SAMS: A DECISION SCALE FOR ASSESSING MEDIUM AND SHORT SCALED/TERM SOFTWARE PROJECTS

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SAMS: A DECISION SCALE FOR ASSESSING MEDIUM AND SHORT SCALED/TERM SOFTWARE PROJECTS

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MELDA AKIN

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
IN
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FEBRUARY 2014

To my mother…

Approval of the Graduate School of Natural and Applied Sciences

Prof. Dr. Cüneyt GÜZELİŞ
Director

I certify that this thesis satisfies all the requirements for the degree of **Master of Science** in **Intelligent Computing System** option of **Intelligent Engineering Systems**.

Prof. Dr. Turhan TUNALI
Head of Department

We have read the thesis entitled **SAMS: A DECISION SCALE FOR ASSESSING MEDIUM AND SHORT SCALED/TERM SOFTWARE PROJECTS** prepared by **Melda AKIN** under supervision of **Prof. Dr. Yaşar Güneri ŞAHİN** and we hereby agree that it is fully adequate, in scope and in quality, as a thesis for the degree of **Master of Science** in **Intelligent Computing Systems** option of **Intelligent Engineering Systems.**

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ABSTRACT

SAMS: A DECISION SCALE FOR ASSESSING MEDIUM AND SHORT SCALED/TERM SOFTWARE PROJECTS

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Main goal of the most of the Software Development Companies (SDC) is to realize most beneficial and profitable software projects, and implement these in a very short time with high quality. In order to reach this goal, these SDC should designate well-analyzed and well-conceived strategies; therefore, new tactics and clearly defined decision making strategies should be developed. Finding an answer for the question titled “which software project is proper to realize?” usually requires exhaustive decision making processes. In addition, these processes may also need several new parameters (arguments) apart from time and cost when different factors emerge, e.g. new market opportunity-based studies, prestige based studies, critical sectors and critical projects. Before selection of the proper project, vital and inevitable parameters and arguments which are used in decision making processes should be decided. These parameters should carry information about all of the possible factors which can affect the decision, such as crucial constraints (legality), functional and non-functional requirements, human and technology resources, scope of project and socioeconomic issues. This thesis proposes a new method titled “A Decision Scale for Assessing Medium and Short Scaled/Term Software Projects” (SAMS) which intends to find the most appropriate projects among several short and medium scaled/term software projects. Moreover, it intends also to figure out most significant parameters should be used for selection process. Furthermore, a new decision making model using a scale form is proposed which takes the proposed parameters, time, cost and a number of existing parameters with particular weights.

Keywords: *Project Selection, Project Assessment, Score Card, Parameter Weighting, Scoring.*

ÖZET

SAMS: ORTA VE KISA ÖLÇEKLİ/VADELİ YAZILIM PROJELERİNİ DEĞERLENDİRMEYE YÖNELİK BİR KARAR ÖLÇEĞİ

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Yazılım geliştirme organizasyonlarının çoğu, kazancı en yüksek ve de en verimli projeleri gerçekleştirmeyi, bu projeleri de kısa sürede ve yüksek kalitede uygulamayı amaçlamaktadırlar. Bu amaca ulaşmak için organizasyonlar iyi analiz edilmiş ve iyi planlanmış stratejiler oluşturmalı, dolayısıyla, açık bir şekilde tanımlanan stratejilere uyumlu olacak şekilde de taktikler geliştirilmelidir. “Hangi proje gerçekleştirilmeye uygundur?” sorusunu cevaplamak detaylı bir karar verme sürecini gerektirir. Bu nedenle, yeni pazar fırsatlarını elde etmeye yönelik çalışmalar, itibar odaklı çalışmalar, kritik sektörler ve kritik projeler gibi etkenler söz konusu olduğunda, zaman ve maliyet haricindeki farklı argümanlara da ihtiyaç duyulur. Proje seçiminden önce, karar verme sürecinde kullanılacak önemli ve zorunlu parametreler (argümanlar) belirlenmelidir. Bu parametreler, kararı etkileyebilecek olası tüm faktörler hakkında bilgileri, kritik kısıtları (yasal zorunluluklar), fonksiyonel ve fonksiyonel olmayan gereksinimleri, insan ve teknoloji kaynaklarını, projenin kapsamını da içeren, sosyo-ekonomik bilgiler taşırlar. Bu çalışma, sayıca birden fazla olan, küçük ve orta ölçekli/vadeli yazılım projeleri arasında, en uygun projeyi/projeleri bulmaya odaklanan “ Orta ve Kısa Ölçekli/Vadeli Yazılım Projelerini Değerlendirmeye Yönelik Bir Karar Ölçeği” (SAMS) isimli bir yaklaşım sunmakta ve proje seçiminde kullanılması gereken en önemli parametreleri belirlemeyi amaçlamaktadır. Bu parametreleri, zaman, maliyet ve önceden belirlenmiş ağırlıklara sahip parametreler ile birlikte, bir ölçek formu kullanarak yeni bir karar verme modeli önerilmiştir.

Anahtar Kelimeler: *Proje Seçimi, Proje Değerlendirme, Skor Kart, Parametre Ağırlıklandırma, Skorlama.*

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Abbreviations

SAMS	A DECISION SCALE FOR ASSESSING MEDIUM AND SHORT SCALED/TERM SOFTWARE PROJECTS
SDC	Software Development Companies
P-M	Person*Month
BCG	Boston Consulting Group
PMO	Project Management Office
PMI	Project Management Institute
PEM	The Proposed Evaluation Method

1. INTRODUCTION

In the late 1990s, project management became very popular for information technology projects and a great number of software organizations have developed many software applications which categorize projects and share information of projects. Tools that developed in the ensuing years lead to the determination of further objectives of companies and evaluate project portfolios according to these objectives [1]. However, project selection process requires new adaptations with the effects of developments which are rapidly changing like technological, economical and political affect the strategies and plans directly. In this dynamic area, for putting the practice determined strategies, up-to-date parameters and right projects are required.

Project selection is the process of evaluating more than one project by considering specific constraints and specialties and then choosing sufficient and approvable projects to match up with the aims of the institution that are predetermined. Project selections are not only highly important for IT departments but also for all the administration departments and it can give efficient and innovative results when it is reformed with the experiences which are brought by businesses [2]. The project selection process has also effect on IT investment evaluations. Information technology investments evaluation is quite difficult task and can be classified as conceptual and functional [3].

During project selection process, as Souder suggests and represented in the Figure 1; the specialties like realism, applicability, sufficiency, flexibility, cost and easiness of access should be considered [4].

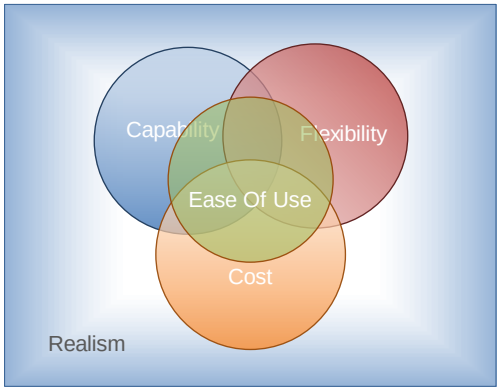

Figure 1 - Significant Criteria Based on Souder

- Realism – Should include all “important” variables of the real problem.

Objectives, strategies, goals and mission of software organizations have to be reflected in the model. The model should handle the project in terms of business values and technical values including the performance, cost and special constraints. Also parameters should evaluate all resources and possible risks.

- Capability – Should be able to integrate the variables into the algorithm.

Projects may have various specifications that require change so that the model should be flexible and applicable to the different type of projects. This change can be a new constraint, a new parameter or some rules that the software organizations must use etc. Also the model should not require additional methods. Compatibility between model and parameters of project affects the result of evaluation positively.

- Flexibility – Should handle various combinations of variables, including new ones.

The selection model should be easy to alternate, if changes are required. The situations which are like needing an adaptation or in terms of business parameters, some changes in rates can be seen necessitate the alternation. Also the model should optimize the final decision.

- Ease of Use – Should be intuitive, not requiring a long or steep learning curve.

Especially software organizations, steering committees have high technical background and generally they support their background with business studies so

that they can be arbiter in all parts of project selection. But the model should be understood by people in all parts of the organization and do not require to extra training or skills for the evaluation and selection process. In this way it should be clear and simple. Additionally, criteria, parameters and rules should be easy to understand and to evaluate.

- Cost – Should be cost effective.

Being cost – effective is an absolute must in all project selection models. If the model is not on finance and technical requirements, it may cause losses. The cost of determining selection and evaluation information and having optimal result must be in acceptable level.

As well as these specialties, in addition to selection chart, pre-selection criteria is the satisfaction level of the suggested project to the strategies that are determined by the firm. A project which is not suitable for the strategies cannot be talked about in the project selection process.

Evaluation of software projects and determining the investment areas have more than one way. Some firms use only quantitive criteria. These criteria consist of financial analysis like net present value, IRR, payback and cost.

Parameters which are related to IRR and support of the project to the business targets are the most important parameters [5]. But these parameters are not enough for a competent result. As suggested, software projects can offer results which may not be concrete during scaling of the projects and the decision making process of which project is most suitable and can mostly fulfill the aims. These quantitive approaches cannot give the correct results singly. Therefore, different approaches are suggested too. Among these approaches, one of the most used ones are the workouts that make multi-phase invested analysis [6-7]. In addition to these workouts, multi purposed optimization, value analysis; critical success factors also help the quantification of quantitive benefits [8]. There is a complex case which is very difficult to calculate, and cannot be represented by mathematical equations. That's why this case has no specific values. In this type of circumstances, the use of qualitative arguments is one of the crucial requirements [9]. As most organizations are aware of the fact that deciding only with the financial parameters isn't realistic

from strategic point of view. They must not only consider the financial parameters but also the non-financial parameters by aiming to determine the most efficient and suitable software projects which are offered [5].

2. MOTIVATION AND LITERATURE REVIEW

2.1. Motivation

Project selection is the evaluation of n projects having regard to constraints and characteristics, in the sequel, selection of sufficient and proper projects for the practice based on objectives which are determined by the company. In the previous years, for this process, generally financial criteria are used and though lack of required technical evaluation, results could not be satisfactory. Because of this reason, especially for the past 15 years, a number of criteria have been developed to be included in the selection process. Nevertheless, evaluation of different strategies which are raised by the technological growth and proposed new projects may not be easy, especially for the small and medium sized enterprises (small and medium sized enterprises: enterprises which employ less than 250 people). In the literature, project selection methods are collected under the two titles as numeric and non-numeric models. These methods may not be usable or may not serve the sufficient result in some cases. On the other hand, companies aim to select the best fit projects and get the optimum result for whatever the reason might be. Various modeling techniques have been developed for that main purpose.

It may be a challenge to select the most approved projects. New arguments are needed apart from time and cost when different factors emerge, e.g. new market opportunity-based studies, prestige based studies, critical sectors and critical projects. These arguments carry information which can be used in an analysis of existing constraints of projects, functional and non-functional requirements, human and technology resources, including scope of project and socioeconomic information. Therefore, a new study is needed to identify the most effective projects by making best use of the information obtained from feasibility studies. In this study, an

approach which is intended to find the most appropriate projects among several short and medium scaled/term software projects in which development period of these projects are at most one year, will be presented. In this approach, a decision making process will be developed, taking into account the time and cost of projects and also existing arguments. In this method, especially prepared scale will be used to give a particular weight to each argument of each project. Thus, the resulting tangible values will be used to select the most appropriate project.

2.2. Literature Review

This section presents the information about the background, definition and history of the project selection and evaluation processes and methods that inspired the proposed project selection and weighting method proposed in this thesis. For this purpose, the key components of the method including specifications and importance of parameters, project management offices, project proposals and weighting methods are examined in detail.

2.2.1. The Significance of Project Selection

The process of choosing the most suitable project has a strategic importance in the organizations and it affects the future of the organizations directly. While a well-executed project selection can move the firm to higher levels, a poor project selection can cause the collapse of the organization because it leads loss of money and time. As a result of this, “project selection” is a key point which is highly important and it has become a research subject in the literature. Actually, the process of project selection is an optimization problem. Because of this, many researchers have focused on mathematical modeling. But as well as mathematical modeling, there are researches that offer different solution models. For example the approach which is offered by BCG (Boston Consulting Group) shows that the projects can be prioritized as “must have, should have, nice to have” [10]. But these kinds of approaches do not give the opportunity of ranking the project as studied by Dickinson et al. [11].

Various techniques are being used for determining the metrics which are going to be used when choosing the projects [12]. Various scoring tools are improved which evaluate the projects by considering the basic criteria like meeting the pre-required needing, return, risk. These algorithms of tools calculate and represent the project’s

value by considering the metrics and cost [13]. In addition to this, analytic network process (ANP) approach is a potential method which offers solution to project selection processes especially in the research and development areas. There are several different researches which investigate the use of ANP and develop a general ANP model [14-16]. Furthermore, there are several studies about project selection based on Fuzzy logic [17-19]. Many different project selection methods have been conducted and introduced to the literature, such as analytical hierarchy method, decision trees, objective programming, quadratic programming, linear programming, non-linear programming, dynamic programming, game theory approach, sorting, ranking, quality function deployment (QFD), data envelopment analysis (DEA), balanced score card (BSC) methods are also being used [20-32] . Although it has been considered that 70% of the firms that are on the Fortune 500 firm list do non-numeric project selection in the researches [33]. There are also researches which explain that even a numerical metric maximizes the profit [34].

