvement [5]. Moreover, SPC practices are required by maturity models, like the CMMI-DEV, to achieve their higher maturity levels. Although SPC can be seen as a practice usually performed only by more mature organizations, it can be a powerful tool to determine whether goals are being achieved or not. However, if SPC is adopted in an organization without taking business goals into account, it is possible that the initiative does not satisfy or even conflict with them. In this context, planning software process improvement initiatives that are strategically aligned can be even harder.

Software improvement goals must be measurable, making it possible to frequently check their achievement. If monitoring is not continuous, even if goals are strategically aligned, the effort to define suitable goals can be less beneficial, since it will not be possible to determine if they tend to be achieved. Nowadays, organizations have realized that monitoring and continuously analyzing business performance is crucial to achieve operational excellence, and to better align daily operations with long-term business strategies [7].

In this context, we present an approach that aims to define and monitor software improvement goals promoting their alignment with business goals. Our approach defines a method to support strategic planning activities, tactical planning activities related to software, considering software improvement goals, SPC and software measurement planning, and also project planning activities related to the defined goals. Our approach also defines an infrastructure to monitor the defined goals.

This paper is divided into six sections, including this introduction. Section 2 presents some background concepts and related work on strategic planning and software improvement goals. In Section 3 we present the proposed method to define software improvement goals and Section 4 describes the infrastructure to monitor the defined goals. Section 5 presents the experience of defining software improvement goals at a Brazilian software development organization. Finally, Section 6 presents some conclusions and future work.

2 Strategic Planning and Software Improvement Goals

According to Mintzberg et al. [8], strategic planning can be seen as the definition of goals, investments and plans based on the analysis of strengths, weaknesses, opportunities and threats related to the organization. Each organization can be analyzed in three different levels [9]:

- *Strategic or Top level*: the highest level of the organization, responsible for identifying the business goals and performing strategic planning. This level aims at long term goals.

- *Tactical or Middle level*: the intermediate level responsible for linking the strategic and operational levels, defining tactical goals and performing tactical planning. This level aims at medium term goals.
- *Operational or Low level*: is the basis of the organization and is related to the actual accomplishment of tasks. In this level, operational planning is performed to define the tasks to be done. This level aims at short term goals.

To accomplish strategic planning, one of the possible approaches is to use BSC - Balanced Score Card [10], a framework for describing strategy and managing its execution, linking goals, actions and indicators. BSC recommends an analysis based on performance indicators using four perspectives: (i) Financial; (ii) Customer; (iii) Internal Business Process; and (iv) Learning and Growth.

Aiming at aligning the efforts related to support business goals applied to the context of information technology (IT), COBIT - Control Objectives for Information Technology [11] was proposed. COBIT describes a set of generic business goals and a set of generic IT goals linked to business goals. Although COBIT is a synthesis of good practices about management, measurement and control of business and IT goals, it does not address specifically the software improvement.

Some researchers have investigated how to support and improve strategic planning. Huang [12] presents an integrated approach for the BSC and a knowledge-based system to support strategic planning. In [13] the MECIMPLAN is presented as a methodology to support strategic planning using agents to generate a list of the most possible scenarios, considering some events and their influence and probability.

To achieve what was established by strategic planning we have to implement the strategies at lower levels of the organization. This requires breaking down strategic planning into tactical planning that can be understood and enacted by the middle level [9]. In software organizations, some tactical goals can be related to software while others can be related to other issues like marketing, training and so on. The tactical goals that are related to software usually indicate the organization desires to improve its software processes and products. Thus, in this work, we are considering the tactical goals related to software as the software improvement goals.

Although tactical planning addresses strategic planning translation to the middle level, the actions defined on the tactical level aim at medium term goals. These actions still have to be more detailed to allow their execution on the operational level, which is the operational planning purpose. Sometimes, projects are utilized as a mean to achieve strategic plan of an organization [14]. Specifically in software organizations, operational level is frequently arranged in software projects. Therefore, operational planning usually becomes project planning.

