Strategically Balanced Process Adoption

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ABSTRACT

Software processes have an important role to play in realizing organizational strategies. When a software organization is about to decide on the adoption of a new process, it should have a clear understanding of its own strategic objectives, as well as the potentials of the new method in supporting or hindering its strategic plan. From this perspective, a successful process adoption initiative is one which provides maximum support to the strategic objectives of an organization while producing a minimum of adverse effects.

This paper introduces the concept of *Strategically Balanced Process Adoption* (SBPA) for anticipating and monitoring the strategic impacts of a new process before and after its adoption. A set of techniques are proposed for the realization of SBPA, which are based on a repository of method fragments, introduced in an earlier ICSP paper. The proposed techniques are deployed in an industrial experience, where the subject organization was about to adopt a custom-designed agile process. The proposed techniques of SBPA helped the subject organization to better design the to-be process, with improved control over its enactment.

Categories and Subject Descriptors

K.6.3 [**Software Management**] – *Software Process*

General Terms

Management, Measurement

Keywords

Software Process, Process Adoption, Software Process Improvement, Strategic Management

1. INTRODUCTION

Changing the development process of a software organization is often motivated by the need for a new process that better supports the organizational strategies. Regardless of the way that the new process is designed (systematic SPI frameworks or ad hoc process assembly), it is expected to improve certain strategic objectives of organization, without producing unexpected side-effects on other strategic objectives. Thus, when a software organization decides on the adoption of a new development process, it should have a clear understanding of the strategic impacts of this initiative. However, gaining such understanding before the adoption of new process is inherently complex, because often the strategic impacts of a new process are visible after its actual enactment.

In an earlier paper [1], we introduced a repository of Agile Method Fragments (AMF), with content collected through systematic reviewing of empirical studies on agile methods. Among the services of this repository is the provision of a list of *objectives* that can be contributed (either positively or negatively) by any agile method fragment. The repository supplies situational evidence for every contribution relation by referencing the empirical study that had reported the contribution relation. For instance, for the agile method fragment Pair Programming, the repository states over 15 objectives (such as Reduced Defect Rate, Better Time to Market, Increased Productivity, etc.), and provides evidence from empirical studies where the enactment of Pair Programming helped or hurt the achievement of those objectives.

Leveraging the knowledge in the AMF repository, this paper proposes a set of techniques for managing a process adoption initiative from a strategic perspective. We introduce the concept of *Strategically Balanced Process Adoption* (SBPA), as a process adoption initiative which promotes a balance among all categories of strategic objectives, before and after the enactment of the new process. The SBPA is explained in two major parts:

- The *pre-adoption analysis,* which anticipates the potential impacts of a new process over the strategic objectives of an organization, before the adoption of the new process.

- The *post-adoption monitoring*, which investigates the actual impacts of a new process over the strategic objectives of an organization, after the adoption of the new process.

Since September 2010 we have been involved in a Software Process Improvement (SPI) initiative in one of the R&D units of the Ericsson Company in Italy. We joined the SPI initiative at the time that the as-is process was analyzed. A to-be process had been proposed to the organization, but was not yet adopted. The proposed to-be process was mainly composed of agile method fragments, which had experienced success in other R&D units of the organization. However, due to the particular situation of the

unit, managers had not been convinced that the new process could help achieve their strategic objectives. The *pre-adoption analysis* techniques described in this paper were introduced in that SPI initiative to anticipate the positive and negative effects that the new process could have for the organization. Some parts of the results of the pre-adoption analysis are explained in this paper. The *post-adoption monitoring* is still in progress - results will be reported in the future.

The remainder of this paper is organized as follows: Section 2 provides a brief background about the approach of Balanced Scorecards in strategic management, from which the inspiration for SBPA was derived. Section 3 explores the concept of balanced process adoption, defines four techniques for pre-adoption analysis, and explains the post-adoption monitoring. This section also specifies the preparative steps, which are needed for strategic analysis of a to-be software process. Section 4 illustrates the application of pre-analysis techniques in our industrial experience. Sections 5 and 6 discuss related work and our future plans.

2. BACKGROUND

In the 1990's, Kaplan and Norton introduced the concept of Balanced Scorecards (BSC). The basic idea of BSC is to support the strategic management of organizations, through the structuring of portfolio strategies from different perspectives. One of the major goals of BSC is to translate the often vague and high-level organizational vision and mission statements into actionable and measurable objectives that, first, are all traceable back to the high level strategies, and second, each can be understood and implemented by accountable staff [2].

The BSC proposes that an organization's strategies should be viewed from four perspectives: (1) *Financial* – strategies for profitability of an organization from shareholders' viewpoint; (2) *Customer* – strategies for creating value from customers' perspective, (3) *Internal Business Process* – strategies for improving the key business processes of the organization; (4) *Learning & Growth* – strategies for improving the qualifications of individuals and growth of the corporation. The BSC suggests that the high-level strategies of an organization (which are often articulated as vision and mission statements) be decomposed into actionable *Objectives*, categorized by the four perspectives, and attributed with quantifiable *Measures,* desired *Targets*, and list of supporting *Initiatives* [3].