Chen represents the main, quantitive and qualitative factors that are anticipated as source for the methods [35]. The details of these factors can be analyzed in Figure 2.

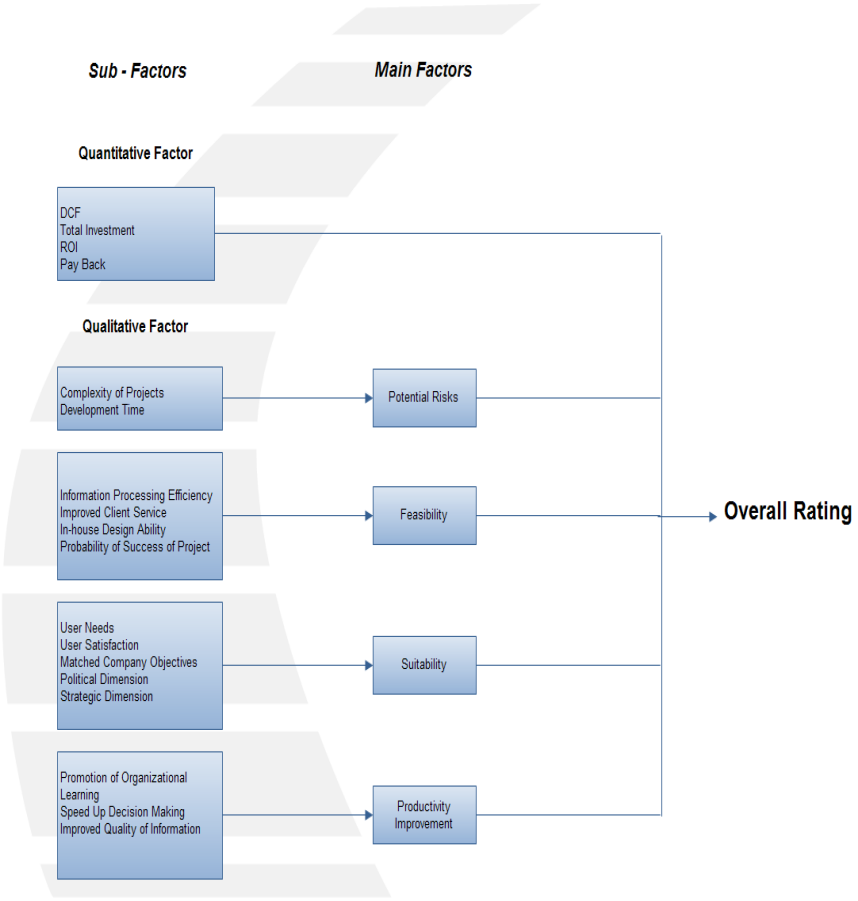

Figure 2 - Quantitive and Qualitative Factors

Although there are several solution methods about the selection of project to be offered, the study of Power Steering Thought Leadership, which was done with 103 participants, showed that only the 24% of the participant organizations have a standard project selection period, in case 4% of the participants are developing project selection models by using the formal feedback loops [36]. Therefore the ultimate aim of this study is to offer a project solution method which requires the minimum number of modifications, the organizations can use efficiently and effectively and to provide the method to be used.

Nowadays, competition environment is changing fast due to a lot of sociologic and economic effects that occurred by the improving technology and changing agendas. Because of this reason, organizations are faced with the situations that affect them negatively as well as many opportunities. To convert this effect to positive in the way of the organizations and to make projects that match with the strategies require serious cost in terms of time and investment. This situation forces the organizations

always to determine current strategically targets and to apply them fast. As a result of this, the littlest mistake which can be done by evaluating the projects can cause huge problems. The organizations ultimate aim is to pull the probability of these mistakes as much as possible to zero, choose the best project and to prioritize the projects according to their determined strategies.

Project selections and evaluations of Information Technologies are also very important for the organizations which are located on different sectors. In the committed researches, these organizations budget for the IT projects and the importance that they give is seen obviously [37]. Because of this reason, a well-planned information technology management is a key in the process of strategy and project selection. Information technology management is a structural system that investigates controls and directs the information systems [38].

In the organizations, doing the projects which are suitable for the pre-determined strategies of the organizations or prioritizing specific projects according to needs is one of the most strategic functions of the firm. This prioritization process requires detailed, orderly and definite calculation period based on the aims which are determined by the organization. This period is highly critical and hard as software projects that are committed or planned to affect some strategies. Also the firm's strategies affect the software projects (software project's type, time, period, limited sources, high risk, high cost, opportunity value etc.). This is why, the decision and project selection mechanism that is going to be prepared is crucial. Because of this the organizations are going to plan their information technology investments according to the result of the project determination and prioritization process. The project management office does this process.

2.2.2. Project Management

Project Management is the systematical planning, running, reporting and controlling of the project activities and outcomes to reach the project aims. When performing these activities, it is important to stay within the limited performance, costs and time.

Project Management activities deliver different advantages for companies:

- Managing the resources and processes more effectively,
- Predicting opportunities,

- Increasing profits,
- Taking measures against risks,
- Improvement,
- Determining activities that are realistic and suit the needs.

PMI (Project Management Institute), which is one of the biggest non-profit organizations in the world, intercommunicates Project Management Processes as 5 different items [39]. These items are: *Initiating, Planning, Executing, Monitoring, Controlling and Closing.* For more information, PMBOK can be studied [40].

2.2.3. Project Management Office

Project management is asserted as a critical approach to secure organizational competitive advantage [41]. Increasing importance and necessities of project management indicate that need of Project Management Methodologies so that Project Management Offices (PMOs) are proposed as the successful solution to improve quality of project management and established to serve a valid solution to this need [42]. Not only Information Technology organizations but also a great number of different type organizations increasingly use project management offices to co-ordinate activities of projects [43]. PMOs also develop and manage these methodologies to catch strategies of organizations with high valued and targeted outputs. Additionally, Santasus point that PMO has a significant role for improving the rate of the project success [44]. However, these developments bring out new investments and plans. Methods have applicable rules and specifications but the needs, plans and strategies of companies are different. Because of this, considerable number of companies has established their own PMOs in 2003 to give form to their unique operations [45].

Existing literature shows that PMOs have six major responsibilities. These are;

- Ranking projects with considering organizational strategies,
- Developing standards, processes and methods of project management,
- Improving organizational capacities,
- Monitoring and controlling organizational project,

- Training all project stakeholder including project team members and project manager,
- Managing the knowledge of the project and team members [46].

At the same time, project management office manages the each step of projects between the start and close of projects and has four main tasks. These tasks are represented as a pyramid in Figure 3.

Figure 3 - Task Pyramid of PMO

- Defining the project proposals, contents and formats,
  - Projects may have criteria and contents which are independent of each other. Additionally, viewpoint and definition style of person who prepares the project proposal form may be different. These differences could cause the problem like difficulty in comparison of projects. In that point, creating the project proposal form format might eliminate the problem. Hereby, projects can compared and become easier to evaluate.

- Checking the coherence and suitability of proposal forms with the format and collecting suitable forms for evaluation,
    - Project proposal forms can vary by project characteristic and the style of the person who prepares the form. Forms that do not adapt with the format should be reviewed and fixed after suitable forms are put into evaluation process.
- Organizing and informing the appreciators,
    - Project appreciators should have sufficient experience and knowledge for the effective evaluation. Additionally, before the start of the evaluation process, appreciators are informed about the process in detail.
- Evaluation,
    - Each project is based on strategies and characteristics of projects, evaluated and each project gains the score.

2.2.4. Project Proposals

IT management's critical aspect is to decide on the best project from a great number of competing IT project proposals. Selecting the right projects from more than one potential projects is a very critical activity and it has been recognized by so many researchers. The substantial strategic resource allocation decision that can link and set up in significant long-term commitments can explain as an optimal selection process [47]. One of the most important points in potential projects is evaluating possible opportunities and risks. Additionally, potential benefits and costs should take into consideration. For optimal selection, these parts should be explained clearly and include all possible metrics; thus extensive and systematic selection process is needed for executive to decide the most suitable project from many alternatives [48]. For that reason, definite project suggestion forms should be created, because Information Technology project selection is really difficult. It has lots of qualitative and quantitative factors to be evaluated in the candidate projects such as strategies, opportunities, benefits, risks, resources etc. so that candidate project forms contains detailed information about projects for the suitable and effective assessment study. In

well-designed project suggestion forms includes project summary, project's benefits, necessities, opportunities, problem's nature and potential solution approach which is provided for the need, implementation of project, time constraints and expected completion time, support for project completion to the determinetad time scale, experiences of project development team which is needed for the project put into practice. Determining the necessity and benefits of projects with non-technical terms, reason of urgency of need, tangible and intangible benefits are accepted as a sufficient when the defining the needs and opportunities for benefits of project execution.

Project team should explain with the key developers or decision makers, approximate ability of the team, number of people who will have active role in the project and their effects to the project.

2.2.5. Choosing Project Selection Model

Generally, time and resources cannot be adequate for putting into practice all of proposed projects, so that various methods are used for selection of projects that can be actualized with the available resources and time. These methods should fulfill the general needs of organizations, classify the information technology projects into a separate category, prioritize the financial income and use various scoring model.

Methods which fulfill the general needs of organizations, urgency level of project, availability and suitability of resources also motivation for the project carry high importance. But generally, it is not easy to prove which project is more important than the other candidate projects. As a result, some problems may occur.

Methods which prioritize the financial income, net profit and return on investment affect the decision. Even though financial criteria carry the high importance during the project evaluation process, getting the real and best fit result is not possible without taking into account technical parameters.

Scoring models present more reliable and realistic results than other models. Especially, if the weighted scoring models are implemented properly, it is possible to select the project that best fit the organizations. Weighted scoring models create suitable projects set for selection process with taking into account more than one

parameters during the evaluation. In this systematic process, first step is determination of importance level of parameters. Each parameter gets the x value which is related with its own importance and it is generated from predefined maximum n value. The sum of parameters' values must be equal to n value. After that, each project is scored based on the pre-defined scoring values. These scores are multiplied with the x importance value and then the total score is generated.

3. PROJECT SELECTION METHODS

Infinite corporate requirements and limited resources necessitate project selection. Generally there is not enough time or resources to implement all projects so that is methods include some key points for project selection. These are;

- Focusing on broad organizational needs.
- Categorizing information technology projects.
- Performing net present value or other financial analyses.
- Using a weighted scoring model.
- Implementing a balanced scorecard [49].

During the selection process, organizations take into account level and usage of inputs and aim to establish values of possible outputs. Suitable projects are determined via these outputs. Strategies, included with all factors and criteria, should be examined as possible as comprehensively to get the best fit results.

Factors that could affect the projects, such as production factors, marketing factors, financial factors, personnel factors, administrative factors and miscellaneous factors are collected under five different headings. These factors are represented in Figure 4 [50].

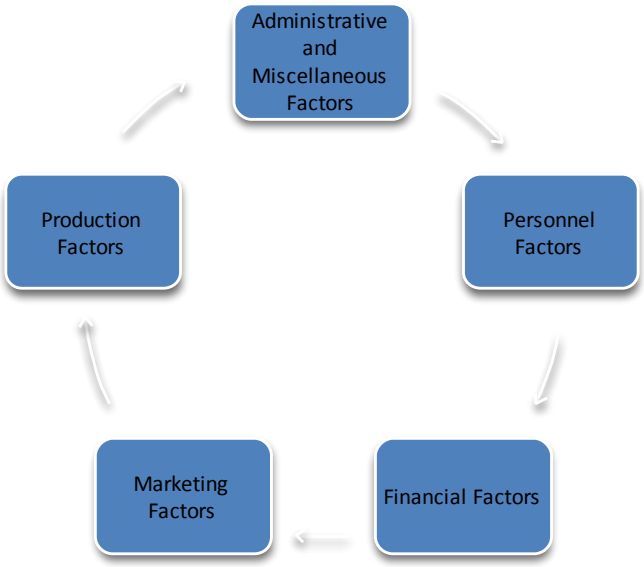

Figure 4 - Factors That Could Affect The Projects

Production factors involve all the production parameters like technological factors, required time until ready to installation, energy, specification, facility, material requirements and changes, software and process requirements, operation and learning curve parameters to get the high quality output.

Marketing factors focus on the output like the other factors and it involves parameters about potential market share, advantages, possible income, consumer acceptance, spin-off project possibilities and estimated life of outputs.

Financial factors involve parameters like payout period, cash requirements, net present value of investments, and time until break-even point, impact on seasonal and cyclical fluctuations.

Personnel factors involve all parameters which are related with the personnel resources and which carry possibility to affect the project. Training and skill requirements, level of resistance from current work force, change in size of labor force, impact on working conditions, inter and intra-group communication requirements parameters are important parameters which should be taken into account during the selection process.

Administrative and miscellaneous factors involve the parameters which are related with the competitors and producers, standards, required technology, controlling new

process, patent and trade secret protection, managerial capacity to direct, impact on image with customers and on information system. Meredith and Mantel grouped them as described as shown in Figure 5 [50].