In project planning, one of the first steps is to define project goals. Projects may have a wide variety of goals. They can also include cost, schedule, and quality requirements [14]. Project goals, as operational goals, provide the basis for measuring the progress toward meeting strategic goals [15].

In addition to identify the strategic, tactical and operational goals, it is important to plan how to monitor and control the defined goals. The measurement of a goal is a way to check whether it has been achieved or not [15]. In software organizations, the control of the goals depends on software measures. Thus, these organizations also need to plan how to measure their software processes and products.

An approach for software measurement is Goal Question Metric – GQM [16], which proposes to plan the measurement based on measurement goals. A variant of GQM is the Goal-Question-(Indicator)-Measure - GQ(I)M [17], a measurement method to guide the identification and definition of software measures to support business goals of the organization. This method defines ten steps to explicitly align software measures to business goals. Another software measurement approach is the GQM⁺ Strategies that provides mechanisms for explicitly linking software measurement goals, to higher-level goals for the software organization [18]. These software measurement approaches focus on measurement and they do not intend to guide the execution of strategic planning activities.

Monitoring and controlling the processes is crucial. However it can be difficult to effectively monitor process data, analyze current status, detect and diagnose process anomalies, or take appropriate actions to control the processes [19]. As mentioned earlier, SPC can be used as a mean to monitor software processes. However, SPC may bring some extra complexity to the context of strategically aligned software improvements, since some extra steps need to be performed in this case.

One of the possible ways to continuously monitor processes is to use agents. An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors [20]. Huang et al. [7] propose an agent based system to support business performance monitoring and analysis. An agent based architecture to business performance monitoring is presented in [21].

Although there are several works that deal with strategic planning, goals monitoring, measurement planning and SPC, these works usually do not address these issues together. We believe that an integrated approach that deals with the definition of strategic, tactical and project goals, considering SPC and software measurement, also supporting the monitoring of the defined goals would be of great value for organizations aiming at addressing these questions.

3 Defining Strategically Aligned Software Improvement Goals

Before the definition of software improvement goals, an organization needs to perform its strategic planning, which will provide guidelines to define these goals in a way that they are aligned with business goals. Our approach defines a method that describes steps to plan and monitor the strategic, tactical and operational levels. The method starts on the strategic level, as shown in Fig. 1.

The characterization of the organization is necessary as a guide for the beginning of strategic planning, outlining the expected time period to perceive planning results, and defining the perspectives of the organization to be considered. In this step, the scope of planning and the intervals of short, medium and long term adopted for the organization, considering its specific characteristics are specified.

To make it easier to establish the right focus on critical areas of the organization, some perspectives which focus on specific issues and are interrelated can be defined, making it possible to address each critical area in a balanced way. In our method, the characterization of the organization includes the definition of important perspectives for the organization. As an example, organizations can use the perspectives suggested by BSC.

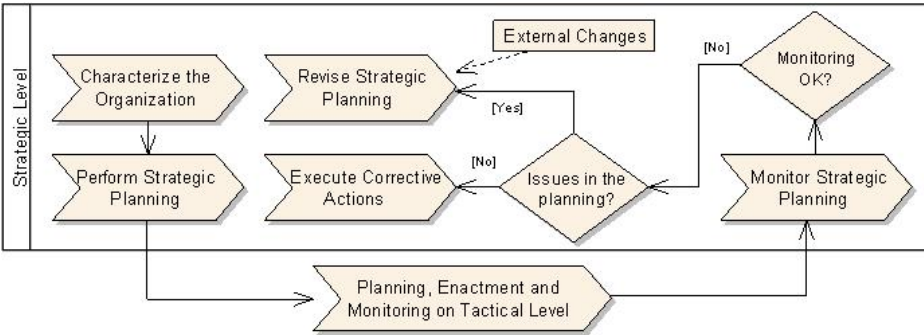


Fig. 1. Context of definition, monitoring and review strategic planning

The next step is to perform strategic planning followed by tactical and operational planning. In the following sections we describe our method considering each level, i.e. strategic, tactical and operational (project). Throughout the description, some examples based on real situations are presented.