The initial concepts of the BSC approach are supported by detailed frameworks for building and implementing particular scorecards. A mapping technique called *Strategy Maps* [4] [4] was proposed for linking strategic objectives across four perspectives, clarifying their cause-and-effect relationships. The *Balanced Scorecard Institute*® proposed a framework (called *Nine Steps to Success^{TM}*) for strategic planning and management. The institute also proposed a maturity model for assessing the quality of strategic management [5]. The model defines eight dimensions for strategic management and proposes five levels of maturity for each dimension.

BSC has also been investigated in the context of information systems and the software industry. Martinsons et al. [6] proposed a customized BSC for Information Systems (IS), in which the original BSC perspectives are substituted by *business value*, *user orientation*, *internal process*, and *future readiness*. They argued that the strategic goals and activities of an IS organization can be classified into these perspectives, and proposed a number of measures for evaluating each category. Following the original BSC guidelines [2], they stated that all of the metrics should be quantifiable, easy to understand, and have meaningful analysis results. Grembergen et al. [7] also proposed a customized BSC for e-Business, which consists of four perspectives: *customer-orientation*, *business contribution*, *operational excellence*, and *future orientation*. Each perspective is then supported by a number of quantifiable measures. Indeed, there are many reports of using BSC for strategic management in the software industry [8-11].

3. BALANCED PROCESS ADOPTION

The basic idea of Strategically Balanced Process Adoption (SBPA) is inspired by the BSC, where it looks for a balanced view of organizational strategies. One of the important problems in the strategic management of organizations is the anticipation of the potential impacts of organizational initiatives over the major categories of strategic objectives. If an initiative results in the improvement of a particular set of strategic objectives, at the cost of uncontrolled deterioration of other sets, this initiative is considered a kind of risk for the balance of organizational strategies.

Within the context of software organizations, the balanced view of organization strategies highly depends to the choice of software development process. The reason lies in the fact that software processes are the main carrier of organizational technological advances, as well as business success, and human-related phenomena, all of which having significant roles in the strategic management of a software organization. Therefore, any kind of major change to the development process of a software organization should be performed with respect to its potential impacts on the strategic objectives of the organization.

The concept of SBPA is particularly important for the adoption of software processes which are mainly built on agile method fragments. The high emphasis of agile methods on product aspects rather than on the process can lead the organization to unknowingly sacrifice certain sets of strategic interests for the sake of improving others. For example, the *valuation of code over documents* is highly advocated by agile methods, and argued to have a direct positive effect on the Productivity of Individuals. However, such practices often have side effects on some other sets of strategic objectives (e.g., negative impacts on System Maintainability). Therefore, it is a must for a software organization about to adopt a new development process (particularly an agile process) to view the adoption initiative with regard to its impacts over various categories of the *organization specific* strategic objectives.

To further clarify the concept of SBPA, we define *Strategically Balanced Process Adoption* as an initiative with the following attributes:

1. It positively contributes to the strategic objectives, which are expected to be improved.

2. It does not cause uncontrolled negative impacts on the strategic objectives, which are not within the focus of improvement.

3. It does not cause overall deterioration of a particular category of strategic objectives, for the sake of improving some other categories.

4. It results in homogenous impacts over all categories of strategic objectives.

The first attribute is the minimum expectation from a SBPA, which assures that the adoption of the new process would lead to the improvement of the set of strategic objectives which were in need of improvement (e.g., due to issues identified in the as-is process); the second and third attributes seek the balance of process adoption respectively from the perspective of every strategic objective and every category of strategic objectives. The last attribute of SBPA is an optional one, which specifies whether a process adoption initiative causes proportionately similar impacts over different categories of strategic objectives (i.e., all categories of strategies will benefit from the initiative to a similar extent). Further explanation of SPBA attributes are presented in the next section.

In order to explore the proper balance of a process adoption initiative, the following questions should be answered:

- How to anticipate the balance of the initiative, *before* the actual enactment of new process?

- How to monitor the balance of the initiative, *after* the enactment of new process?

The first question is addressed as *pre-adoption analysis*, which introduces four strategic analysis techniques. It investigates the balance of process adoption at two levels: *objectives* and *categories*, respectively exploring the improvement and the preservation of the status of strategic objectives and categories of strategies. The second question is addressed as *post-adoption monitoring*, which as its name implies is about monitoring the balance of initiative after the enactment of the new process.

Prior to conducting pre-adoption analysis (or post-adoption monitoring) a set of preparative steps are required. These steps are mainly about setting up the strategic model of the organization and inspecting the contributions of new process over the strategic objectives of organization. These are briefly explained in the following two subsections.

3.1 Defining Organizational Strategies

To perform the pre-adoption analysis, the organization should have a clear understanding of its strategic objectives at different levels, and the way these objectives would impact each other. Indeed the strategic objectives must be categorized into predefined categories, which represent major classes of strategies that are important for the organization. The categorization of strategic objectives is represented by the following relation: Categ(C, SO) where:

- C is a category of strategies.

- SO is the strategic objective

For instance, Categ(Business, Reduced Time to Market) represents that the strategic objective Reduced Time to Market belongs to the category of Business strategies.

