

A Development of the Effectiveness Evaluation Model for Agile Software Development using the Balanced Scorecard

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Abstract—Most of standard procedures for the Software Development Process focus on the technical dimension; however, they are still deficient in performing with the project strategies. Therefore we develop a model consisting of the well-known standard procedure; ISO/IEC12207, and the Balanced Scorecard to fulfill missing dimensions for software projects. We bring the Agile Software Development Processes mapped with the ISO/IEC12207 to create the action plan in the Balanced Scorecard. The result of this research is a Scorecard composed of objectives, measures and processes results that are effectiveness evaluation procedure for facilitating the project manager in order to make a decision to align with project strategies.

Index Terms— Agile Software Development, Balanced Scorecard, ISO/IEC12207, Analytical Hierarchy Process

I. INTRODUCTION

CURRENTLY, many organizations focus on effectiveness evaluation for assessing and making a decision for projects. The Balanced Scorecard is a popular tool to evaluate projects aligning with the business objectives. Financial and non-financial must be balanced, not perform only one perspective.

The standard procedure for the Software Development process that focuses on the purpose of communication among acquirers, suppliers and other stakeholders, Software Quality Assurance (SQA), ordering and the Software Management [1] but not focus on performing with the project strategies.

The Agile Software Development is well known as a Software Development method that focuses on customer collaboration and quickly responds to change. So, it is the popularly accepted for software organizations.

The Agile Software Development method based on the Software Process standard should perform with the project strategies. To help the project manager make a decision, we present "A Development of Effectiveness Evaluation Model for the Agile Software Development Using the Balanced Scorecard"

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The purpose of using the Balanced Scorecard is to ensure that the project meets goals and objectives of project strategies. And ISO/IEC12207 is a standard and a good practice in the Software Development.

The aim of the presented paper is to combine the Balanced Scorecard with ISO/IEC12207 to develop the Effectiveness Evaluation tool for the standard Agile Processes to help the project manager make a decision aligning with project strategies, project goals, objectives, measure and Software Processes, find the cause of problem and solve problem in correct processes.

The remainder of this paper is divided into five sections. Section 2 describes the related theories and previous researches. Section 3 describes methodology and implementation to build the model. Section 4 is the result. The last section is the conclusion and future works of this paper.

II. BACKGROUND

A. Balanced Scorecard

The Balanced Scorecard was established by Robert Kaplan and David Norton in 1992. They defined the Balanced Scorecard as a multi-dimensional framework for describing, implementing and managing strategies at all levels of an enterprise and by linking objectives, initiatives and measures to the organization's strategy [2].

There are four perspectives that relate to business critical success factors:

1. Financial perspective describes how to create growth in the shareholder value i.e., to ROI, revenue growth, costs, profit margins, cash flow, net operating income etc [3].
2. Customer perspective releases quality products/services, understand requirements and meets customer needs.
3. Internal process perspective manages and improves processes that produce and deliver quality products/services.
4. Learning and growth perspective improves skill and innovation of staffs, increases employee's motivation and retention

The Balanced Scorecard converts business strategies to action plans. Each perspective is composed of strategic objectives, measures, targets and initiatives. These are linked to the main business strategies. It helps the project manager to ensure that the decision aligns with business strategic priorities from the Scorecard. Furthermore the

Balanced Scorecard makes people and all activities align with main business strategies.

B. ISO/IEC12207

ISO/IEC12207 is a standard Software Life Cycle Processes for systems and Software Engineering to employ the elements of an established set of Life Cycle Processes to provide products and services. In terms of software projects this standard is used in the assessment of conformance of the project to the declared and established environment.

ISO/IEC12207 contains processes, activities, and tasks that will be applied during the acquisition of software products/services and during the supply, development, operation, maintenance and disposal of software products [1].

ISO/IEC 12207 addressed the Software Life Cycle Processes within a systems context for making processes to be standardized. The standard represents the process reference model that intends to be adopted by an organization based on its business needs and application domain. Each process contains process purposes (the objective of the process performing), process outcomes (evidences), activities and tasks that are applied during the acquisition of a software product.

To adapt the processes of ISO/IEC12207, first defining the appropriate Life Cycle Model to the organization. Second, selecting a suitable the Life Cycle Model for the project. Third, applying the Life Cycle Model in order to achieve the purposes and outcomes of the stages of the Life Cycle Model.