3.1 Strategic Planning

In our approach, strategic planning is performed by eight steps, as Fig. 2 illustrates. The first step is the definition of the mission and the vision of the organization, which will guide the definition of strategic goals. The mission of an organization represents its overall purpose and the vision describes what it would like to be, considering a determined time period [9]. After that, the strategic goals and their indicators must be defined. To make it possible to focus on critical areas of the organization, each strategic goal must be related to one perspective, among those that were specifically defined for the organization. To assure balanced perspectives, there must be at least one strategic goal for each perspective defined to the organization.

The definition of a strategic goal must describe the following information: (i) Action: desired action, such as: increase, decrease, improve, maintain; (ii) Action target: what must be affected by the action, for example: revenue, client satisfaction, quality; (iii) Perspective: perspective to analyze the goal, such as financial. Table 1 shows some examples of strategic goals.

In addition to identify the strategic goals, it is important to plan how to continuously monitor them. Therefore, indicators must be identified and related to each strategic goal defined. To promote pro-active monitoring, the description of the indicators specifies the target in three ranges of values: (i) Acceptable range: values are considered within the target and there is no risk of deviation around; (ii) Risk range: values are considered within the target, however, they indicate some risk of deviation around (potential deviation); and (iii) Unacceptable range: values are considered out of the target, pointing a real deviation.

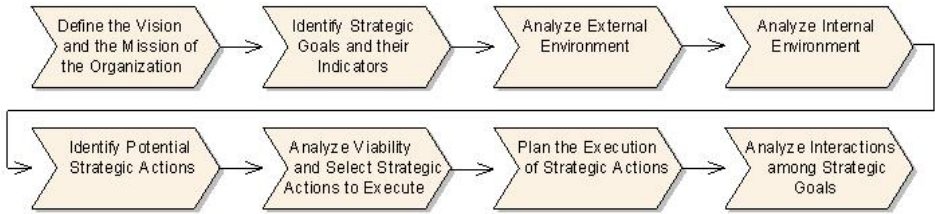


Fig. 2. Strategic planning steps

Depending on the defined indicator, it can be necessary to specify three targets considering the expected results in the short, medium and long term. These targets can be specified in an ad-hoc way, based on historical data or using simulation to identify possible values. A high maturity organization (i.e. the one that performs the practices required by higher levels of maturity models, like the CMMI-DEV) must specify these targets based on knowledge about its processes, acquired using SPC.

Table 1. Examples of strategic goals

Strategic Goals		
Action	Action Target	Perspective
Increase	Revenue	Financial
Increase	Client satisfaction	Client

To facilitate the achievement of strategic goals, it is important to analyze the internal and the external environments of the organization, identifying forces that can contribute or threaten their achievement. The analysis of external environment includes identifying factors or tendencies which are external to the organization and could represent threats or opportunities. Moreover, it is necessary to analyze possible impacts related to each factor: an impact can be positive, identifying an opportunity, or negative, identifying a threat. The analysis of internal environment includes an evaluation of its strengths and weaknesses based on the defined strategic goals.

Strategic goals aim at long term results. Thus it is necessary to decompose them into strategic actions that when executed, make it easier to achieve the strategic goals defined. Strategic actions must aim at achieving strategic goals increasing the opportunities and strengths identified and addressing the threats and weaknesses perceived in external and internal environments analysis. Potential strategic actions should be identified with the participation of professionals from the tactical level. The definition of a strategic action must describe the action, the expected value, the target of the action and the expected contribution for the related strategic goal. This definition must determine if the strategic action is related to software. Table 2 shows examples of these actions.