The original BSC suggests to use a table of four sections, each containing the strategic objectives that belong to one of the four

major strategic perspectives (Financial, Customer, Internal Business Process, Learning and Growth) [2]. In case of a software organization these perspectives can be customized to represent their own major strategic concerns (such as classifications proposed in [6, 7]). The other form of representing strategic objectives is to use *Strategy Maps* which are intended to visualize how strategic objectives of each category would impact the objectives of other category [4]. We propose the use of *Strategies Graph* (SG) for representing the Decompositional and Contributional relations of strategic objectives. The idea of SG was inspired by goal graph structures in Goal-Oriented Requirements Engineering, particularly the *i** modeling framework [12]. The decompositional relations represent the logical AND/OR decompositions of high-level objectives to those of lower-levels; and Contributional relations represent the positive and negative impacts of strategic objectives over each other. . The contributional relations can be plotted across different categories (e.g., business, customer, internal process) and levels (high-level visional strategic to low-level actionable objectives) in the Strategies Graph. Figure 1 shows a portion of a sample SG.
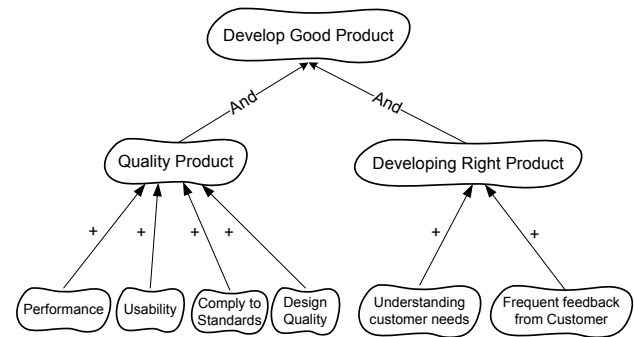

Figure 1: A portion of a sample Strategies Graph

Relations among the strategic objectives are formulated by the relation: ObjRel(SO1, SO2, K, T) where:

- SO1 is the decomposed or contributed strategic objective

- SO2 is the decomposing or contributing strategic objective

- K is the kind of contribution, which can be C or D, respectively representing contributional and decompositional relations.

- T is the type of relation, which for contributional relations can take values of {++, +, -, --}; and for decompositional relations {AND, OR}.

For instance for the SG of Figure 1, ObjRel(Quality Product, Performance, C, +) represents the positive contribution relation which exist from the strategic objective Performance towards Quality Product.

The pre-adoption analysis takes a qualitative approach for analyzing the potential impacts of a new process over strategic objectives of an organization. Thus, at this stage it is not required to provide quantifiable metrics and target values for every objective. These factors will be needed at the next stage (Post-Adoption Monitoring).

3.2 Inspecting the Contributions of New Process

Inspecting the contributions of a new process is intended to identify the types of impacts that a new process would make on the strategic objectives of an organization. This is based on the following assumptions:

- The new process is decomposable into a number of *method fragments* (as described in [13]). A method fragment can be a process or product fragment.

- Every fragment of the new process makes distinguishable contributions to the strategic objectives of organization.

- The overall impact of the new process over the strategic objectives is the aggregation of contributions of its fragments over different portions of strategic objectives.

Two approaches are proposed for exploring the contributions of a method fragment over strategic objectives: *Evidence-Based* and *Consensus-Based*. In the evidence-based approach the contribution of a method fragment to a strategic objective is supported by evidential knowledge, which is provided by the repository of method fragments (introduced in [1]). This repository provides structured evidential information for a set of method fragments, mostly agile ones. The content of the repository has been populated through extensive systematic literature review of empirical studies, which had reported various objectives that can be contributed by a method fragment in different project situations. The content of this repository is evidential in that it provides references to the original studies which had reported each contribution. If a strategic objective of the subject organization is among the objectives dataset of a candidate method fragment found in the repository, that information can be used as evidence for exploring the contribution relation. Otherwise, the contribution relation is determined through the consensus-based approach, which relies on an agreement among process analysis team members about the contribution relation, based on the definition of the method fragment as understood by the team members. Contribution relations are defined as the following relation: Cont(MF, SO, R, T) where:

- MF is the name of contributing method fragment

- SO is the name of contributed strategic objective SO

- R is the rationale of contribution, which explains why such contribution might happen

- T is the type of contribution, which can be {++, +, -, --} respectively representing strongly positive, positive, negative, and strongly negative contributions.

A positive contribution implies that the adoption of method fragment MF would improve the strategic objective SO, and vice versa for a negative contribution. For instance, Cont(Pair Programming, Reduced Defect Rate, Two programmers make less defect, ++) implies that the adoption of method fragment Pair Programming would improve the strategic objective Reduced Defect Rate, because of the mentioned rationale. As another example, Cont(Pair Programming, Individuals Productivity, Less LOC per Developer per Month, -) represents the negative impact of the method fragment Pair Programming on strategic objective Productivity of Individuals. (In both examples the contribution

relations have been identified through the evidence-based approach, with the help of knowledge provided in the repository of method fragments. This repository is available online at http://www.ProcessExperience.org)

3.3 Pre-Adoption Analysis

After establishing the strategic model of organization and inspecting the potential impacts of the new process over the organizational strategic objectives, it is now possible to analyze the balance of the process adoption initiative. Here, four techniques are described for the pre-adoption analysis. For each technique, first the target of the technique is stated, and then the steps which should be taken.