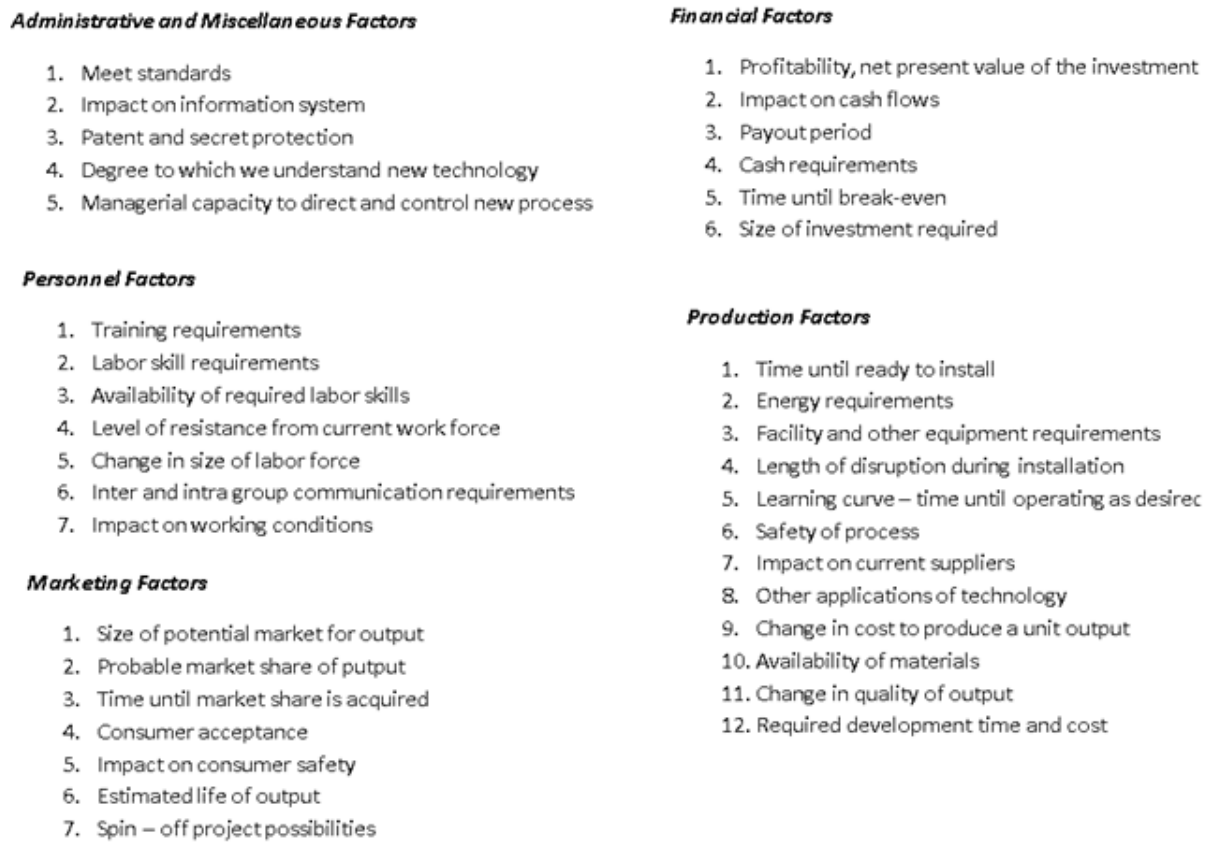

Figure 5 - Scopes of Factors

Project selection and prioritization operation have been done with methods which are classified into the two main groups as benefit measurement methods and constrained optimization methods. Constrained optimization methods use the mathematical approaches. Benefit measurement methods contain two groups as numeric models and non-numeric models. Non-numeric models do not use numbers, use inputs as they are implied by name. On the other hand, numeric models do. Numbers are the main inputs of models. The significant point is that criteria measurement might be subjective or objective. But, each model has the possibility to decide which project will be done on its own. The opinions of decision makers are crucial in this process.

Numeric models are newer and contain two main classes as Profit/Profitability Model and Scoring Models. These models are divided into subtypes depending on specifications. Non-numeric models are simpler and have five sub classes to consider. These are; Sacred Cow, Operating Necessity, Competitive Necessity, Product Line Extension, Comparative Benefit Model. Up-to-dated classification of selection and prioritization is represented in the Figure 6.

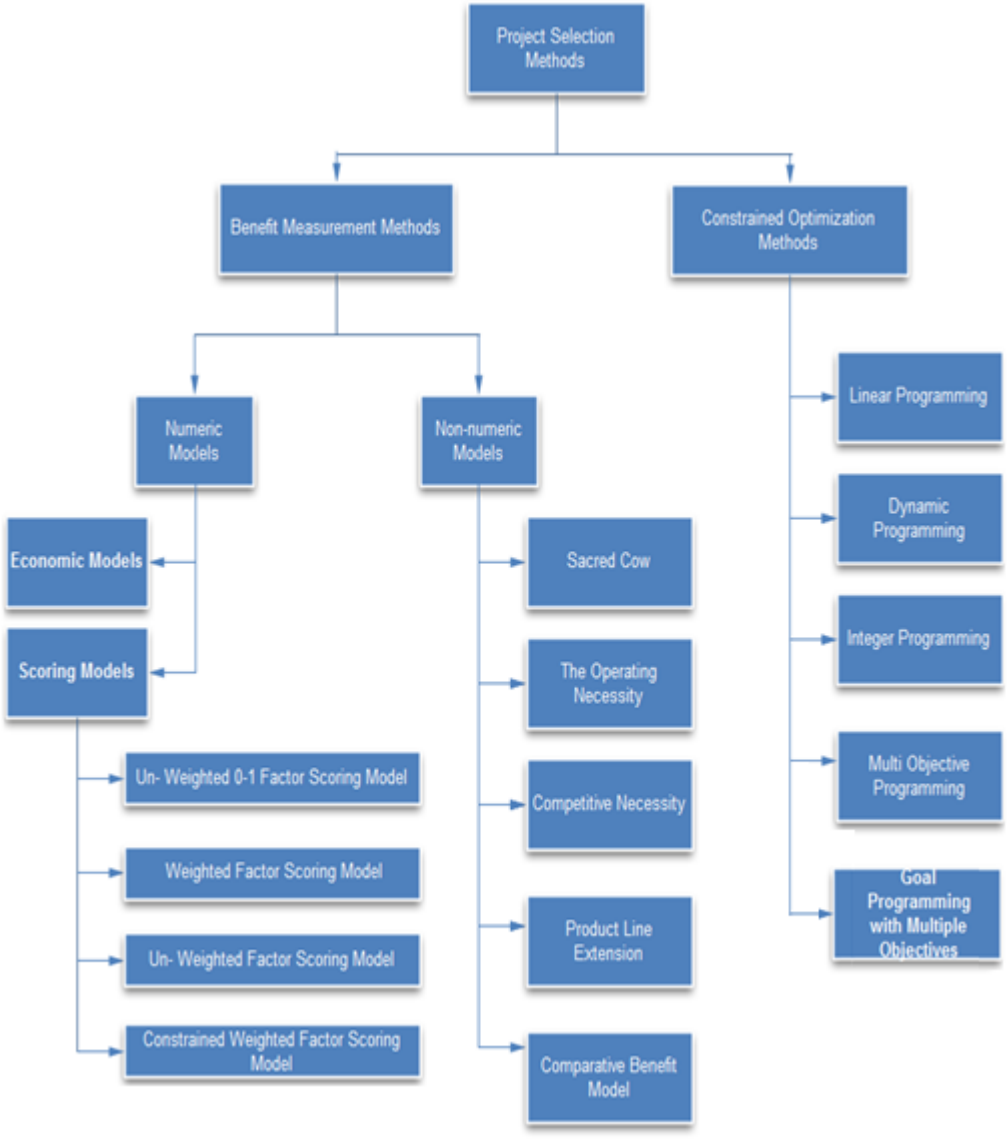

Figure 6 - Classification of Selection and Prioritization Models

3.1. Benefit Measurement Method

Benefit Measurement Method is a comparative approach and it is the most common one. It is easier than the evaluation of constrained optimization methods because it does not require complex calculations or various constraint satisfactions.

It can be classified into two categories as Numeric Models and Non-Numeric Models.

3.1.1. Numeric Models

Inputs which are used in project selection process are numerical values. After a comparison among projects has been done based on these numerical values, evaluation is not open to interpretation. It includes two classes; Economic Models and Scoring Models. Profitability models use just one criterion. These are profit and aim to maximization. On the other hand, scoring models evaluate projects based on more than one parameter.

Numeric models are understandable and very simple to use. Selection and absolute yes/no decisions are possible. Furthermore, inputs are familiar to accounts and outputs to decision makers so that these types of models are perceived as advantageous models. On the other hand, there are some disadvantages that should be taking into account during the selection process. Ignoring the non-monetary factors, input errors (e.g., unclarity in inputs), ignoring periods over payback can be thought as disadvantages.

3.1.1.1. Economic Models

There are some basic criteria which are used for potential projects elimination assessment. These criteria are;

- Actual Net Value

- Internal Profitability Ratio

- Internal Efficiency Ratio

- Average Efficiency Ratio

- Benefit/utility Cost Ratio

- Reimbursement Period

Models are based on initial fixed investment and cash flow and provide calculation by considering turnaround period, average yield ratio, internal efficiency ratio and profitability index. Since such models ignore non-financial but required factors that must be taken into consideration during election process, they do not give the real results. At the same time, although model outputs are explicit (0-1); internal efficiency models can give more than one output and cash flow concept can cause complicacy for project assessment.

3.1.1.2. Scoring Models

Score card technique was introduced for the first time in literature with a Harvard Business Review article called “The Balanced Scorecard – Measures That Drive Performance” article written by Robert S. Kaplan and David P. Norton in 1992 “Putting the Balanced Scorecard to Work” (1993) and “Using Balanced Scorecard as a Strategic Management System” (1996) which was developed by adding new information to the first article by the authors, were the follow-up studies of Kaplan and Norton. Subsequently, they distinctly explained actual modality of their method with the book “Converting Strategies to the Action Method” [32, 51].

Scoring models have more understandable and simpler shapes/frameworks than mathematical models have. Besides, they provide evaluation of multiple criteria, adaptation to changes and give more weight to some traits than others and this leads to different way of calculation. However, since they are simpler and more understandable, they cause addition of redundant traits which can cause mistakes to scoring. And since the output will be relative, the accuracy of the results will not be certain. Sample score card is represented in Table 1.

Table 1 - Sample Score Card Model

Parameters	Weight	Project 1	Project 2	Project 3	Project 4	Project 5
1. Supports the key strategies.	25%	80	50	100	100	90
2. Improves the loyalty of company.	15%	10	50	20	80	60
3. Can be implemented with the existing resources.	10%	70	50	100	60	30
4. Can be implemented in 6 months.	5%	10	50	10	20	20
5. Involves urgency.	15%	30	50	40	70	25
6. Has low risk in time and finance.	10%	100	50	60	80	40
7. Does not require extensive training.	10%	60	50	50	90	30
8. Software platform is suitable.	10%	80	50	80	90	30
Weighted score of project:	100%	57.5	50	63.5	80.5	49.25

Project screening matrix that is represented in Table 2, is one of the alternatives to simple score card. The main idea is same but the representation and format of matrix is different.

Table 2 - Project Screening Matrix

Criteria	***Strategic Fit***	***Urgency***	***Improve Loyalty***	***Innovation Value***	***Suitability to Software Platform***	***Weighted Total***
Weights	***3***	***3***	***1***	***2***	***2***	***-***
Project 1	8	2	0	1	9	50
Project 2	10	5	0	0	7	59
Project 3	5	1	0	7	10	52
Project 4	10	8	2	4	8	80
Project 5	4	3	0	10	10	61
⋮	.	.	.	.	.	.
Project n	6	6	2	0	10	58

As seen in Figure 7, four score card techniques are available for project selection process.

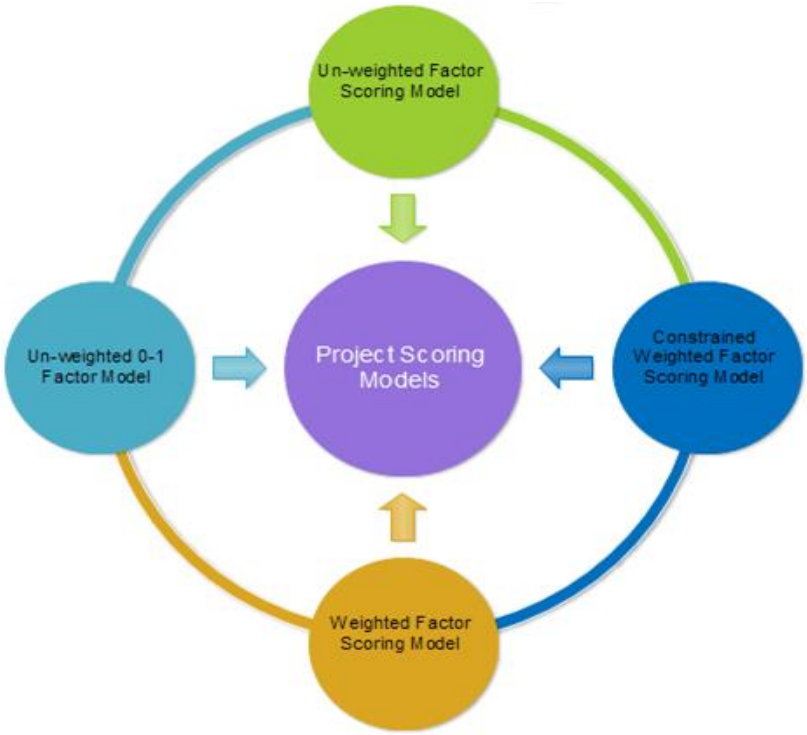

Figure 7 - Available Score Card Techniques

Advantages of score card;

- It is more understandable than other models.
- It is more practical for integration of possible changes on projects than others.
- Since trade-off is more measurable between the parameters, sensivity analysis is possible.
- Since some criteria are more overwhelming than others, measurements are conducted as required.