Table 2. Examples of strategic actions

Strategic Goal:		Improve client satisfaction		
Strategic Actions		Contribution	Software Related	
Decrease	20%	Software products price	40%	Yes
Improve	-	Software products quality	30%	Yes
Decrease	15%	Time to market	20%	Yes
Improve	-	Client attendance	10%	No

After the identification of the strategic actions, it is necessary to analyze their viability and select those that will be executed. For each strategic action selected, it must be defined: (i) Its priority; (ii) Responsible: responsible for executing the action (tactical level); (iii) Resources: financial resources available for executing the action; (iv) Indicator: indicator related to the action monitoring.

To complete strategic planning, it is important to analyze the strategic goals defined, the strategic actions and the indicators to identify and document possible interactions among them. Each interaction among any goals defined in our method can be classified as a qualitative and direct interdependence, a qualitative and inverse interdependence or a quantitative interdependence.

3.2 Tactical Planning Aligned to Strategic Planning

In strategic planning, strategic actions are planned and the responsibility for their implementation is assigned to some professionals. In tactical level, on the other hand, these professionals perform tactical planning to execute the assigned strategic actions. Tactical planning guides operational planning. It can be monitored through the use of operational level execution and monitoring data. If any deviation is detected, an analysis must be performed to determine if it is necessary to execute corrective actions or if tactical planning has to be revised.

Tactical planning starts with the decomposition of the strategic actions into tactical goals. Fig. 3 shows the steps for tactical planning. Since the focus of this work is on software organizations, the method proposed by us details only the tactical goals that are related to software products or processes, what we name software improvement goals, as mentioned earlier. However, to allow adequate monitoring of strategic goals, it is also recommended to identify tactical goals not related to software and their monitoring indicators. A tactical goal not related to software is described as the action, the action target, the expected value, the expected contribution to the related strategic action, and the interactions with other goals.

Strategic actions related to software must be decomposed into software improvement goals. To make it easier to monitor software improvement goals and to allow a better visibility of the results, we propose the definition of medium term software improvement goals (from now on, MTSIG) and short term software improvement goals (from now on, STSIG). Each MTSIG has to be decomposed into STSIGs, which indicate nearer milestones in the way to achieve the MTSIG. From time to time, tactical planning needs have to be updated, and in these occasions, MTSIG could become STSIG. To illustrate, an organization could have as a MTSIG to adopt CMMI Level 3 practices, while adopting CMMI Level 2 practices could be one of its STSIG.

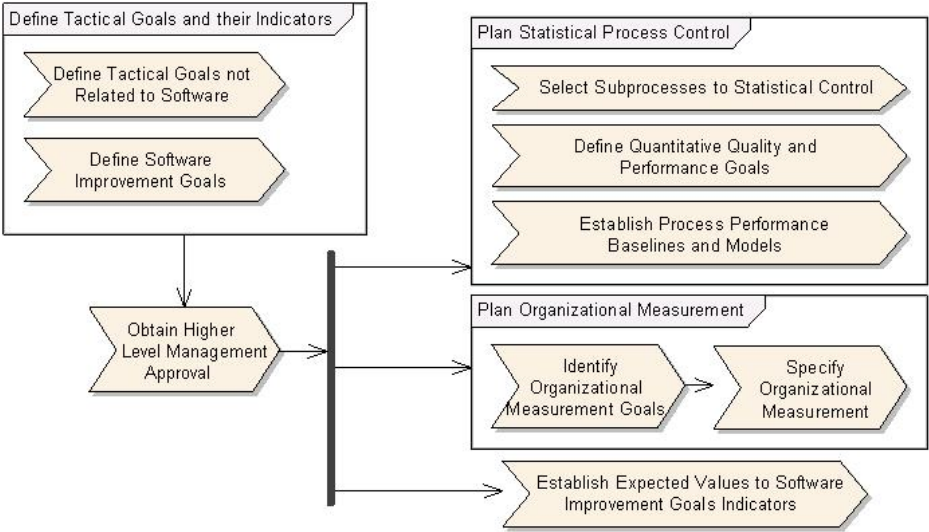


Fig. 3. Tactical planning steps

The definition of software improvement goals describes: the action, the expected value, the action target, the expected contribution to the strategic action related (if it is a MTSIG) or to the MTSIG (if it is a STSIG). The interactions with other goals are also described. Table 3 exemplifies two MTSIG. To allow the monitoring of the defined software improvement goals, indicators related to each goal are defined in the same way as the indicators related to strategic goals.