3.3.1 Balance Improvement

The introduction of a new process to an organization is often motivated by a set of strategic objectives that are currently not well met. This can be due to problems of the current development process, which prevented the organization from achieving its strategies; or a change in strategies, which made the current process inadequate of meeting the target values of the new strategic objectives. To reach a balanced state after adopting the new process, it is necessary that the new process address the strategic objectives that are not sufficiently met. Thus the first target of SBPA is to investigate whether:

> *The new process is positively contributing to the strategic objectives, which are expected to be improved.*

It should be mentioned that this paper is not concerned with the problem of finding the strategic objectives that are in need of improvement. We assume that these objectives are known to the organization.

The Balance Improvement analysis is performed through the following steps:

1. Identify the list of strategic objectives whose current status is not satisfactory and needing improvement – this set of objectives is called ToBeImprovedObjs.

2. Based on the results of (3.2), identify the list of strategic objectives that will receive, from the fragments of the new process:

    a. Only positive contributions – this set is called ToBeImprovingObjs.

    b. Conflicting contributions (both negative and positive contributions) – this set is called ToBeConflictingObjs.

    c. Only negative contributions – this set is called ToBeDeterioratingObjs.

3. To analyze the Balance Improvement target, the following cases should be considered:

    a. If ToBeImprovedObjs is a subset of ToBeImprovingObjs, then the target is met.

    b. If ToBeImprovedObjs has any common element with ToBeConflictingObjs, then every strategic objective which belongs to the common set should be further investigated to anticipate whether it will eventually deteriorate or improve (this investigation will be explained in the next subsection).

c. If `ToBeImprovedObjs` has any common element with `ToBeDeterioratingObjs`, then the target cannot be fully met. When this situation occurs, the analysis team should decide on corrective actions on the new process (e.g. altering the constituent fragments, or changing the settings of current fragment), depending on the significance of the strategic objectives in question.

3.3.2 Balance Preservation

The improvement of strategic objectives that were expected to be improved by the adoption of the new process should not result in a false perception of overall process improvement. That is because a new process that is designed to effectively improve a limited set of objectives can produce uncontrolled negative impacts on other sets. In SBPA, one of the attributes of an optimal to-be process is that it does not leave uncontrolled side-effects over the organizational strategies – especially those which are out of the focus of improvement. Thus, the second target of SBPA is to inspect whether:

The new process is not causing uncontrolled negative impacts on the strategic objectives which are not within the focus of improvement.

The analysis technique is described in the following steps:

1) Calculate the *contribution weight* of every strategic objective, expressed as $CW (SO)$ – which is the sum of the value of contribution relations that a strategic objective (SO) receives from different fragments of the new process. The value of (qualitative) contribution links is quantified as follow:

   a. +1 for Positive Contribution

   b. +2 for Strongly Positive Contribution

   c. -1 for Negative Contribution

   d. -2 for Strongly Negative

2) The target is ideally met when the contribution weight of all strategic objectives is positive. But that is not usually the case. Thus, for every strategic objective with $CW (SO) < 0$:

   a. If the SO belongs to the `ToBeDeterioratingObjs` then the analysis team should go through the following check list to see whether the perceived deterioration of the SO is under control:

      i. Is it tolerable for the organization to see this strategic objective deteriorating, in trade-off with the improvement of other objectives?

      ii. Is there any fragment in the new process of software development that could overcome the negative contributions, but was overlooked in step 3.2.

      iii. Is there any corrective action applicable on the new process, which would overcome the negative contributions? If yes, the impacts of this corrective action on other strategic objectives of organization should be re-explored by repeating step 3.2.

      iv. If all above conditions are denied, the negative contribution of the new process to the subject strategic objective is considered to be uncontrollable.

   b. If the SO belongs to the `ToBeConflictingObjs` then the analysis team should go through a similar check list , but with the following condition added:

      v. Is it worth accepting the negative contribution, in trade-off with the positive ones towards the same strategic objective?

3.3.3 Balance Preservation across Categories

The improvement of organizational strategic objectives can be viewed at different levels. The previous technique was focusing on instances of strategic objectives, and was concerned with keeping the balance of each individual objective against others. However, one of the issues which might disturb the balance of a process adoption initiative is that the new process worsens one or more categories of strategic objectives. For instance, for an organization that is doing badly on customer-related strategic objectives, the first priority of process improvement would be the improvement of its customer-related strategies. However, this should not result in the deterioration of other categories of strategic objectives such as those for business or internal process. Thus, the third target of SBPA is introduced at the category level of organizational strategies, and is intended to inspect whether:

The new process is not causing overall deterioration of a particular category of strategic objectives, for the sake of improving some other categories.