Disadvantages of score card;

- On unweighted score cards, all parameters are considered as to have the same importance and thus the most suitable Project list for the strategies may not reflect the reality/fact
- Since many criteria can be integrated, unnecessary parameters can cause misleading results
- Outputs of unweighted score card models are congeneric

These Unweighted 0-1 Model, Unweighted Score Model, Weighted Score Model, Constrained Score Model is called as a Multi-Criteria Scoring Models. In Unweighted 0-1 Model, the project either satisfies criteria or not. If it satisfies, then the criterion has value 1. If not, then the criterion has value 0. In Unweighted Score Model, a project is scored on discrete linear numerical scale subject to the extent to which satisfies criteria. In Weighted Score Model, criteria's related importance can be adjusted. This adjustment is made by weighting related contribution to the overall score of projects. It is one of the most used methods. Different type of studies are seen in the literature [52-54]. Converting values of parameters to the Fuzzy numbers provides acceptable and effective results. In Constrained Score Model [55-56]. There is different type of usage, it includes switch criteria which must be satisfied else overall project score will be 0.

Multi-Criteria scoring models can be defined as a general mathematical formula as follows;

$$S_i = \sum_{j=1}^{n} s_{ij} w_j \quad (1)$$

Where;

S_i : Total score of the *i*th project

n: Maximum number of selected parameters

s_{ij} : Value of the *j*th parameter of the *i*th project

w_j : Weight of the *j*th parameter

Here, parameters denote criteria. The weights can be generated by several techniques.

Each scoring model has different specifications and needs. However, these models require two common points. These points are agreement on criteria and the score which is assigned to each parameter.

Multi-Criteria Scoring models have common procedure. It includes three steps; preparing criteria list, giving a weight to each unique criteria, combining scores of all criteria and finalizing the score. The process is represented in Figure 8.

Generally, project choosing transactions start with the examination of predetermined targets of a firm. After, a factor list that identifies scope of the criteria is prepared by taking into consideration of the targets. These criteria are centralized according to measurement method. And the total score is calculated for each project. Hereby, the most suitable projects for the identified strategies of the firm can be aligned.

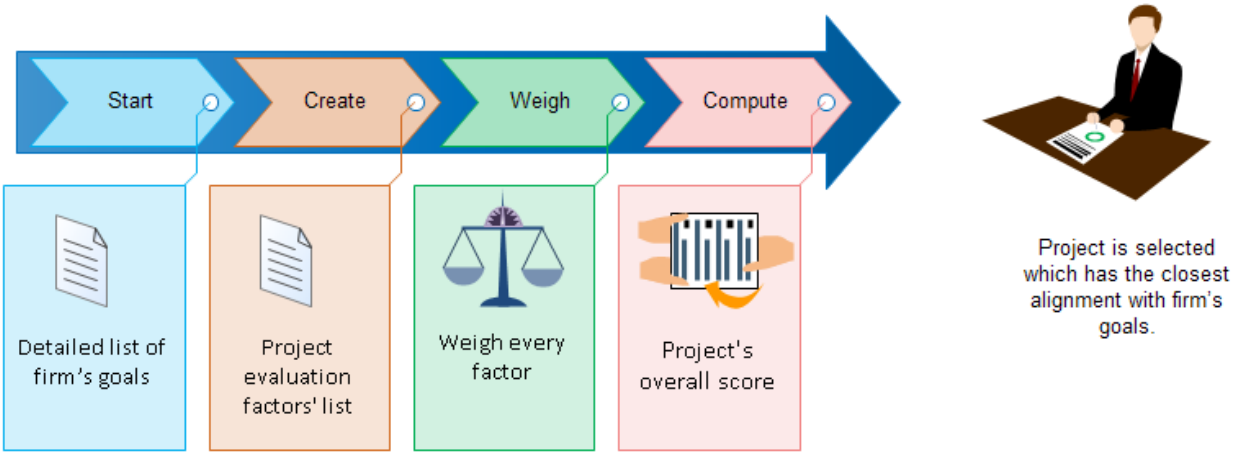

Figure 8 - Representation of Multi-Criteria Scoring Model Procedure

A. Un-weighted 0-1 Factor Scoring Model

In the project selection process, various criteria generate different type of parameters. Importance of these parameters may not be the same. However, un-weighted 0 or 1 Factor Scoring Model does not allow to rate projects with several parameters. The main idea is that all parameters have equal importance. Although the method takes into account various parameters during the selection process. This idea causes erroneous project selection. The sample of this model is represented in Table 3.

Before the practice of un- weighted 0-1 factor scoring model, relevant parameter set is decided by the managers and experienced seniors. Selected parameters are listed in the specific form. The raters, who are competent in terms of skills and project selection, score the projects on each unique parameter, depending on whether or not the parameter qualifies the related criteria. These criteria is thought as the satisfying the strategy of the organization. It is easy to compute. Each criterion is scored as 1 or 0 for each parameter that should be considered. For the result, it requires just total or the averages of scores. Then, the score of the project is compared against all other candidate projects. But the method is not suitable for the effective project selection because of different level of importance.

Table 3 - Un-weighted 0-1 Factor Scoring Model

Parameters	Qualifies	Does Not Qualify
1. Supports the key strategies.	x	
2. New technical expertise does not require.		x
3. Improves the loyalty of company.	x	
4. Can be implemented with the existing resources.	x	
5. Can be implemented in 6 months.		x
6. Involves urgency.	x	
7. Has low risk in time and finance.	x	
8. Does not require extensive training.		x
9. Software platform is suitable.	x	
10. Carries the innovation value.		x
Total:	6	4

Mathematical representation of the model is [57]:

$$Sp = \sum_{i=1}^{n} Pv_i \quad (2)$$

Where;

Sp: Score of the project

n: Maximum number of selected parameters

Pv_i: Value of the *i*th parameter (this should be 0 or 1)

B. Un-weighted Factor Scoring Model

Un-weighted Factor Scoring Model may be defined as one of the simplest methods. It does not require specific computations. Also, it may be thought as a utilization of the un-weighted 0-1 factor modeling's limitations. This model replaces the 0-1 with the scaled values. Each parameter of the project's criteria is evaluated depending on determined score scales. Generally, 1 to 5 scales is adopted. 5 can be "very good", 4 "good", 3 "fair", 2 "poor", 1 is "very poor". Each parameter of each project is evaluated and the scores are calculated. Rating, based on score of projects, is done. The sample model is represented in Table 4.

Mathematical representation of the model is [58];

$$Sp = \sum_{i=1}^{n} s_i \quad (3)$$

Where;

Sp: Score of the project

n: Maximum number of selected parameters

s_i: Value of the *i*th parameter (this should be empty or x)

Table 4 - Un-weighted Factor Scoring Model

Criteria				
	Functionality	Ease of Use	Interoperability	Extensibility
Scores	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Project 1	x	x	x	x
Project 2	x	x	x	x
Project 3	x	x	x	x

C. Weighted Factor Scoring Model

When the numbers of criteria in the project increase, project selection method becomes more complex. In that point, weighted factor scoring model provides systematic process. With this method, a number of criteria can be evaluated and be used in the reformation and improvement processes. Generally, weights are determined by Delphi Technique or AHP technique which is the form of multi criteria analysis [59-62]. Weights can be sum up to 1 or 100. Due to the fact that non-numeric criteria can join to the evaluation process, data which are very close to the reality can be obtained at the end of the evaluation process. Just after the evaluation of all parameters, the project with the highest point between the evaluated projects is selected. Some small differences can be seen at the end of the process but they are not taken into account.

Mathematical representation of the model is [57];

$$Sp = \sum_{i=1}^{n} w_i \, s_i \qquad (4)$$

Where;

Sp: Score of the project

n: Maximum number of selected parameters

w_i: Weight of the *i*th parameter (this should be 0 or 1)

s_i: Value of the *i*th parameter (this should be 0 or 1)

Main steps of weighted factor scoring model;

1. Determining the important parameters to the project selection and evaluation process.

2. Assigning weights according to importance of each parameter.

3. Assigning scores to each parameter of each project.

4. Calculating the total weighted sum via values of weights and sores.

D. Constrained Weighted Factor Scoring Model

The Constrained Weighted Factor Scoring Model carries particular specification. New multiplicative parameter is added to the mathematical representation of Weighted Factor Scoring Model. This additional parameter is named as a constraint and is added to the model rather than the weighted factors. These constraints are important because they reflect the project characteristics. The model performs the most sophisticated of the acceptably easily implemented numeric project selection methods [63]. It is also possible to incorporate the financial and subjective criteria such as the operating necessity, competitive necessity, as well as business criteria and technological criteria.

It can be explained in two different manners. One of the mathematical representations of the model is;

$$S_i = \sum_{j=1}^{n} s_{ij}\, w_{ij} \prod_{k=1}^{v} c_{ik} \tag{5}$$

Where;

S_i: Score of the *i*th project

n: Maximum number of selected parameters

v: Maximum number of constraints

s_{ij}: Value of the *j*th parameter of the *i*th project (this should be empty or x)

w_{ij}: Weight of the *j*th parameter of the *i*th project (this should be 0 or 1)

c_{ik}: *k*th Constraint of the *i*th project (this should be 0 or 1)

Here, *i*th project would satisfy the legal requirements, if all of the c_{ik} are 1, otherwise the results would be 0; therefore *i*th project should be rejected directly.

3.1.2. Non-numeric Models

Non-numeric models are older than numeric models. They do not have numeric inputs and that's why they serve as subjective selection and evaluation. Nevertheless, the implementation of these models is easier than the numeric models. The Numeric models reflect better solution set. In other words, non-numeric models might not give the real suitable solution because non- numeric models do not have the ability to evaluate all parts of project in full objective manner.

3.1.2.1. Sacred Cow

In the Sacred Cow method, the decision of the manager, leader or someone who is well-esteemed in the organization is the only factor in the project selection without employing any other selection or evaluation method [64]. Prestige, necessity of project, legal necessities, client demand, market and system requirement, technological necessities and requirements and some regulations have the key role in the decision making process. When the executives decide to put the project into practice, the project is progressed without any metric evaluation or feasibility study.

The main idea is the following "If the available capability is enough for the project, the project will be done." The team is just responsible for the progress and implementation of project. Besides, the word "Sacred" implies that project will be brought to close if the well-esteemed person understands that the decision is not suitable for the organization.

3.1.2.2. The Operating Necessity

The Operating Necessity is a project selection method which meets the requirement to improve and regenerate process, provide continuity or function properly with impact of technology and processes that require changing, developing or cohesiveness obligations [64].

In recent years, different types of competitions, alternation and integration processes are intensively in use. This issue affects the organizations directly and organizations must take them into account to get the desired success. On the other hand, technology became a necessity for all parts of the organizations. According to developing technology regulations, procedures are edited so that new technologies have a high importance for the current and future status of the organizations. For

instance, “e-fatura” regulations in Turkey are one of the most required projects [65]. Organizations must have a technological platform which is suitable for the system; provide process continuity and disaster recovery scenarios. In that point, organizations do not use any numeric model because it is a mandatory project.

3.1.2.3. Competitive Necessity

Competition is seen in all kinds of business areas, including universities, banking, software organizations, hospitalities etc. Therefore, these organizations should satisfy their needs to increase their power and to preponderate in competitions, so that the main issue is to decide the project which provides gain an advantage over other organizations. For example, online banking systems, online reservation systems, mobile phone applications, digital watches are the product of the competitions [64].

3.1.2.4. Product Line Extension

The Product Line Extension technique will be used if the firm is planning to publish a new product or to integrate a new annex to use the actual system for adding positive value to the firm [64]. It is also acceptable when the firm tries to achieve performance increasing by propagating product variety. Detailed calculations or profit ratio might not be important. To start a project or not will be decided by measuring general performance change success.

3.1.2.5. Comparative Benefit Model

Comparative benefit model is preferred when the numbers of candidate projects are available at the same time. These projects may have various specifications and criteria which are not easy to compare with each other in terms of suitability of strategies or benefits. Especially, legal necessities, technological necessities make the process easier because these are thought as “must-have” projects. Apart from this situation, project selection and evaluation process becomes more complex and evaluation takes a long time. Furthermore, in general organizations have no pre-defined model of project selection. According to specifications of projects, the method is selected. The selection committee discusses the benefits of projects for measurement or they can implement the Delphi Method or Q-Sort Method.

a. Delphi Method

Delphi method is one of the most popular, long range and qualitative technique which has been applied widely to many problems in various domains [66]. It is an iterative technique and is developed in the 1950s first by RAND in the U.S. Air Force to forecast the technology impact on warfare [67]. It is in general useful for complex problems which require a consensus among experts.