Table 3. Examples of medium term software improvement goals

Strategic Action:		Improve software products quality	
Medium Term Software Improvement Goals			
Action	Value	Action Target	Contribution
Deploy	-	CMMI level 3	40%
Decrease	10%	Defect density	60%

The definition of software improvement goals (considering MTSIG and STSIG) may involve important decisions to the organizations, which may need the approval from higher level management. Therefore, once the goals are defined it may be necessary to present them to higher level management to guarantee their approval and commitment. This step could be unnecessary, depending on the relationship among the different levels of the organizations, considering the autonomy of the tactical level and the participation of higher level management throughout the definition phase.

Once their software improvement goals are defined, an organization needs to plan SPC of its processes (if it is a requirement) and also plan the measurement initiative of the organization. Our method applies to organizations that want to statistically

control its processes as well to the ones that want to use less formal ways of control, since it optionally supports software SPC planning as part of tactical planning.

SPC requires time and adds costs to the organization and, therefore, does not need to be applied to all software processes of the organization. Thus, this step starts with the selection of the subprocesses that are going to be statistically controlled. This selection must be based on the software improvement goals defined. Based on the selected subprocesses, it is necessary to identify the quantitative quality and performance goals of the organization and analyze the behavior of these subprocesses, considering these goals and also measurement data from the enactment of the subprocesses. This knowledge must be stored through the establishment of process performance baselines, that characterize real results previously obtained through the enactment of the processes, describing their expected behavior. It is also possible to define process performance models, which relate statistically controlled process attributes to try to forecast the process behavior.

Regardless of the adoption of SPC by the organization, the monitoring of each of the defined goals is strongly related to measurement data from projects and from the organization itself. However, if SPC is used, software measurement becomes even more critical. Therefore, organizational measurement planning is part of tactical planning, and is performed in parallel with SPC planning (if applicable).

The measurement planning step consists of identifying measurement goals from the short term software improvement goals and from the quantitative quality and performance goals, if available. Afterwards, it is necessary to specify organizational measurement, identifying and describing measures from the goals. Literature presents some approaches to derive measures from goals, such as GQM [16].

The monitoring of software improvement goals is done through the analysis of the indicators related to these goals, as described earlier. However, the expected values for these indicators have to be defined or updated in the last step of tactical planning, since SPC and measurement on the organization could influence these values. Thus, to complete tactical planning related to software, it is necessary to establish expected values to the indicators related to the software improvement goals.

3.3 Project Planning Aligned to Tactical Planning

On the operational level of software organizations, tactical planning guides the planning and execution of each software project. Each project is monitored, and if any deviation is detected, an analysis is done to determine if it is necessary to run corrective actions or if project planning has to be revised.

Our approach to project planning focuses on project goals, SPC and measurement as shown in Fig. 4. Therefore, the several other steps usually required to plan a project are not considered.

Each project has its unique characteristics that must be addressed. Thus, project planning begins characterizing the project. This step defines, among other kinds of information, the expected contribution of the project to the tactical goals, considering each project being run. This information is important to determine the achievement of tactical and strategic goals.