The analysis technique is carried out with the following steps:

1. For each category of objectives, calculate the total weight of the negative contributions (TWNC) and the total weight of the positive contributions (TWPC) made towards the strategic objectives of that category. Calculate the total net weight of contributions (TWC) for that category TWC = TWPC – TWNC.

2. A process adoption is considered unbalanced if either of these conditions hold even in one category of strategic objectives:

   a. The TWC is negative, which shows that the new process is causing the deterioration of that category.

   b. The TWC is positive overall, but the TWNC is a large negative number, which suggests that the small overall gain of the new process (in this category) may not be worth the risk.

3.3.4 Homogenous Contributions across Categories

The fourth perspective from which the balance of a process adoption can be viewed is the relative homogeneity of contributions that the new process makes to different categories of strategic objectives. This kind of balance analysis is to determine whether the new process is proportionately treating all categories, i.e., different categories are benefiting or hurting to the same degree from the adoption of new process. This can be investigated by identifying the variance of the percentage of different types of contributions, made from the new process to different categories of strategic objectives. Thus, the fourth target of SBPA is to inspect whether:

The new process is causing homogenous impacts over all categories of strategic objectives.

Analyzing the homogeneity of contributions across different categories has a precondition. This analysis is meaningful only if strategic objectives are evenly distributed across different categories; i.e., the variance of the number of strategic objectives in different categories does not exceed certain limit. For example, in an organization with 100 strategic objectives grouped in 3 categories, with distribution of 28 objectives in the first category, 38 in the second, and 34 in the third; it makes sense to analyze the homogeneity of contributions across categories, because the variance is not too much and objectives are almost evenly distributed among categories. But, if the number of objectives were distributed unevenly, e.g., 80, 15, 5 among three categories, then due to the high variance of number of objectives across categories, the homogeneity analysis will not be meaningful. The reason is that for instance, the last category will be fully supported by the new process if it receives only five positive contributions; whereas the first category would need 80 positive contributions to get the similar status.

The following technique is proposed for this analysis:

1) Build the *contribution distribution table*, which for each category of strategic objectives shows the number and percentage (within the category) of strategic objectives which are:

   a. *Supported* – SO belongs to the ToBeImprovingObjs

   b. *Declined* – SO belongs to the ToBeDeterioratingObjs

   c. *Conflicted* - SO belongs to the ToBeConflictingObjs

   d. *Unaddressed* – Otherwise.

2) To investigate the homogeneity of the contributions across categories, explore the variance of contributions of the new process to the strategic objectives. This technique would show whether the new process is making similar contributions to different categories. To do so, for each status value (supported, declined, conflicted, unaddressed), calculate the variances of percentages and numbers in different categories. For instance, calculate the variance of the percentage of strategic objectives with the status value of Supported among different categories. The lower the variance measures, the more homogenous contributions are made from the new process to different categories of objectives.

The homogeneity of the contributions of a new process to different categories of strategic objectives becomes important when the organization expects that improvement in some categories of strategies will lead to improvements in some other categories. For example, it is often expected that improvements in the internal development process will lead to improvements in achieving business objectives as well as technological ones. Analyzing the homogeneity of SBPA is a mechanism for investigating this issue.

3.4 Post-Adoption Monitoring

Post-adoption monitoring aims to assess the actual impacts of the adopted new process on the strategic objectives of the organization. Unlike pre-adoption analysis, which was based on evidential or consensual anticipations of the future status of strategic objectives, post-adoption monitoring is based on data about the actual status of strategic objectives achievement. Post-adoption monitoring is a necessary action to see whether promises of the new process are achieved within the current organization setting, or there is need for further customization of the process or change of other organizational parameters.

In order to conduct a post-adoption analysis, strategic objectives should be supported by *quantifiable metrics*, with specified *target* and *threshold* values. The target value of a strategic objective represents its desired status; and the threshold value represents its worst tolerable status, which might be reached by its deterioration.

Post-adoption monitoring involves continuous monitoring of strategic objectives, comparing current status with what was analyzed at the pre-adoption analysis. In detail, post-adoption monitoring aims to assess:

1. The degree to which the indicators of strategic objectives which were analyzed to be improved, are actually improving; and whether this improvement is adequate for meeting the expected target values.

2. The degree to which the indicators of strategic objectives which were analyzed to be deteriorating, are actually declining; and whether this deterioration is still tolerable for the organization.

3. The degree to which the indicators of strategic objectives which were analyzed to receive conflicting contributions from the new process, are actually changing; whether this change is positive or negative; and if negative whether it is tolerable.

4. To capture the unexpected behaviour of strategic objectives, e.g., strategic objectives which were analyzed to remain unaddressed by the adoption of the new process, but their indicators show improvements or deteriorations.

5. For either improving or deteriorating strategic objectives, conducting a root-cause analysis to find the actual causes of change. If changes were rooted in the fragments of the new process, then update the repository of method fragments [1] with the newly investigated evidence.

6. In cases of deteriorating strategic objectives, if the root cause was in the new process, inform the process design team (or other responsible organization members) to fix the problem, if the deterioration was not tolerable.