C. Agile Software Development

The Agile Software Development was created by Agile Manifesto in 2001. Agile is a Software Development method based on customers' collaboration, sharing values and allowing for changes in requirements. The highest priority is to satisfy the customer through early and continuous delivery of valuable software [4].

The scrum is a popular process for adapting to the Agile Software Development. The scrum cuts activities into iterations called sprints. Each sprint phase spends time 2-4 weeks for developing a short-term plan. Developers must have the daily meeting for discussion about daily tasks.

At the beginning, the scrum implementation is split lists of requirements into Products Backlog. Prioritizing lists of products backlog and selecting to the Sprint Backlog (a list of tasks) by the development team. Then fixing a period of sprint phase and estimating the time spent on each task to be done within the sprint. The daily scrum meetings keep track of the previous day and the current day.

D. Analytical Hierarchy Process

The Analytic Hierarchy Process (AHP) is a theory of measurement through pair-wise comparisons and relies on the judgments of experts to derive priority scales. It was developed by Thomas L. Saaty in the 1970s

To make a decision by the AHP has following steps.

1. Defining the problem and determining the kind of knowledge sought.
2. Structuring the decision hierarchy from the top with the goal of the decision, then the objectives from a broad

perspective, through the intermediate levels to the lowest level.

3. Constructing a set of pair-wise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.
4. Using the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Doing this for every element. Then for each element in the level below add its weighed values and obtaining its overall or global priority. Continuing this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained [5].

E. Related works

Marion Lepmets [6] survey the alignment of process goals and its business goals in process improvement. The research indicates that in theory process assessment should align operational processes to an organization's business goals and motivate developers and operators to work towards achieving their organization's business goals. In practice, there was no correlation between conducting process assessments and such goal alignment.

Yan Xiaoli [7] found that the Balanced Scorecard method can be used for both the enterprise tier and the project tier and can be structured consolidated. This paper has generated support to apply the Balanced Scorecard in the software project tier for developing the Effectiveness Evaluation.

The Agile Software Development methods are a set of Software Development practices that respond to traditional methods. Mapping the Agile Software Development with ISO/IEC12207 was established by Minna Pikkarainen [8]. The results of the mapping of the Agile performance assessment experience and ISO/IEC 12207 was applied to map in a part of initiatives of the Balanced Scorecard to make a standard and good practices in the Agile Software Development.

Sarfraz Hashemkhani Zolfani [9] found that the Balanced Scorecard had hierarchical structures. The AHP method assumes that the factors presented in the hierarchical structure were independent. The AHP has been successfully applied in numerous the Balanced Scorecard studies. This paper uses the AHP for making a decision between the measures from the Balanced Scorecard and processes from ISO/IEC12207.

III. METHODOLOGY

The methodology is divided into three steps to transform business strategies into action plans. These three steps are described in detail below.

A. Implement the project goal, perspectives strategies, measures and targets for the software project.

The Balanced Scorecard implementation in a project size is composed of a project goal, perspectives strategies, measures, targets and initiatives. An example in this paper sets all composition for a medium software project.

First, defining a software project goal and a strategy for each the Balanced Scorecard perspective to align with the

goal. The general software project goal is "Delivering quality products on time" and strategies that are

1. Financial perspective – adding a value to the products and managing financial effectively.
2. Customer perspective - giving customers’ confidence by improving the customer satisfaction with the quality of products delivered.
3. Internal process perspective - reducing risks to late delivery.
4. Learning and growth perspective - continuing learning and technological tools.

Second, prioritizing perspectives by considering the significantly project goal.

1. Customer perspective.
2. Financial perspective.
3. Internal process perspective.
4. Learning and growth perspective.

Third, defining the objectives for each perspective to agree with the strategies. Then linking connection to all of the objectives in order to understand the cause and effect of relationship. It is called "Strategy Map" [9]. The Strategy Map is shown in Figure 1.