The purpose of the Delphi Method is to make predictions, to reveal the real opinions of experts without any external effects and to make consensus. In that point, The Delphi Method is explained as a method which is based on anonymity, statistical group response and controlled feedbacks. The method should be conducted by a director and necessitates expert groups who will be anonymous in the form during the questionnaires process and feedback receives of a statistical representation of the "group response". These experts are chosen for their knowledge and experience. The aim is to reduce the response range and to be closer at the expert consensus [67].

b. Q Sort Model

Q-Sort Selection Technique can be used to determine the priorities, if the project group will be selected from numerous projects. This Q-Sort selection technique is one of the most straightforward techniques among several selection techniques for ordering projects. This technique is not only preferred in IT projects, but also in other science’s fields [68].

As seen in Figure 9, the main work is to divide the projects into three different groups; high, medium and low [69]. This will be done according to their relatives. If the divided group has more than eight members, the subdivision will be done with two categories instead of one. These categories will be called as medium-plus and medium-minus. The categorization will be continued until all the categories have the maximum eight members. When this rule has been followed, the projects will be ordered from the best one to the worst in each category.

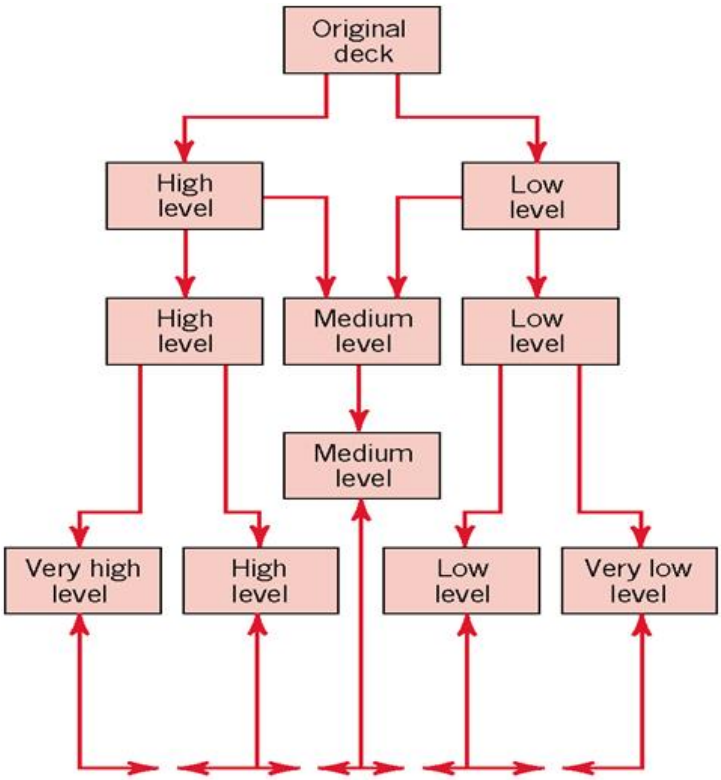

Figure 9 - Q Sort Technique [69]

Relative merits have distinctive role on the ordering process. In the ranking process of projects, raters may use overall judgment or specific criteria.

3.2. Constrained Optimization Method

Constrained Optimization Method is a mathematical approach that used for large projects. It includes complex mathematical calculation process based on different type of case scenarios and probability of outcome and then selecting projects on the results [70]. According to need of project's evaluation, it uses decision trees, linear programming, dynamic programming, integer programming and multi-objective programming. Generally, these methods are preferred if the project is complex or larger. Various calculations are needed in order to decide on which project should be done or rejected.

3.2.1. Linear Programming

Linear Programming is a decision making model that was first generated at the end of 1940s. It is a deterministic approach and preferred in a wide range of area such as industrial, military, economy even social sciences. Before the development of linear programming, observations indicated that a number of problems could be expressed by mathematical systems of linear equations and inequalities. This realization gave a rise to the linear programming development [71].

Linear programming, in other word linear optimization deals with finding optimal solutions or values which can be defined with linear inequalities and linear equalities [72]. Generally this equation focuses on finding the minimal or maximal values taking into account defined conditions, constraints or restrictions.

During the project selection processes, the goal is to rank and search out the project which is satisfy the objective points of organizations; evaluation is put into practice based on these conditions and constraints. In the literature, so many project selection techniques which include linear programming are seen, such as [20, 73-74].

3.2.2. Dynamic Programming

Dynamic programming is a solution method, like divide and conquer method, for solving complex problems by dividing the cases into the simpler sub-problems, so defining the sub-problems is one of the most crucial parts in the solution process [75-77]. It transforms complex problems into a sequence of simple problems. The approach searches to solve each unique sub-problem only once and then saves answers in a unique table, thereby reducing the number of computations are required [78]. Also it is useful when the number of problems that repeating grows exponentially as function of the input's size [79].

Dynamic programming is accepted as one of the most useful method and can be examined via studies such that [80-83].

3.2.3. Integer Programming

Integer programming models arise practically a wide range of area of mathematical programming [84]. There are three different type of integer programming cases; pure, mixed and zero-one. Pure ones are cases that in which all parameters are needed to

have integer. Mixed ones are cases that in which some of parameters but not all are needed to have integer values. Zero-one cases that in which all of the parameters must have 0 or 1 as a value.

They also have important role in decision making process for managerial decisions and can be integrated various cases according to conditions. The expected result, such as, seeking the project that satisfied strategies of organization and have the best benefits, is defined as an objective function. This objective function, parameters and constraints are linear. As explained previous paragraph, it is a feasibility model that related parameters are restricted to be integers.

Integer linear programming models are widely seen in project selection and evaluation processes, such that [17, 20, 85-87].

3.2.4. Multi-Objective Programming

Multi- objective programming, in other words, multi criteria optimization or multi attribute optimization or Pareto optimization is an area of multiple criteria decision making which deals with the mathematical optimization problems containing more than one objective function to be optimized concurrently. It can be used in case which require optimal decision when trade-offs exist due to two or more conflicting objectives [88].

In practice, linear programming contains a lot of parameters and their values are assigned by the decision makers. Sometimes, decision makers may not know the values of parameters. In such circumstances, Fuzzy Linear Programming (FLP) problems may be occurred and they are solved by multi-objective linear programming. In the literature, some of these types of studies can be examined [89-92].

The project selection and evaluation processes can be defined as multi-objective decision making problems because of the so many conflicting criteria and objectives. Some instances can be found in [93-94].

3.2.5. Goal Programming with Multiple Objectives

Goal programming is a tool that has been proposed as a solution method and approach for the analysis and evaluation of cases which involves multiple and conflicting objectives [95]. It is one of the oldest methods. Literature studies shows that the notion is generated in 1952 and became an applicable form in 1960s [96]. Among the various proposed methodologies of multi criteria decision making, goal programming is thought as the most popular and widely used [82].

The model is a form of linear programming cases which contains constraints. These constraints may be defined as conflicting criteria. Additionally, goal programming models are formulated under the same assumptions, conditions and limitations as linear programming models. The cases which can be solved with the goal programming, can be solved also by the simplex method [97]. The model provides the flexibility to achieve goals only at the expense of other goals.

On the other hand, the goal programming requires the establishment of a weighting system for the determined goals such that weighted goals or lower- ranked goals are regarded on only after the higher ranked goals are satisfied.

4. THE PROPOSED MODEL FOR PROJECT SELECTION

This chapter gives the details of the “Proposed Project Selection Model” (SAMS) including “Proposed Evaluation Method”, technical and business parameters.

4.1. Proposed Project Selection Model

The project selection and evaluation endure a problem that every organization faces and plays a crucial role in the companies’ prosperity.

Most of the modern organizations, especially software development organizations, aim to make the best decisions during the project selection process which brings the success and catches the recent trends; thus they use several project selection and evaluation methods. Decision process on project selection requires well-designed selection method that measures the various factors which affect the process, and it has to be considered before the start of the project. In spite of various project selection and evaluation methods are available, a number of projects may not be evaluated good enough using them. Technology is developing every moment and

that is the reason why new methods are needed to handle all the parts of the projects. In that point, the main question arises: “Which is the best method that evaluates projects?”

Plenty of IT projects are suggested to software organizations. These organizations should select and decide the projects according to the total output of the projects and opportunities. It is not an easy decision but it is also quite complex. It contains numerous questions and uncertainties, and poor selection can intensely cause a loss and decrease the level of organizations; thus they must also reflect the real values of projects. In addition, selection criteria, related information and strategies have to be prioritized during selection process. Here, three questions come out:

1. Which criteria affect the project selection?
2. Which information should be gathered for the selection process?
3. How can we make the best selection?

Until this part, benefit measurement methods and constraint optimization methods in project selection and evaluation are examined. They include many different project selection methods based on qualitative, quantitative and judgment based. In recent years, many experts think that these techniques may not be adequate for the competent and suitable selection/evaluation. There the new selection techniques are needed to be developed.

SAMS is a score card technique which contains weighted parameters, and it offers very simple form which is easily be adapted for different type of projects. Moreover, the proposed model allows organizations to select their own parameters, therefore a flexible form structure is offered. Furthermore, Sherer [38] indicated that the level, size and industry of the organizations might affect or change the model. And well planned information technologies governance has the key role on the project selection and evaluation. Additionally, SAMS contains important issues which have to be considered during the selection process. These issues have been defined by Souder [4] as follow: realism, capability, ease of use, flexibility and cost.

The decision parameters of the proposed project selection and evaluation method contain not only financial parameters but also many tangible and intangible technical parameters. It is based on the experiences and the history of the organization’s

decision processes. The score card technique has the superiority between the other approaches because of this feature [98].

During the design phase of the score card, it is possible to use different criteria and parameters in proposed form according to the organizational standards. However, the aim of the study is to present an easy-to-use way to integrate the score card without considering the special situations of the different type of organizations. Therefore, generic parameters and issues are considered in proposed score card;

- Strategically suitability of project,
- Organizational suitability,
- Financial return,
- Ability of satisfying requirements of time, money and resource,
- Effort of implementation,
- Technical ability and feasibility,
- Management and planning,
- Opportunity cost and risks.

In this proposal, the score card does not contain a long parameter list, because this might cause such a problem as losing the strategical focuses; therefore only core parameters are used to evaluate the projects. Sustainability and long-term usage of the method provide the continuity of the process. For some organizations, flexibility of the method carries high importance since they need to add extra parameters or remove the unrelated parameters based on their own perspective.

The proposed method contains three main parts: technical and business parameters and constraints. In the technical parameters part, projects which are suggested to the organization will be evaluated according to the technical values of the projects, and this part includes 7 main and 42 sub parameters. Latter, the aim of the business parameters part is evaluating the projects in terms of business values, and this part includes 9 main and 27 sub parameters. These technical and business parameters are gathered based on the experiences of software companies and standards. To evaluate general score, each parameter has a weight. The proposed weighting technique will be explained in the next part and the approach does not contain personal evaluations and it serves the objective result.

Before the selecting and evaluating of the projects using score card technique, project proposal forms should be completed for each potential project and possible risk factors should be evaluated. After the selection and prioritization process, the goal is to present the decisions and to integrate the results into the master plan of the organization. In addition, if any project has high risk factors, before project selection process, several alternatives should be addressed, and the proposed project selection method should not be used. The projects which have high risk may require additional planning (as shown in Figure 10), however this thesis does not investigate plans.

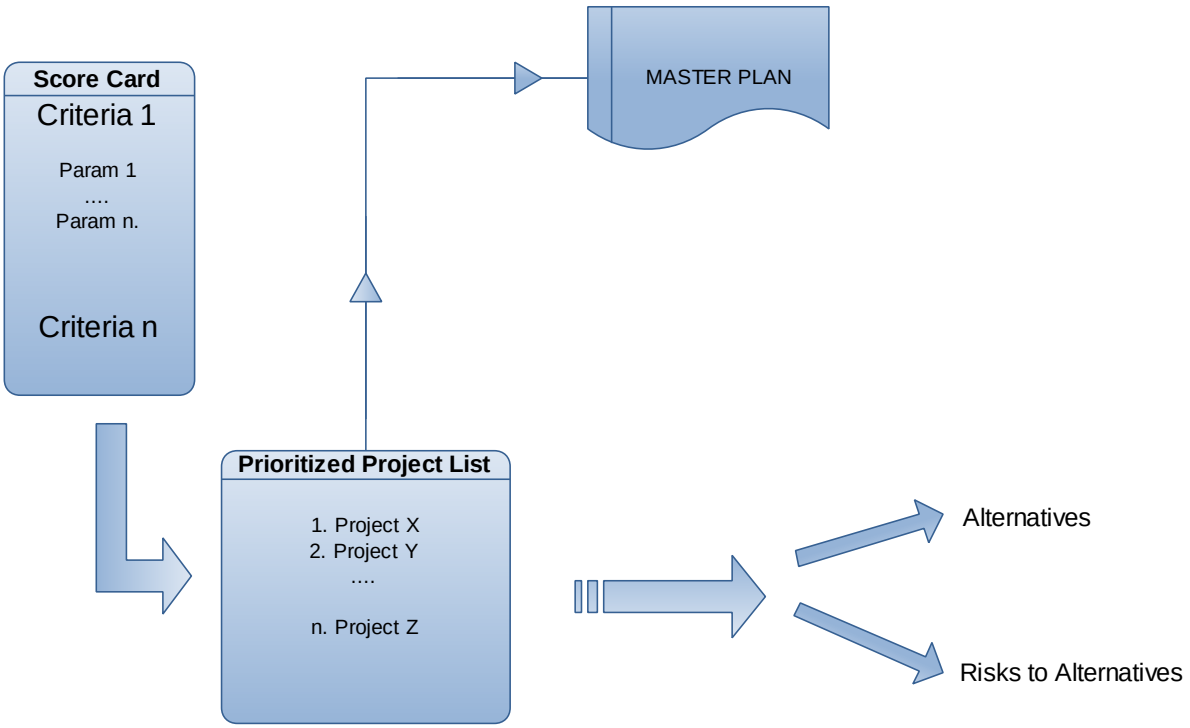

Figure 10 - Master Plan Integration Process

These tools do not intend to develop strategies and they only provide the road map to the implementation of the proposed projects which are eliminated based on the chosen technique. The most crucial projects are determined and prioritized, and then the portfolio is put as a framework forward to the strategic management office of the organization. When a project is accepted, software organization starts to plan the management and implementation processes. Additionally, evaluation team is composed of experienced seniors, experts and managers who know the organization's strategies and able to examine and evaluate the software projects in

terms of technical and business values. These experts should remain anonymous to others during the evaluation process in order to prevent subjectivities.