4. INDUSTRIAL EXPERIENCE

The proposed pre-adoption analysis techniques have been experimented with in an industrial setting. The experiment was conducted in parallel with an agile adoption initiative in one of the Ericsson R&D units in Italy. The R&D unit had decided to gradually adopt some of the fragments of the Scrum process. To mitigate the risks of process adoption, the new process was going to be first tried in a pilot project. The unit was going to investigate the compatibilities and conflicts in the new process by putting it in a test run, and monitoring the results. The authors of this paper proposed the strategic balance analysis, as a complement to the approach that the unit was pursuing. The distinguishing aspect of the proposed strategic balance analysis approach was that it investigates the potential impacts of the new process over the

strategic objectives of the organization based on experiments or experiences from other organizations that are already in the literature. This empirical evidential knowledge is systematically provided by the repository of agile method fragments [1].

In this experiment, strategic objectives of the R&D unit were extracted using a *participatory* and *model-driven* approach. The approach was participatory because representatives of almost all organization roles (to the level that was related to this initiative) participated in defining and structuring the strategic objectives. To facilitate the process of identifying strategic objectives we took a model-driven approach, in which the *Strategies Graph* was used to visualize the strategic concerns of the organization. The use of the Strategies Graph helped not only in eliciting strategic objectives, but also in raising the level of shared understanding of participants about the strategic concerns of various parties in the organization. A very small portion of the Strategies Graph of this experiment is shown in the Figure 1. In this experiment, participants came up with about 50 strategic objectives, classified into three categories: Business Value, User Orientation, and Internal Process (categories inspired by Martinsons et al. [6]).

4.1 Experiment with Pre-Adoption Analysis
Here we explain the way we experimented with each of the techniques proposed for pre-adoption balance analysis.

4.1.1 Balance Improvement
In our experiment, the subject organization had a set of pre-identified strategic objectives that were expected to be improved by the adoption of the new agile process. These objectives were {Improved Productivity, Reduced Waste, Better Time to Market, Improved Communication / Collaboration}.

What we noticed in the Ericsson experiment was that the strategic objectives that had been pre-identified for improvement were mostly high-level objectives, which could have been decomposed to, or are contributed to, by many finer-grained, more specific strategic objectives. This issue became apparent when together with organization members we completed the Strategies Graph. Questions arose as to which of the high-level strategies were to be further clarified in terms of their constituent (or contributing) lower-level objectives. For instance, the strategic objective 'Reduced Waste' was identified to be decomposable into five other strategic objectives. Having done this, we could identify the exact middle- and low-level strategic objectives which were actually in need of improvement. Finally, we identified 23 strategic objectives, at different levels, which were expected to be improved by the adoption of the new process, resulting in the ToBeImprovedObjs set.

After inspecting the contributions of the fragments of new process over the Strategies Graph, the elements of ToBeImprovingObjs, ToBeDeterioratingObjs, and ToBeConflictingObjs were identified. In the experiment, the ToBeImprovedObjs had four elements in common with the ToBeConflictingObjs, but no element in common with the ToBeDeterioratingObjs. However, the common set of ToBeImprovedObjs and ToBeConflictingObjs were middle- and high-level strategic objectives, each was contributed to by a number of lower-level strategic objectives.

Another result of this analysis was the following observation: in most cases the lower-level strategic objectives would belong either to the ToBeDeterioratingObjs or ToBeImprovingObjs, or they do not receive any contribution from the new process; however, middle- and high-level strategic objectives often receive conflicting contributions from the new process and belong to the ToBeConflictingObjs (which is quite reasonable because the received contribution of a high-level objective is the aggregation of contribution that its lower-level objectives received).

4.1.2 Balance Preservation
Among the strategic objectives that were not in the focus of improvement, two were identified with CW < 0; one of them belonged to the ToBeDeterioratingObjs and the other one to the ToBeConflictingObjs. The deteriorating one was then identified to be supported by some of the already in-place development techniques, which were going to remain unchanged after the adoption of the new process. Thus, the negative impact of new process to this objective was decided to be tolerable. However, for the conflicting strategic objective, the trade-off analysis failed to find any already in-place technique, or any other fragment of new process to make it up. This issue led the analysis team decide on a new supportive action, to preserve the balance of that particular strategic objective.

It should be mentioned that in this experiment the new process had only four fragments. These fragments were specifically chosen by the process design team in order to address some of the issues of the current process. If the to-be process was more complex, it could be expected that a greater number of strategic objectives would have negative CWs. The reason for this assumption is that at least from the business perspective, the cost of incorporating a complex set of changes (which radically alters the current process) is more than the cost of modifying current process, with a limited set of fragments. Therefore, for complex process adoption initiatives, strategic objectives which belong to the Business category are more prone to be side-effects of the initiative.

4.1.3 Balance Preservation across Categories
In this experiment, after calculating the total weight of positive and negative contributions (TWPC and TWNC) the total weight of contribution (TWC) of all categories turned out to be positive. Indeed, none of the categories received a substantially bad TWNC, which indicated that the adoption of the new process would not cause the overall deterioration of one category of objectives as a side-effect of improving some other categories.