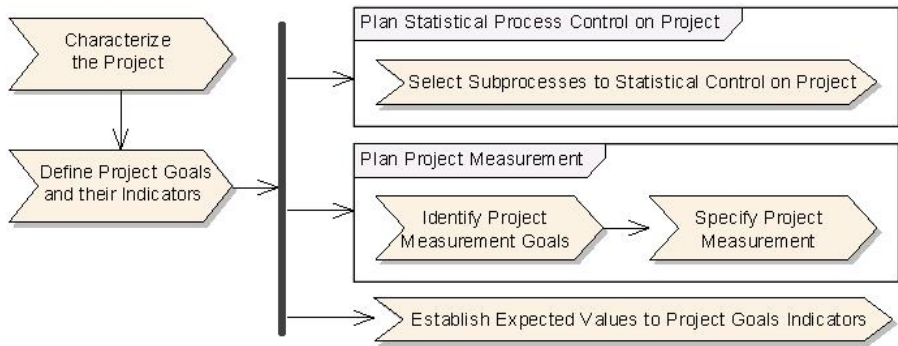


Fig. 4. Project planning steps

Once the project is characterized, it is necessary to define its goals, which are initially selected from short term software improvement goals (STSIG) and from quantitative quality and performance goals (if SPC was selected during tactical planning) that apply to the project. To assure project alignment to tactical planning, and therefore to strategic planning, it is common to consider all STSIG and quantitative quality and performance goals (if available) as project goals. If on very specific situations some of these goals do not apply to the project, it is necessary to document and justify this situation. An example of this situation is when the organization has some projects related to a specific software product and there is a STSIG which specifies the maximum response time for this product. This STSIG is not applicable to a project that is not related to this product.

Project goals definition also considers the needs of projects, their characteristics and constraints, as well as customer requirements. Thus, the analysis of these project specific kinds of information can lead to new project goals, regardless of the software improvement goals. Therefore, it is possible to assure that projects are going to implement the software improvement goals, but projects are not constrained by them. Each new project goal has to describe the action, the expected value, the action target, and the interactions with other project goals.

If the organization has adopted SPC and planned it on the tactical level, each project needs to plan how to statistically control processes throughout its enactment. SPC planning on a project consists of selecting subprocesses that will be statistically controlled on the project, based on quantitative quality and performance goals. This selection must be based on the subprocesses selected for SPC during tactical planning.

Regardless of the adoption of SPC by the project, the monitoring of each project goal is performed through measurement. Therefore, measurement planning of the project is part of project planning, and is performed in parallel with SPC planning (if applicable). The measurement planning step consists of identifying measurement goals from the project goals, identifying measures related to measurement goals, planning how to collect and analyze each measure, based on the measurement planning performed on tactical level.

To complete project planning, it is necessary to define or update the expected values for the indicators related to the project goals. At this point it is important to check

the consistency among these expected values and the quantitative quality and performance goals considered on the project.

4 An Infrastructure to Monitor Software Improvement Goals

Throughout the enactment of projects, project goals must be continuously monitored aiming at detecting real or potential deviations. This information is also used to monitor goals that were defined on tactical and strategic levels. However, to continuously monitor the three levels at the same time can be very hard.

To support monitoring activities, our approach suggests an infrastructure to continuously and proactively monitor the defined goals. This infrastructure is based on agents and is capable of monitoring goals, searching for deviations and alerting whenever a real or potential deviation is detected. To do so, we have defined two agents: Indicators Update Agent and Deviation Detection and Notification Agent, as depicted in Fig. 5 and Fig. 6.