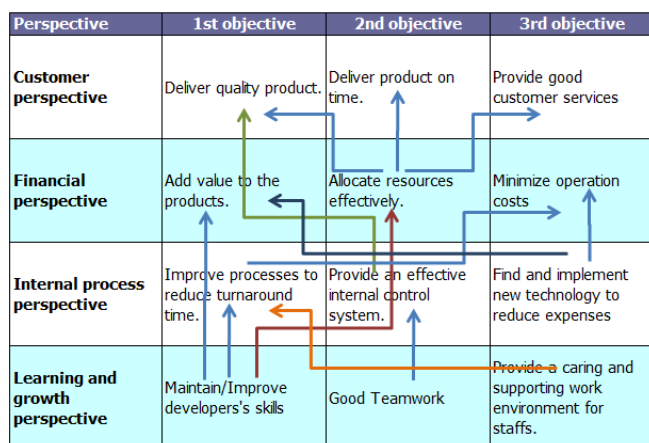


Fig. 1. The Strategy Map of the software projects.

The Strategy Map can be explained as a Software Development based on the ability of the person. Therefore learning and growth perspective is the first step to develop the personal skills and knowledge. They use knowledge to develop the techniques and improve processes that make a good teamwork (Internal process perspective). When a project has a clear and accountable process, they can manage resources fairly, reduce costs and add values to the result (Financial perspective). After three perspectives had been developed to make customers satisfied, customers perspective were success.

Forth, defining measures and targets for each perspective that aligns with the strategic objectives. The measures must be quantifiable for evaluating in terms of the objective achievement. The result from this step called "Scorecard".

In Table 1 shows the customer perspective of the Scorecard [10, 11]. The strategies of the customer perspective are "providing confidence to the customers by improving the customer satisfaction with the quality of products delivered". Therefore objectives to achieve the strategy should be composed of delivering a good quality of the product, in time and a good quality of service. In

addition, each objective should have measures and targets to monitor the Scorecard value to align with the strategy.

TABLE I
CUSTOMER PERSPECTIVE OF THE SCORECARD

Objective	Measure	Measures' Description	Target
Deliver quality product	Functionality	Percentage of functions follow requirements.	> 70%
	System response time	Time from start to end a system process.	< 2 minutes
	Bugs resolved	(Number of bugs resolved * 100)/Number of test cases executed	> 85%
	Availability	Average time from start system to downtime.	> 85%
Deliver product on time	Timing	Tasks finished within time	in time
Provide good customer services	Satisfy customer	Survey the satisfy customer	> 75%
	Timing	Tasks finished per a service	> 60%

B. Implement initiatives by selecting the Agile Software Development Process based on ISO/IEC12207

Referring to "Mapping Agile Software Development onto ISO/IEC 12207" [8], the research have focused on ISO/IEC 12207:1995 but we take account into the ISO/IEC 12207:2008, the latest version of the standard.

ISO/IEC 12207:2008 defines a common framework for the Software Life Cycle Processes, with the well-defined terminology, that can be referenced by the software industry [12].

The result of mapping the Agile Development Processes onto ISO/IEC 12207:2008 defines 27 processes that apply the defined processes to achieve the measure targets.

C. Mapping the processes onto the Scorecard using AHP

After the Scorecard was done, the next step is processes planning to meet the goals set. This paper uses the Agile Software Development processes from the previous step for planning.

AHP is used for mapping Software Development Process onto the Scorecard. At the beginning of AHP step is structure the decision hierarchy from the measures with related processes. For example, a measure (Software Response Time) a Hierarchical Analysis is as follows.

As regards to Figure 2, the first level of the hierarchical is a measure that replaces it with the Software Response Time. The second level is the decision criterion that is replaced with the goal achievement processes and improved processes. The third level is selected processes that follow the second level.

Then prioritize related processes by comparing with the same level of the hierarchy. The pair-wise comparison by putting scores (referring to the standard preference table [5]) into a matrix pattern that shows in Table 2. Summing up the row and normalizing by dividing the row sum then

finding the row average. In the decision criteria level the weight of achieved process is 0.2 and the weight of improved process is 0.8.