As mentioned before, this experiment was carried out in parallel with an existing initiative of agile adoption already in progress. In our observation, this fact might have indirectly influenced the way stakeholders expressed strategic objectives, predisposing them towards agile values. For this reason, the candidate method fragments were mostly analyzed to have positive impacts over strategic objectives, with few negative impacts. In general, this issue – i.e., incomplete or biased construction of the Strategies Graph – can be considered as a threat to the validity of analysis results.

4.1.4 Homogenous Contributions across Categories
In this experiment, strategic objectives were grouped into three categories: User Orientation, Business Value, and Internal Process, respectively containing 16, 15, and 20 strategic objectives. Figure 2 shows the distribution of the number and

percentage of strategic objectives with different statuses in each of the three categories. For instance, it shows that 80% (16 out of 20) of the strategic objectives of the Internal Process category would be supported by the fragments of the new process, with 10% conflicted, 10% unaddressed, and none declined.

Figure 2: Contribution Distribution Tables (U: Unaddressed, C: Conflicted, S: Supported, D: Declined)

User Orientation			16		Business Value			15		Internal Process			20
U	C	S	D		U	C	S	D		U	C	S	D
#	0	0	15	1	#	0	3	13	0	#	2	2	16	0
%	0	0	93	7	%	0	20	80	0	%	10	10	80	0

The variances of numbers and percentages of different statuses across categories were then calculated. The results showed that the new process makes a homogenous contribution to the Supported strategic objectives across different categories, as the variances of the percentages and numbers were quite low. The contributions to Declined strategic objectives also had low variances.

4.2 Impacts of SBPA

The application of SBPA had the following impacts on the organization in which we conducted the experiment:

1. The *participatory* and *model-driven* approach of identifying strategic objectives enabled different parties in the organization to express their strategic concerns, which improved the completeness of the SG. Indeed, this process helped organizational members to gain a shared understanding of the organizational strategic objectives.

2. The use of SG for analyzing a set of candidate agile process fragments introduced a new decision making approach within the organization, which can be used for the evaluation of a wide range of organizational initiatives.

3. The *Balance Improvement* technique had a considerable impact on the organization's decisions about their candidate agile practices. In fact, through this analysis the managers discovered that the proposed set of practices are incomplete with regard to the strategic objectives that were expected to get improved by the introduction of the new process.

4. The *Balance Preservation* technique clarified the set of strategic objectives which might be declined (or conflicted) by the introduction of new method. This clarification helped process mangers to know which strategic objectives would need to be monitored more closely after adopting the new process.

5. The category-level analysis techniques of SBPA guided the decision making of process analysis team by giving them a wider spectrum of strategic concerns which should be considered in the process of designing a new process. In fact, the original idea of introducing a new agile process to the R&D unit was highly under the influence of the Lean approach of process improvement, which focuses on the removal of software process waste [14]. The category-level analysis techniques raised the importance of other categories of strategic objectives for the analysis team, and

helped them to keep the integrity of the new process with respect to its contributions to various categories of strategic objectives.

5. RELATED WORK

The techniques proposed in this paper can be used to support the adoption of different kinds of processes. We have focused on the case of agile adoption, since the repository of method fragments that we have developed mainly provides information about agile processes. In this section, we review a number of agile adoption frameworks, with special focus on the kind analysis methods that they prescribe for investigating the suitability of a candidate process for an organization.

Sidky et al. [15] proposed an agile measurement index for evaluating the degree to which an organization can become agile. Based on this index, they defined an agile adoption framework. The first step seeks to identify *discontinuing factors* – whose presence indicates unreadiness of the organization to adopt agile. Project and organizational capability for adopting agile are then assessed. Based on the degree of potential agility, the most suitable set of agile practices are proposed. An application of this framework in adopting agile processes for the development of life-critical systems is presented in [16]. Despite the novelty of this framework in proposing a set of agile practices with respect to the potential agility (agile-ability) of an organization, the framework does not relate agile practices to a balanced consideration of strategic objectives.

Qumer & Henderson-Sellers [17] proposed an agile adoption framework backed by an agility measurement technique. The adoption framework, called Agile Adoption and Improvement Model (AAIM), introduces six levels of agile adoption: Agile Infancy, Agile Initial, Agile Realization, Agile Value, Agile Smart, and Agile Progress. At each level, the AAIM incorporates certain agile principles (e.g., Speed, Flexibility, People-orientation, Leanness, etc.) into the organization. This framework uses the 4-DAT agility measurement technique, which provides specific metrics for quantitatively assessing the agility level of a software process. Unlike [15], the AAIM does not explicitly propose agile practices to an organization,.Rather it focuses on the localization of agile principles. In relying on a quantitative measurement scale, the framework is sensitive to the way individual measures are combined to produce a single measure to represent the overall agility degree of a process.

Krasteva et al. [18] proposed an experience-based framework for adopting agile practices, using techniques from assembly-based situational process engineering. Sureshchandra et al. [10] proposed a framework for adopting agile in distributed development,composed of four stages: *Evaluation*, to determine the degree of distribution of the project; *Inception*, to form the distributed teams, and the way agile practice can be incorporated into the development infrastructure; *Transition*, to enact the agile practices into the development activities; and *Steady State*, to provide baselines for smoothly adding further distributed teams into the project.