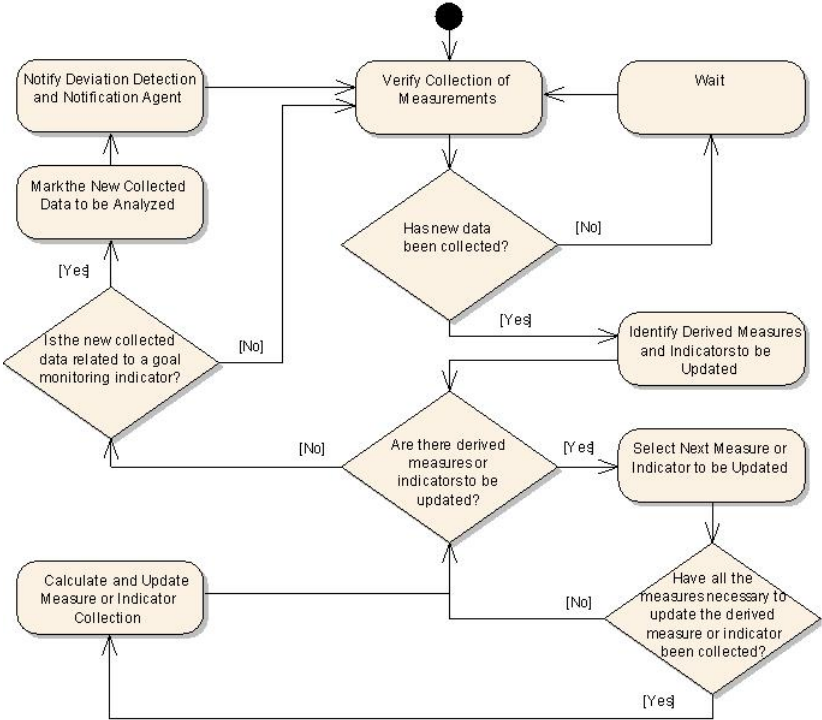


Fig. 5. Steps of the Indicators Update Agent

The monitoring of the goals defined on each level happens through the monitoring of the actual values of the indicators related to the goals. However, indicators are often measures derived from other ones. Thus, to be able to get an online updated monitoring of these indicators, it is necessary to continuously monitor the collection

of new measures, to analyze if any indicator has to be updated (recalculated), and update it, if necessary. Likewise, the analysis and detection of deviations are accomplished through the collection of measures that are part of indicators related to goals. Thus, goals' monitoring begins by monitoring each measure collected.

The Indicators Update Agent is responsible for assessing the need to update indicators whenever new measurement data is collected, and then update them. Fig. 5 shows the steps performed by the Indicators Update Agent. The Deviation Detection and Notification Agent is responsible for analyzing each measure collection that affects indicators related to the defined goals, checking the occurrence of deviation and, whenever a deviation is detected, notifying the occurrence through an alert. The deviation checking consists of analyzing the data collected to compare it with the three ranges of values defined for the indicator (as defined in Section 3.1). If data is out of the acceptable range, a real or potential deviation occurred. The main steps performed by the Deviation Detection and Notification Agent are shown in Fig. 6. These agents and the related infrastructure are currently being implemented and will be fully functional in the near future. Once implementation is complete, we will be able to use them in real situations and properly evaluate their behavior.

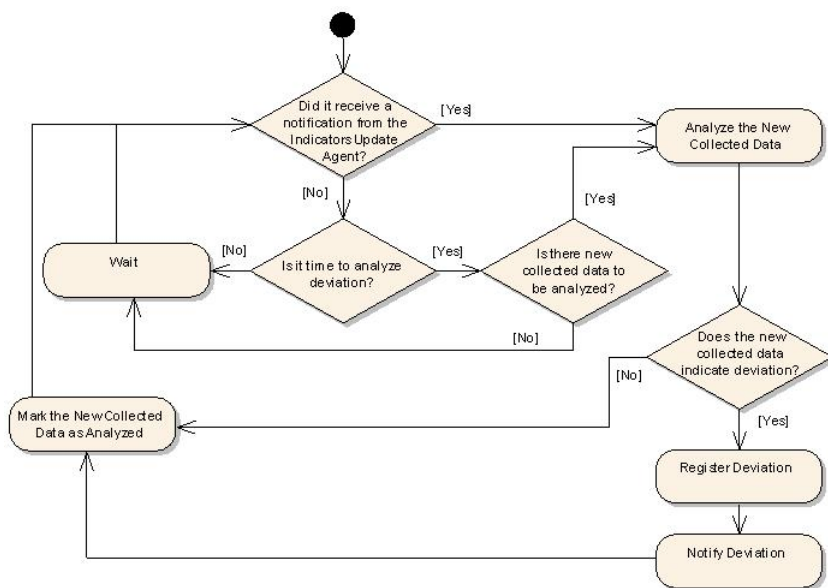


Fig. 6. Steps of the Deviation Detection and Notification Agent

5 Defining Software Improvement Goals at a Brazilian Software Development Organization

COPPE/UFRJ is one of the most important Software Engineering research and consulting centers in Brazil, located at Rio de Janeiro. Its Software Engineering initiatives are supported by the Software Engineering Laboratory – LENS (the acronym in