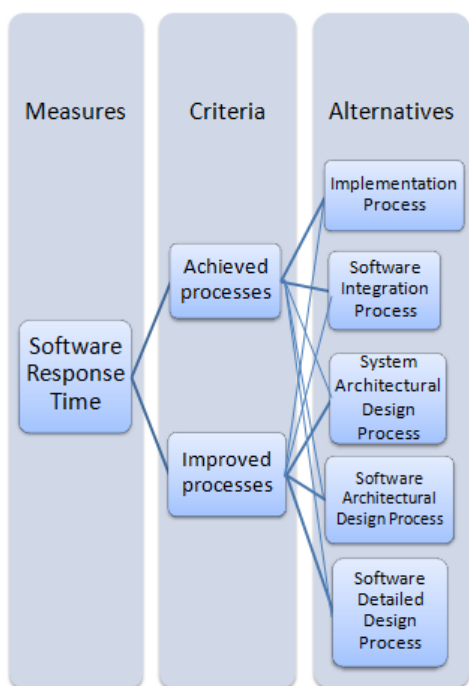


Fig. 2. The decision hierarchy for selected processes.

TABLE II
IMPROVED PROCESSES PAIR WISE SCORE MATRIX

Improved processes	Implementation Process	Software Integration Process	Software Architectural Design Process	System Architectural Design Process	Software Detailed Design Process
Implementation Process	1	1/2	1/6	1/4	1/5
Software Integration Process	2	1	1/7	1/5	1/6
Software Architectural Design Process	6	7	1	3	2
System Architectural Design Process	4	5	1/3	1	1/2
Software Detailed Design Process	5	6	1/2	2	1

The results in selected processes are 0.024945819, 0.030317103, 0.214133202, 0.091853714 and 0.138750163 that mean the Software Response Time is the most affected by the Software Architectural Design Process. If the Software Response Time score is low, the project manager should emphasize the Software Architectural Design Process as a first priority. The inferior are the Software Detailed Design Process, the Software Architectural Design Process, the Software Integration Process and the Implementation Process respectively.

Then calculating the consistency ratio to reduce the bias of respondents. In Table 2 shown the result of the CR is 0.064011094. If the consistency ratio is more than 0.1, reevaluate their choices.

IV. RESULTS

The result of a development is an Effectiveness Evaluation or the Scorecard that is composed of project goals, strategies perspectives, measures, targets and related processes. All of components has a relationship and agrees with the project goal. Furthermore, the project manager can also look back to ISO/IEC12207 Agile processes to monitor and control the cause of the problem processes. When the Scorecard value is low, it is a signal to warn the project manager to closely focus on that perspective.

V. CONCLUSION AND FUTURE WORKS

This paper presents the top-down model that emphasizes to achieve and understand the project goal completely. The top of model is setting the project goal, then refining into greater detail until to ISO/IEC12207 processes. For starting, we set the software project goal, after that we set objective strategies for each perspective to agree with the goal, and then prioritizing four perspectives in the Balanced Scorecard and developing the Strategy Map for clearly understanding to the project goal, setting measures and target to achieve the objectives strategies. Finally we use the AHP to map between measures and ISO/IEC 12207 process.

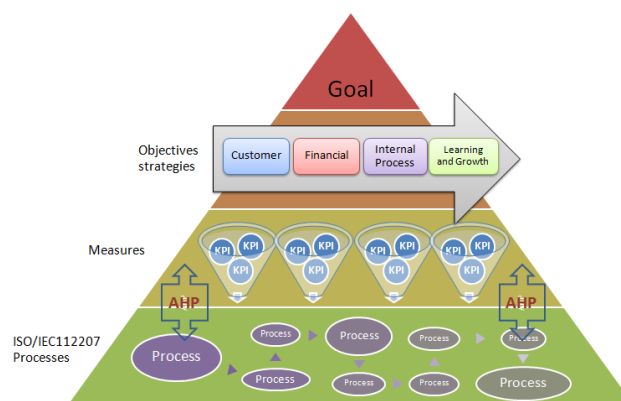


Fig. 3. The overview of this paper.

As regards to Figure 3, the method is divided into 4 parts. From the beginning we determine the project goal and then the objective strategies, after that prioritize 4 perspectives as regards the Balanced Scorecard, determine measure and targets for each perspective. Finally, using the AHP to map the measures and ISO/IEC12207 processes.

In the future to completely implement the model, the process definition from ISO/IEC12207 processes should be agreed with the measure targets. The project manager is able to monitor and control the project to agree with the project goal.

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