Our approach in supporting the pre-adoption phase of process adoption with strategic analysis is quite unique, as none of the reviewed agile adoption frameworks introduces any technique in this regard. The proposed techniques can be used in conjunction

with other existing frameworks of agile adoption to further strengthen the choice of new process from the perspective of its compliance with the overall strategies of the organization.

6. DISCUSSION AND FUTURE WORK

Adopting a new process is a risky undertaking which should be carried out with adequate knowledge of its potential benefits and drawbacks. From the viewpoint of strategic management, process adoption is a significant organizational initiative, which might impact a wide range of strategic objectives. Some objectives might benefit from the adoption of a new process, some might be hurt. Therefore, it is important for organization managers to first, know the potential impacts of new process on strategic objectives, second, know whether the new process is in line with their strategic plans, and third, know if the new process would make negative impacts over the already improved strategic objectives. Having this knowledge about the strategic impacts of a new process would help managers choose the optimum solution for their development process, and make informed decisions about its advantages and drawbacks.

This paper defined the concept of Strategically Balanced Process Adoption (SBPA) which aims at a balanced performance across different categories of strategic objectives while adopting a new development process. The realization of the SBPA was then explained in two major parts: *pre-adoption analysis* and *post-adoption monitoring*. For the pre-adoption analysis four techniques were proposed, which anticipate the affects of a new (candidate) process over the strategic objectives of an organization, before the new process gets enacted. The idea of pre-adoption analysis is very similar to the rule of finding bugs in the process of software development – *the earlier a defect is found, the cheaper it is fix it*. Similarly, detecting and fixing the negative impacts of a development process (over strategic objectives of an organization) is for sure less expensive at the time that the new process is not yet adopted than afterwards. Of course any process initiative comes at a certain cost and might negatively impact some of the strategic objectives of an organization. One of the important points in SBPA is its focus on the analysis of the *controllability* of negative impacts over strategic objectives. The negative impacts of an adoption initiative are controllable if they are supported by reasonable justifications, or corrective actions to make them up. For instance, the adoption of an agile process that deploys Pair Programming, as part of its fragments, might result in the reduction of individuals' productivity (in terms of LOC per Month per Developer). However, this negative impact is controllable, if it is justified to be the reasonable cost of having fewer defects in code.

Although the presented techniques of pre-adoption analysis use some quantitative computations, the overall approach is not *computational* in that the computations are not intended to produce precise absolute numbers leading to unambiguous decisions. Instead, these techniques are *indicator-oriented*, i.e., they are used as indicators that provide a kind of dashboard or decision-aid in order to evaluate the envisaged process change in a more global perspective.

The idea of investigating the balance of a process adoption initiative was inspired by the approach of Balance Scorecards (BSC) in strategic management of organizations. The BSC argues that organizations should have a clear definition of their strategic objectives at different levels of granularity and various categories; also should have a clear understanding of the impacts of each organizational initiative over the organizational strategic objectives; and try to reach a balance state of performance across different categories of strategic objectives, upon the introduction of any new organizational initiative.

The proposed techniques for the realization of the SBPA are based on the repository of method fragments, introduced in our earlier ICSP paper [1]. This repository was originally built for agile method fragments, and for each fragment it specifies the list of objectives which can be contributed by the adoption of that fragment. The content of this repository is collected through an extensive literature review of empirical studies. For every contribution relation that is stated for any agile method fragment, the repository provides the link to the empirical study which had reported that contribution.

The reliance of the SBPA on the repository of agile method fragments has both positive and negative aspects. On the positive side, it supports the strategic analysis with evidential situations from the experiences of other organizations in trying similar fragments in their projects. Therefore, the analysis results are more reliable, compared to the cases that the basis of analysis is just the commonly known knowledge of agile processes, or the experience of a process consultant. Besides, the strategic knowledge of agile fragments can help organizations in completing their Strategies Graph. However, relying on the evidential repository has some negative aspects and imposes some limitations. The negative aspects are issues such as the lack of adequate information for some agile method fragments, or the mismatch of organization situation with the information that is available in the repository. The primary limitation that can be imposed by the heavy reliance on this repository is that the content of repository only supports the strategic analysis of agile method fragments (and a few non-agile method fragments). Thus the strategic analysis of non-agile method fragments would be left based on the consensus of analysis team and description of process, and not based on firm evidences from the repository.

A final point about SBPA is that the balance of a process adoption does not mean that the proposed process is the best solution for the organization. However, the SBPA attributes are quite important, and can greatly impact the choice of a candidate development process.

As future work we are going to propose a complete framework for strategic software process adoption. This framework would include techniques for strategic trade-off analysis and strategic root-cause analysis. The other major future work is the expansion of the repository of method fragments by supplying information for further method fragments, and providing more evidences for its current set of fragments. The proposed techniques of this paper have been experienced in one industrial case. Further experiments are intended to be done.

7. ACKNOWLEDGMENTS

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