4.2. Project Proposal Form

Project proposal form is used for the project first stage representation (available at Table 5). Generally each project is evaluated in terms of the contribution to the cash flow; if acceptable then the project is evaluated by the technical parameters and business parameters according to the method.

Table 5 - Project Proposal Form

Project Name :
Department :

Scope

Assumptions

Expected Life Time	Investment Cost	Expected Profit
Year 1		
Year 2		
Year 3		
Year 4		
Year 5		

Expected Time :
Expected ROI:

4.3. Project Assessment (Evaluation) Form

Great number of projects can be candidate projects, and these are included in the evaluation process via assessment form. This form gives necessary information about the project and each project should be included and analyzed with the predetermined- weighted parameters. Weighted parameters will create the prioritized project list. Here, weights can be modified according to organizational needs or standards.

Project assessment form composed of technical and business parameters and constraints. Table 6 shows (in two parts) the proposed form, it can also be found in the Appendix. In the technical parameters part, projects which are suggested to the organization are evaluated according to the technical values of the projects by sub-technical parameters. Technical part of the form includes 7 main parameters and 42 sub-parameters. Second part of the form consists of business parameters which are composed of 9 main parameters and 27 sub-parameters. These technical and business parameters are collected and weighted based on the experiences of several leading software companies, the analogies and the history of the organization's decision processes. These parameters represent unique features of the project and have different weight values. The weights that are allocated to each parameter indicate their relative effects and importance. On the other hand, these weights may be changed according to organization's structure and needs. The most significant parameter's weight should set as 10 and the weight value of parameter decreases to the less significant one.

The project evaluation process should be conducted by the director who has the highest experience and knowledge and direct communication with each evaluation team member. As mentioned in the previous chapters, decision makers are anonymous to each other. The evaluation process starts with the evaluation of each sub parameter on the score card. Decision makers give 0 or 1 according to their initiative which is based on experience and knowledge. If the project satisfies parameter *X*, the decision maker should give 1, otherwise should give 0. Then weights of determined parameters are multiplicated with these 0 or 1. Next, the decision makers are going to rank each project with a score from 0 to 100. They can give the highest score to the project which is according to them the most suitable.

Table 6 – The Proposed Project Assessment Form (Technical part #1)

	Parameters	Parameter Code	Parameter Definition	Weight	Pr #1	Pr #2	Pr #3	Pr #4	Pr #5
Technical parameters	Technical Feasibility	PTTF1	New technical equipments are not needed	8					
		PTTF2	There are adequate sources to complete the project	7					
		PTTF3	The project does not require studying/working with different technologic areas	4					
		PTTF4	Project has potential to create further reusable components	4					
		PTTF5	Current software methods are suitable for realizing the project	6					
		PTTF6	It can be conducted with the current infrastructure of the organization	10					
		PTTF7	Development platform of the project would be used for futher projects	8					
		PTTF8	The organization has enough connections to implement and test the project	6					
		PTTF9	Many of the subsystems of the project can be built with existing components	6					
		PTTF10	The workflow and businessflow plans are reasonable to realize it	4					
	Development Cost	PTDC1	Current staffs don't need to acquire new skills	6					
		PTDC2	Training costs are not more than 15% of project budget	7					
		PTDC3	Training period is not loger than 20% of project process	6					
		PTDC4	There is no need to employ new personnel for the project	6					
		PTDC5	Some subsystems can be conducted with low-cost-freelance personnel	8					
		PTDC6	Project can be conducted with the current hardware infrastructure	7					
		PTDC7	New software platforms or tools are not needed	7					
		PTDC8	Project can be conducted with the actual working environment	7					
	Staff Abilities	PTRA1	Project team members have sufficient expertise on development platform	8					
		PTRA2	There are several project members who can work with scientific competence	2					
		PTRA3	Project executive and project teams have sufficient domain knowledge	6					
		PTRA4	PM ratios and values are realistic	9					
		PTRA5	Project team members are eligible to work with other projects parallelly	2					
	Prosess Improvement	PTLD1	Project has a potential to increase productivity of the staffs	1					
		PTLD2	Project is crucial to create high quality processes	4					
		PTLD3	Outputs of the project have a great potential to accelerate development period	4					
	Interoperability	PTI1	Project has a potential to create a new platform which can be used for other tools	6					
		PTI2	Project can easily be integrated with the other software projects	6					
	Extensibility	PTE1	Amendments can easily be implemented to the project based on new needs	8					
		PTE2	Architecture enables the madificaitons and maintanence in runtime	6					
	Quality	PTQ1	Desired level of "error tolerance" is feasible	6					
		PTQ2	Probability of hardware failures does not affect the continuity of system	6					
		PTQ3	The effects of any failure may not lead a catastrophic problem	6					
		PTQ4	The software is not a cost/business critical software	6					
		PTQ5	Level of expected maintainability is feasible	6					
		PTQ6	System is easy to use so probability of users' failures does not affect the outputs	6					
		PTQ7	The software can be operated with many other systems	4					
		PTQ8	The software will be used by a very limited amount of users	6					
		PTQ9	Potential users of the software are experienced; therefore no detailed user manual is required	6					
		PTQ10	Detentions and delays caused by software processes can be tolerated	6					
		PTQ11	The software will be migrated from an existing system	6					
		PTQ12	Maintanence of the software system has a great potential to get profit	6					
			Technical Total						

Table 6 – The Proposed Project Assessment Form (Bussiness part #2, and evaluation part)

	Parameters	Parameter Code	Parameter Definition	Weight	Pr #1	Pr #2	Pr #3	Pr #4	Pr #5
Business Parameters	Strategical Compliance	PBSC1	The project is suitable with the organizational strategies	10					
		PBSC2	The analysis which is done for the strategical compliance is sufficient	8					
	Contribution of Prestige	PBCP1	The project may contribute a positive value to the organization	10					
		PBCP2	The project has the advantages or superiority comparing to others	9					
	Legality	PBL1	Legal confirmation or special licence do not needed for the project	6					
		PBL2	Project is suitable with the software development standards	9					
	Innovation Value	PBIV1	The project has a great innovation potential	8					
		PBIV2	Project may lead to create new processes or new products	8					
		PBIV3	Project may take the place of product which is provided from outsources or imported	8					
	Competitive Advantage	PBCA1	Organization may gain superiority and prevent the opponent companies with the project	8					
		PBCA2	Project is the key for being successful in the competitive area	8					
	Patent Opportunity	PBPO1	Project contains patent opportunity	8					
	Target Market Share	PBTMS1	Organization may have higher market share value with this project	7					
		PBTMS2	New usage area or new market can be originated via outputs of project	8					
	Organization Suitability	PBOS1	Organization is totally ready for the implementation of the project	8					
		PBOS2	Organization does not have problems about project adaptation	9					
		PBOS3	Organization may have an opportunity of use of free technologies	4					
		PBOS4	Organization may improve current strategies of the company	4					
	Risk Value	PBRV1	Possibility of longer implementation time is low	4					
		PBRV2	Estimated staffs turnover rate is low	3					
		PBRV3	Up to %20 increase in project's budget can be tolerated	5					
		PBRV4	Up to %50 decrease in ROI is acceptable	5					
		PBRV5	The marketing and working environment is not volatile	8					
		PBRV6	Variance on the financial services and markets may not affect the budget and phase planning of project	6					
		PBRV7	Up to %20 additional new technological equipments is acceptable	5					
		PBRV8	Providing necessary technologies and staffs is simple	6					
		PBRV9	Integration problems stem from different software platforms or products can be tolerated	6					
	Constraint	PC1	Project is suitable with the updated laws and regulations	1/0					
		PC2	Project is suitable with the ethical rules	1/0					
			Business Total						
			Weight / 100						
			Total Score						

In the last step, the director collects the score card and announces the prioritized project list. Meanwhile, minimum 200 points is needed to get the project value accepted for the final evaluation.

4.4. Parameters

In the selection and evaluation phase, parameters have the key role and carry a high importance during the process. These parameters are the main indicators of the process result. That is why deciding the right parameters for use, is the beginning of the way which progress to a successful selection.

As explained before, the proposed project selection model is designed based on two main parts. These are the technical parameters and business parameters which are shown in Figure 11.

Figure 11 - Parameter Pool

4.4.1. Technical Parameters

In this study, technical parameters are classified with the minimum number of parameters and contain 7 main parameters and 42 sub-parameters.

4.4.1.1. Technical Feasibility

Project selection and evaluation is an incessant problem in each organization. It requires a reliable technique which can serve the trouble-free and accurate solution. In that point, one of the parameters which carry vital importance on the selection process is technical feasibility. It focuses on obtaining an understanding of the organization's current technical resources and practicability to the prospective requirements of the proposed projects. Technical feasibility can also be defined as the attainability of the software using existing resources, technology, equipment and manpower.

Technical feasibility parameters indicate the possibility of carrying out the project with current techniques.

Decision parameters:

- New technical equipments are not needed
- There are adequate sources to complete the project
- The project does not require studying/working with different technologic areas
- Project has potential to create further reusable components
- Current software methods are suitable for realizing the project
- It can be conducted with the current infrastructure of the organization
- Development platform of the project would be used for further projects
- The organization has enough connections to implement and test the project
- Many of the subsystems of the project can be built with existing components
- The workflow and business flow plans are reasonable to realize it

4.4.1.2. Development Cost

Development cost is one of the most deterministic parameter of the projects. Various techniques are used for the software development cost estimation. They consist of different type of classes. These techniques are used for several purposes, such as budgeting, tradeoff and risk analysis, project planning and control, process improvement, and investment analysis [99-103].

Decision parameters:

Training Cost

- Current staff does not need to acquire new skills
- Training costs are not more than 15% of project budget
- Training period is no longer than 20% of project process

Human Resources Costs

- There is no need to employ new personnel for the project
- Some subsystems can be conducted with low-cost-freelance personnel

Hardware Costs

- Project can be conducted with the current hardware infrastructure

Software Platform Cost

- New software platforms or tools are not needed

Working Environment Cost

- Project can be conducted with the actual working environment

4.4.1.3. Staff Availability

Decision parameters:

- Project team members have sufficient expertise on development platform
- There are several project members who can work with scientific competence
- Project executive and project teams have sufficient domain knowledge
- PM ratios and values are realistic
- Project team members are eligible to work with other projects in parallel

4.4.1.4. Process Improvement

Since, quality products can be produced using quality processes; thus if the project intends to improve current processes of the organization in production, it should be taken into consideration seriously. Here, the level of improvement is significant, this should be decided by the evaluators using following parameters.

Decision parameters:

- Project has a potential to increase productivity of the staffs
- Project is crucial to create high quality processes
- Outputs of the project have a great potential to accelerate development period

4.4.1.5. Interoperability

The “Interoperability” term is defined by IEEE for the information technology services to allow information exchange as follows, “*the ability of two or more systems or components to exchange information and to use the information that has been exchanged*.” [104].

Interoperability is the computer system ability to interact with the other diverse systems, work together, execution of programs and run applications on different platforms without any loss or trouble. The system which is integrated to the existing main system should communicate each other provider regardless of operating systems and architectures. It is crucial for the sub systems collaboration and

integration. For the continuity of information exchange, existing systems must be compatible.

Decision parameters:

- Project has a potential to create a new platform which can be used for other tools
- Project can easily be integrated with the other software projects

4.4.1.6. Extensibility

Extensibility is the principle of system design where the implementation takes future needs, change requirements, growth, modification or some improvement tasks into consideration. The goal is to minimize the impact on existing functionality, sustainability of processes while expanding the system. It can also be defined as the modifiability of software application's behavior at run time without making any major changes on the infrastructure, original source code change or recompiling the whole project. Extensibility provides the continuity to the system.

Decision parameters:

- Amendments can easily be implemented to the project based on new needs
- Architecture enables the modifications and maintenance in runtime

4.4.1.7. Quality

Required level of quality has a very significant role in development and implementation of the software projects. Since high quality expectations from the software mean paying much more time for design and testing activities, the total cost and need for resources, therefore, increase dramatically.