Portuguese), which develops software products aiming to aid these initiatives [22]. As a software organization, this laboratory was successfully appraised in accordance with the level E of MR-MPS model [3], a Brazilian reference model for software process improvement, compatible with CMMI-DEV [5]. Recently, our approach was used by LENS to accomplish its strategic and tactical planning.

We believe this experience was a great opportunity to evaluate parts of our approach. Subjects were all master or PhD students or professionals, but all of them were also working on industry initiatives. The group of subjects consisted of fourteen people and involved professionals that had never took part on strategic planning activities before as well as professionals that had already participated in different strategic planning efforts. The strategic and tactical level professionals accomplished some meetings at which each strategic planning step proposed by our approach was enacted. During this planning, five strategic goals, eight external factors, three strengths and two weaknesses were identified. Based on the external and internal analysis, eighteen strategic actions were planned. One of the defined strategic goals was “Achieve the level A of MR-MPS” model and one related strategic action defined was “Deploy new software processes required by the level A”.

After performing strategic planning, as suggested by our method, we have performed tactical planning activities. It is important to mention that strategic level professionals also participated in this planning. The strategic actions which were related to software were decomposed into software improvement goals. However, we have observed that before planning statistical process control, it was necessary to address some specific issues identified throughout the strategic and tactical planning. Thus, the tactical planning was temporarily suspended and some action plans were defined to address these issues. It was interesting to realize that throughout strategic planning it was possible to identify issues that could threaten the achievement of the defined goals. Thus, before finishing this planning, strategic level professionals took some important decisions in order to address these issues and notified them to all organization.

To complete the study, a brief survey about the proposed approach was sent to all subjects of the study. We have reached 86% of answer rate. Subjects were asked about some aspects of our approach, such as: the expected benefits from the enactment of the strategic planning performed, the adequacy of the method used and the adequacy of the sequence of steps. The survey showed that the professionals expected good benefits from the enactment of the strategic planning accomplished. In regard of the proposed method, considering the opinion of the subjects, there is some indication that the sequence of steps is adequate. According to the subjects, the use of a method that guides the steps that need to be followed and the information that has to be provided, considering the specific context of a software organization, made it easier to accomplish strategic and tactical planning and guided the debate, avoiding waste of time. Some improvements to our approach were identified and they were already analyzed and deployed.

6 Conclusions

Software process improvement initiatives need to be aligned with the business goals of the organization. If these initiatives are performed in an organization without taking

business goals into account, it is possible that the initiatives do not satisfy or even conflict with them.

In this paper we present an approach to define and monitor software improvement goals promoting strategic alignment. Our approach supports strategic, tactical and operational planning activities focusing on software processes and products. Measurement planning and statistical process control are addressed too. A method for strategic, tactical and operational planning is described and an infrastructure to support the monitoring of the defined goals across the three levels is presented.

Our method was partially used on a real context and brought several good results, guiding the strategic and tactical planning, promoting the software improvement alignment and avoiding waste of time. There is some expectative that the aspects addressed by our approach can help software organizations to achieve the expected software improvement benefits.

We intend to use our approach on other real contexts soon. We are also developing the infrastructure to continuously monitor the goals defined in the strategic, tactical and operational levels. We also intend to develop a tool to support the use of the method to make it easier to use the approach in others situations. Currently, we are performing a survey to characterize similarities among software projects. We believe this characterization will make it possible to compare similar deviation scenarios. Based on previous deviations, our infrastructure can monitor the project goals, recommend adequate actions to address detected deviations and propagate it to the upper levels.

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