While, there are many quality attributes that can be considered for selection process, the proposed system intends to make selection process simple and fast; thus it takes only most significant quality attributes as parameters into account. These attributes are as follows:

- Reliability

- Maintainability
- Robustness
- Ease of Use
- Efficiency
- Security
- Compatibility

Considering the quality attributes listed above, following parameters are included in the proposed project evaluation form:

- Desired level of “expected error tolerance” is feasible (Reliability)
- Probability of hardware failures does not affect the continuity of the system (Robustness)
- The effects of any failure may not lead a catastrophic problem (Reliability and Robustness)
- The software is not a cost/business critical software (Reliability)
- Level of expected maintainability is feasible (Maintainability)
- System is easy to use so probability of users’ failures does not affect the outputs (Robustness)
- The software can be operated with many other systems (Compatibility)
- The software will be used by a very limited amount of users (Security)
- Potential users of the software are experienced; therefore no detailed user manual is required (Ease of use)
- Detentions and delays caused by software processes can be tolerated (Efficiency)
- The software will be migrated from an existing system (Many of the attributes)
- Maintenance of the software system has a great potential to get profit (Maintainability and Cost)

Although, many of these parameters can be considered as constraints or essential parts of software, they can be taken into account as parameters depending on decision of manager for short term projects. Furthermore, if a project manager desires to use any of these parameters as constraint on the form, the parameter can easily be transferred to constraint section, and the evaluation results can be calculated in this way.

4.4.2. Business Parameters

This part contains 9 main parameters and 27 sub parameters. Organizations generally focus on business parameters, but the solution is more meaningful if they are evaluated including the technical parameters. Also, these parameters carry high importance as much as technical parameters. Business parameters and technical parameters are connected to each other and affect the decision process directly. In a well-designed score card, parameters are easy to understand, comprehensive and up-to-date.

4.4.2.1. Strategical Compliance

The success of organizations is mostly dependent on strategies. These strategies are developed based on the main structure, history and previous works of the company. They lead the way to the organization and affect the future of the companies. Hence, strategically compliance parameters can be thought as one of the most significant parameters in business side evaluation process.

Projects may carry innovative value (may be the first project in related area) or they may carry high opportunity but if they are not suitable for the strategies, these projects should be rejected.

Decision parameters:

- The project is suitable with the organizational strategies
- The analysis which is done for the strategical compliance is sufficient

4.4.2.2. Contribution of Prestige

Prestige is accepted as one of the most significant parameters for the organizations. Great deals of projects are realized even if they have high cost or long time. In business area, prestige is seen as very valuable specification and it can also change the strategies of organizations so that projects should be evaluated taking into account prestige contribution.

Decision parameters:

- The project may contribute a positive value to the organization

- The project has competitive advantages or superiority comparing to others

4.4.2.3. Legality

Legality is classified into constraint parameter list. If the parameter is not satisfied, the project should be rejected. All of the projects have to be developed according to the updated laws and regulations. If this will not be done, the project will be canceled without any privileges.

Decision parameters:

- Legal confirmation or special license is not needed for the project
- Project conforms to the software development standards

4.4.2.4. Innovation Value

Innovation value may not exist in all of project. It might be thought as a distinctive parameter but it is not included into the “must” parameter list.

Decision parameters:

- The project has a great innovation potential
- Project may lead to create new processes or new products
- Project may take the place of product which is provided from outsources or imported

4.4.2.5. Competitive Advantage

Competition is classified into three groups; performance model, predatory model and head-to-head model. Organizations compete through one of them. Some companies prefer the performance model. In this model, the organization has the information about the work of other competitors and they generate or modify their strategies based on them. There are also organizations that prefer the predatory model. The idea in this model is being successful in the competitive area and having the complete control in the market. Also in head-to-head competition model, the aim of the organizations is beating and preventing the other competitors. Therefore, it is seen as the significant parameter too.

Decision parameters:

- Organization may gain superiority and prevent the opponent companies with the project
- Project is the key for being successful in the competitive area

4.4.2.6. Patent Opportunity

Patent opportunity adds a positive value directly to candidate projects and it may change the existing or future plan of the organizations. Also, projects which can carry the patent opportunity may be more costly than others but it has the sustainable advantage and provides the continuous revenue.

Decision parameter:

- Project contains patent opportunity

4.4.2.7. Target Market Share

Projects that focus on increasing the target market share are formed generally based on the investments and experiences of existing projects. Although, target market share is a significant parameter it is not the determinative parameter of the project. In fact, the project that increases the target market share may have impact on the future positioning and strategies of organizations.

Decision parameters:

- Organization may have higher market share value with this project
- New usage area or new market can be originated via outputs of project

4.4.2.8. Organization Suitability

Decision parameters:

- Organization is totally ready for the implementation of the project
- Organization does not have problems about project adaptation
- Organization may have an opportunity of use of free technologies
- Organization may improve current strategies of the company

4.4.2.9. Risk Value

Risk value can change the result of the project evaluation process. Since all possible risk factors and risk issues should be evaluated before project selection process (this evaluation is not being investigated in this thesis), if there is a possibility of high risk issues, the project should be eliminated in advance (or should be evaluated by upper management or arbiter seperately). Thus, here risk factors which can be tolerated during design time or easily be handled are considered as parameters.

Decision risk parameters:

- Possibility of longer implementation time is low
- Estimated staffs turnover rate is low
- Up to 20% increase in project's budget can be tolerated
- Up to 50% decrease in ROI is acceptable
- The marketing and working environment is not volatile
- Variance on the financial services and markets may not affect the budget and phase planning of project
- Up to 20% additional new technological equipments is acceptable
- Providing necessary technologies and staffs is simple
- Integration problems stem from different software platforms or products can be tolerated

4.4.3. Constraints

Constraints as parameters should be evaluated separately than project score, because if any of these constraints is not satisfied then project must be rejected directly according to the proposed formula (7). In this thesis, while two inevitable constraints are proposed, a project evaluator can increase the number of these according to their organizational standards or needs. These constraints are as follows:

- Project is suitable with the current laws and regulations
- Project has no ethical issues

4.5. The Proposed Evaluation Method (PEM)

Both of weighting and analogical methods are used in the proposed evaluation method to transfer the relative parameters to assessable quantitive numbers, and to take experts judgments into consideration. The weights allocated to each parameter indicate their relative effects and significance. In addition, several weighting methods have been developed facilitating the process over the past decades. Therefore a number of previous studies came up with efficient approaches to project features' weights optimization. Moreover, several methods propose algorithmic assessment, objective assessment with the formulation, and personal or analogical judgment.

The proposed evaluation method (PEM) is designed on both algorithmic and analogical assessments. PEM consists of two parts in which the first part considers the expert judgment decisions, and the second grades the projects with objective parameters.

The Proposed Formula is derived from 5th;

$$S_i = [EJ + \sum_{j=1}^{n} s_{ij}\, w_{ij}\,] \prod_{k=1}^{v} c_{ik} \qquad (7)$$

Where;

S_i : Score of the *i*th project

EJ: Expert judgment score (0-100)

n: Maximum number of selected parameters

v: Maximum number of constraints

s_{ij}: Value of the *j*th parameter of the *i*th project (this should be 0 or 1)

w_{ij}: Weight of the *j*th parameter of the *i*th project (this should be1 to 10)

c_{ik}: *k*th Constraint of the *i*th project (this should be 0 or 1)

The formula is applied to get the prioritization for each project. PEM approaches to use a weight value according to relevance and significancy of the owner parameters scaling from 1 to 10, and use parameter as yes or no sentences (0 or 1). Next the parameter score can be found by multiplication of the weight and parameter value. The total score of the project then can be calculated by summation of all parameter scores. In the meanwhile, experts judge and grade each project separately by giving a rank score from 0 to 100 (no two projects can get the same value) according to their observation and experiences. Finally the grand total score of the projects is found by adding these rank and project scores (in case of more than one evaluation on a project, the grand total of the project can be finalized with cumulative of all evaluator grand totals). This grand total score is used to rank project. PEM claims the more score is the better choice. In the last step, the director collects the score card and announces the prioritized project list.

The developed score card has a number of rules in order to make elimination before the evaluation process.

These are accepted directly if:

I. The project which prevents possible vital risks on other projects
II. The project is classified as mandatory project as it provides competitive advantage
III. The project is needed to fulfill a legal obligation

5. EXPERIMENTAL RESULTS

In this thesis, an experimental study was conducted to assess the validity and reliability of the proposed system. The experimental study also intends to optimize the outcome of the project prioritization process on the scorecard and to determine the vital parameters. In addition, the number of the parameters in the experiments was reduced to increase understandability and simplicity of the experiments.

In the experimental study, a number of interviews have been made with several software development enterprises and professionals to create a standard scorecard template which is likely to consist of highly readable and understandable evaluation statements. As a benefit, a couple of companies which were involved in the experiments have got a chance to figure out some weaknesses in project management activities during the experiments, thus to revise their decisions making processes. Although, usage of the weights of the scorecard parameters made the decision process a bit longer, it helped to reduce the probability of wrong decisions. Furthermore, there are some difficulties in completion of all parameters in the scorecard; however it seems that these are mandatory parameters to get right decision results.

In the experimental study, five real software projects (actually implemented or refused) were evaluated by five professionals using the proposed scorecard. These projects are offered by the different departments of the companies based on their needs and thoughts which may carry them to the higher levels or may improve the efficiency of the development processes.

All the necessary details about the selected projects can be seen in Appendix B. All the projects were evaluated using the proposed scorecard in where the details are given in Project Assessment Form.

Short descriptions of these projects are as follows:

P1: “Developing Central Document Sharing Center” is proposed by the Strategic Planning and Organization Department of the Company X. The aim of the project is providing the effective sharing center, keeping documents and folders up to date and preventing sharing incorrect information inside of the company.

P2: “Developing Customer Management System” is proposed by the Customer Management Office. The aim of this project is managing all type of documents of customers, making the documents accessible and keeping these secure.

P3: “Designing Web Pages” is proposed by the Marketing and Sales Department of the Company X. The aim of the project is having a responsive website.

P4: “Developing Product Management and Tracking System” is proposed by the Purchasing and Achieving Department. The aim of the project is tracking devices in a secure way and keeps them safe within the company.

P5: “Implementing Business Intelligence System for the Company” is proposed by the Management Office. The aim of the project is developing the best future plan and creative and significant strategies depending on existing data.

Evaluation results of the five projects and the details of the experimental study is given Table 7.

In SAMS, process resulted the priorities as follows;

1. Project 5: Implementing Business Intelligence System for the Company
2. Project 3: Developing Customer Management System
3. Project 2: Designing Web Pages
4. Project 1: Developing Central Document Sharing Center
5. Project 4: Developing Product Management and Tracking System

The decision of the company X was different. The company prioritized the projects without the proposed SAMS score card as;

1. Project 1: Developing Central Document Sharing Center
2. Project 2: Designing Web Pages
3. Project 4: Developing Product Management and Tracking System

The decision makers of the company even did not evaluate the “Implementing Business Intelligence System for the Company” and “Designing Web Pages”. These two projects were directly rejected and the resources have been used to realize other projects.

Table 7 - Decision Comparison

Project		Value[1]	Rank	Suggested Decision[2]	Actual Decision[3]	Match Ratio[4] (%)	Possible Profit/Loss[5]
# 1	Form Score	1015	4	ACCEPT	ACCEPT	100	0
	Rank Score	300					
	Grand Score	**1315**					
# 2	Form Score	1361	3	ACCEPT	ACCEPT	100	0
	Rank Score	450					
	Grand Score	**1811**					
# 3	Form Score	1490	2	ACCEPT	REJECT	0	$347,000
	Rank Score	350					
	Grand Score	**1840**					
# 4	Form Score	885	5	REJECT	ACCEPT	0	-$51,100
	Rank Score	200					
	Grand Score	**1085**					
# 5	Form Score	1612	1	ACCEPT	REJECT	0	$229,000
	Rank Score	410					
	Grand Score	**2022**					
	TOTAL					40	$524,900

[1] The values coming from the project evaluation forms and expert judgments

[2] "Suggested Decision" is the final decision of SAMS method

[3] "Actual Decision" is the final (real) decision of the Company X

[4] Match ratio shows the level of similarity between actual and suggested decisions

[5] The value represents the possible profit/loss due to the suggested decision. Minus value shows actual profit of the company (possible loss because of the suggested decision), positive value shows profit opportunity that company X has already lost

Experimental results show that Project 1 and Project 2 are likely to be accepted by the proposed system, and they actually carried out. Since decisions made by both systems are same, no loss or profit should, therefore, be considered. For project 3, while the proposed system accepts, the project actually has not been carried out, thus actual implementation caused to lose a possible profit of $347K. In project 5, again there is a loss of possible profit which is about $229K. On the other hand, the proposed system suggested to reject project 4, the project actually has been carried out, thus a loss of $51K concerned because of the proposed system; this might be caused by wrong parameters choices or weights.

Finally, overall result shows that if the proposed system is used, the companies would be able to have extra $524K and further investments. This amount should be considered a loss because of wrong decision makings.

As a conclusion of experimental study, SAMS has a very high potential to maximize the overall profits of the enterprises.

6. CONCLUSIONS

This thesis investigates and focuses on the effective evaluation process and structure for organizations that have medium and short scaled/term software projects and purpose of prioritizing the projects depending on business and technological parameters. Software projects, which are specified as needs to the PMO, include the score card evaluation process in order to test and analyze the proposed score card.

As an overview, this thesis conducts a software project selection and prioritization model which is based on the most significant parameters. Each parameter is added to the proposed score card based on experiences, needs and feedbacks of several software organizations and software experts. In addition, validation of the model is tested with the five real software projects with 5 blind reviewers. Although it is not designed as an exact solution for all type of organizations, it can be adapted and a customized by particular users.

A number of interviews and visits have been realized for investigations, suggestions based scorecard and setting up the experiments, then the proposed score card has shaped in the last form. Furthermore, interviews made during preparation of the scorecard helped some of the interviewed companies to figure out their weaknesses about project planning and management. In addition, they found the opportunity to revise their decisions. On the other hand, the determination of weights for the parameters led some delays on the project selection process. However, this determination should be done once, and they can be used, unless changes are required.

The evaluators may have difficulties to fill the evaluation list which exist of 69 parameters. This difficulty might occur due to the length of the parameter list and the coverage of the parameters however, the organizations are allowed to make some change in score card according to their structure and their needs. The proposed technique can be called as a suitable platform that does evaluation on several organizations.

Although various evaluation techniques have been developed, no technique which covers technical parameters, business parameters and constraint together exists in the literature. As a conclusion, the proposed model intends to meet the deficiency on

proper project selection model that could be used by compact and small companies for their short/medium term software projects.

For the further studies, new parameters can be investigated. Moreover, risk factors can be included the scorecards and then new evaluation model can be constructed. The proposed model concentrates on the medium and short scaled software project assessment however; this study can be improved to be used for long term critical project. Technological developments and changings and also legal regulations have high impacts on the evaluation processes. They create some additional and new requirements. These requirements are defined with the new parameters. For example, each additional legal alteration should be taken into account during the evaluation process in order to get optimized results. Additionally, business competitions parameters could be extended in the future with the impact of technology. For example, digital advertisement is getting more popular than offline advertisements. In the future, various applications, which are supported by smart phones and uses 3D technology, have the ability to make a significant difference in the competitive arena.

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APPENDIX

A. The Proposed Project Selection Form

	Parameters	Param Code	Parameter Definition	Weight	Pr
Technical parameters	Technical Feasibility	PTTF1	New technical equipments are not needed	8	
		PTTF2	There are adequate sources to complete the project	7	
		PTTF3	The project does not require studying/working with different technologic areas	4	
		PTTF4	Project has potential to create further reusable components	4	
		PTTF5	Current software methods are suitable for realizing the project	6	
		PTTF6	It can be conducted with the current infrastructure of the organization	10	
		PTTF7	Development platform of the project would be used for futher projects	8	
		PTTF8	The organization has enough connections to implement and test the project	6	
		PTTF9	Many of the subsystems of the project can be built with existing components	6	
		PTTF10	The workflow and businessflow plans are reasonable to realize it	4	
	Development Cost	PTDC1	Current staffs don't need to acquire new skills	6	
		PTDC2	Training costs are not more than 15% of project budget	7	
		PTDC3	Training period is not loger than 20% of project process	6	
		PTDC4	There is no need to employ new personnel for the project	6	
		PTDC5	Some subsystems can be conducted with low-cost-freelance personnel	8	
		PTDC6	Project can be conducted with the current hardware infrastructure	7	
		PTDC7	New software platforms or tools are not needed	7	
		PTDC8	Project can be conducted with the actual working environment	7	
	Staff Abilities	PTRA1	Project team members have sufficient expertise on development platform	8	
		PTRA2	There are several project members who can work with scientific competence	2	
		PTRA3	Project executive and project teams have sufficient domain knowledge	6	
		PTRA4	PM ratios and values are realistic	9	
		PTRA5	Project team members are eligible to work with other projects parallelly	2	
	Prosess Improvement	PTLD1	Project has a potential to increase productivity of the staffs	1	
		PTLD2	Project is crucial to create high quality processes	4	
		PTLD3	Outputs of the project have a great potential to accelerate development period	4	
	Interoperability	PTI1	Project has a potential to create a new platform which can be used for other tools	6	
		PTI2	Project can easily be integrated with the other software projects	6	
	Extensibility	PTE1	Amendments can easily be implemented to the project based on new needs	8	
		PTE2	Architecture enables the madıficaitons and maintanence in runtime	6	
	Quality	PTQ1	Desired level of "error tolerance" is feasible	6	
		PTQ2	Probability of hardware failures does not affect the continuity of system	6	
		PTQ3	The effects of any failure may not lead a catastrophic problem	6	
		PTQ4	The software is not a cost/business critical software	6	
		PTQ5	Level of expected maintainability is feasible	6	
		PTQ6	System is easy to use so probability of users' failures does not affect the outputs	6	
		PTQ7	The software can be operated with many other systems	4	

		PTQ8	The software will be used by a very limited amount of users	6	
		PTQ9	Potential users of the software are experienced; therefore no detailed user manual is required	6	
		PTQ10	Detentions and delays caused by software processes can be tolerated	6	
		PTQ11	The software will be migrated from an existing system	6	
		PTQ12	Maintanence of the software system has a great potential to get profit	6	
			Technical Total		
Business Parameters	Strategical Compliance	PBSC1	The project is suitable with the organizational strategies	10	
		PBSC2	The analysis which is done for the strategical compliance is sufficient	8	
	Contribution of Prestige	PBCP1	The project may contribute a positive value to the organization	10	
		PBCP2	The project has the advantages or superiority comparing to others	9	
	Legality	PBL1	Legal confirmation or special licence do not needed for the project	6	
		PBL2	Project is suitable with the software development standards	9	
	Innovation Value	PBIV1	The project has a great innovation potential	8	
		PBIV2	Project may lead to create new processes or new products	8	
		PBIV3	Project may take the place of product which is provided from outsources or imported	8	
	Competitive Advantage	PBCA1	Organization may gain superiority and prevent the opponent companies with the project	8	
		PBCA2	Project is the key for being successful in the competitive area	8	
	Patent Opportunity	PBPO1	Project contains patent opportunity	8	
	Target Market Share	PBTMS1	Organization may have higher market share value with this project	7	
		PBTMS2	New usage area or new market can be originated via outputs of project	8	
	Organization Suitability	PBOS1	Organization is totally ready for the implementation of the project	8	
		PBOS2	Organization does not have problems about project adaptation	9	
		PBOS3	Organization may have an opportunity of use of free technologies	4	
		PBOS4	Organization may improve current strategies of the company	4	
	Risk Value	PBRV1	Possibility of longer implementation time is low	4	
		PBRV2	Estimated staffs turnover rate is low	3	
		PBRV3	Up to 20% increase in project's budget can be tolerated	5	
		PBRV4	Up to 50% decrease in ROI is acceptable	5	
		PBRV5	The marketing and working environment is not volatile	8	
		PBRV6	Variance on the financial services and markets may not affect the budget and phase planning of project	6	
		PBRV7	Up to 20% additional new technological equipments is acceptable	5	
		PBRV8	Providing necessary technologies and staffs is simple	6	
		PBRV9	Integration problems stem from different software platforms or products can be tolerated	6	
	Constraint	PC1	Project is suitable with the updated laws and regulations	1/0	
		PC2	Project is suitable with the ethical rules	1/0	
			Business Total		
			Weight / 100		
			Total Score		

B. Sample Projects

Project 1;

Project Name : Developing Central Document Sharing Center
Department : Strategic Planning and Organization

Scope

Great number of documents are used and archived in the company. Some of documents are edited concurrently by the project members or updated frequently. Also they may download the document from their mail services but may not upload to the intranet. Because of the fact that no version is available on the documents, duplications may occur or incorrect information may be shared by the members. Additionally, reporting becomes more complex because it is hard to find last updated documents in the system. As a result, reports may not present the accurate data. These types of circumstances affect the future of the company in a bad way directly.

Document Sharing Center is need for preventing these types of problems and creating effective reports.

Assumptions

It is a legal issue.

Expected Life Time	Investment Cost	Expected Profit
Year 1	15000 $	5000 $
Year 2	4000 $	10000 $
Year 3	3000 $	15000 $
Year 4	3000 $	20000 $
Year 5	3000 $	25000 $

Expected Time : 6 months
Expected ROI : 67 %

Project 2;

Project Name : Developing Customer Management System
Department : Customer Management Office

Scope

There are 110 active, 245 passive customers. Company has ongoing projects for active customers. Also passive customers are who had project before but no ongoing project is available now.

Folders are created for each customer in existing platform and contain special documents about the customer, such as, company information, interactions, proposals, contracts, meeting reports, email archives, help desk ticket information. Some of them are sent to the customers via postal services as a rule of procedures. In so far as no versioning, security, or format integrated files exist, preventing incorrect document sharing may not be possible. Also, these files cannot be accessible out of the company. So It is not easy to manage all of documents, keep updated, make accessible and secure. For better secure managing, customer management office proposes the new Customer Management System platform. In the requested system, unique folders will be created taking into account size, type, and updated formats of document needs. These files can be seen and editable without downloading and can be follow by the personnel who are interested in. If the personnel follow the documents, the system will send an informative e-mail to the personnel per each alternation, such as, update, new file adds. The system will gain the time, traceability to the company. Also it will be easy to reach, manage, alter and share the documents including reduction of paper consumption.

Assumptions

It is a legal issue.

Expected Life Time	Investment Cost	Expected Profit
Year 1	30000 $	15000 $
Year 2	1000 $	7000 $
Year 3	1000 $	9000 $
Year 4	1000 $	12000 $
Year 5	~ 2000 $	15000 $

Expected Time : 10 months
Expected ROI : 65.7 %

Project 3;

Project Name : Designing Web Pages
Department : Marketing and Sales Department

Scope

Current web site of the company is not responsive and cannot reflect the real value of the company. Additionally, a great number of people prefer to use tablets, smart phones and have the internet connection so they prefer to do their interactions via these types of devices. Especially, competitors companies present their services and sales of products online. The company website should be responsive, more effective, informative, and easy to use and support the online sales and interactions for catching up competitors and gaining new customers.

Assumptions

It is a legal issue.

Expected Life Time	Investment Cost	Expected Profit
Year 1	100000 $	120000 $
Year 2	5000 $	150000 $
Year 3	5000 $	200000 $
Year 4	5000 $	-
Year 5	8000 $	-

Expected Time : 4 months
Expected ROI : 282 %

Project 4:

Project Name : Developing Product Management and Tracking System
Department : Purchasing and Archiving Department

Scope

Company contains numerous technological devices, products, hardware, software and licenses. Some of them are sold, some of them are rented and some of them used inside of company. Keeping their information such as warranty issues, provider, if it is located, location information, specialties of the product etc. requires understandable and manageable structure. Existing structure has no technological platform; it is tracked by the responsible personnel. Also archiving department wants to track high cost devices via Wi-Fi signal sensors. If the device is carried or moved to more than 5 meters away by someone, the system will sound the alarm and inform the responsible person.

Assumptions

It is a legal issue.

Expected Life Time	Investment Cost	Expected Profit
Year 1	25000 $	15000 $
Year 2	2000 $	30000 $
Year 3	2100 $	40000 $
Year 4	2300 $	
Year 5	2500 $	

Expected Time : 5 months
Expected ROI : 150 %

Project 5;

Project Name : Implementing Business Intelligence System for the Company
Department : Management Office

Scope

Company should create a future plan and strategies depending on existing data and plan. It is difficult to calculate current growing data and make estimation about their future so that's why business intelligence systems are required. Business Intelligence systems lead the way to the companies during the decision phase.

Decreasing costs, investigating and finding new opportunities, increasing performances are key points. These key points can be supported and provided by the business intelligence system. As a result, phases of company will become more effective and realistic if the system is developed.

Assumptions

It is a legal issue.

Expected Life Time	Investment Cost	Expected Profit
Year 1	150000 $	-
Year 2	5000 $	400000 $
Year 3	5000 $	
Year 4	5000 $	
Year 5	6000 $	

Expected Time : 10 months
Expected ROI : 166 %

C. Assessment Form of the Sample Projects

	Parameters	Param Code	Parameter Definition	Weight	Project #1					Project #2					Project #3					Project #4					Project #5				
					E#1	E#2	E#3	E#4	E#5	E#1	E#2	E#3	E#4	E#5	E#1	E#2	E#3	E#4	E#5	E#1	E#2	E#3	E#4	E#5	E#1	E#2	E#3	E#4	E#5
Technical parameters	Technical Feasibility	PTTF1	New technical equipments are not needed	8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
		PTTF2	There are adequate sources to complete the project	7	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
		PTTF3	The project does not require studying/working with different technologic areas	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
		PTTF4	Project has potential to create further reusable components	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1
		PTTF5	Current software methods are suitable for realizing the project	6	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		PTTF6	It can be conducted with the current infrastructure of the organization	10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
		PTTF7	Development platform of the project would be used for futher projects	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
		PTTF8	The organization has enough connections to implement and test the project	6	0	1	0	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
		PTTF9	Many of the subsystems of the project can be built with existing components	6	1	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1
		PTTF10	The workflow and businessflow plans are reasonable to realize it	4	1	0	1	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	0	1
	Development Cost	PTDC1	Current staffs don't need to acquire new skills	6	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0
		PTDC2	Training costs are not more than 15% of project budget	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
		PTDC3	Training period is not loger than 20% of project process	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
		PTDC4	There is no need to employ new personnel for the project	6	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		PTDC5	Some subsystems can be conducted with low-cost-freelance personnel	8	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
		PTDC6	Project can be conducted with the current hardware infrastructure	7	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		PTDC7	New software platforms or tools are not needed	7	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		PTDC8	Project can be conducted with the actual working environment	7	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Staff Abilities	PTRA1	Project team members have sufficient expertise on development platform	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0
		PTRA2	There are several project members who can work with scientific competence	2	1	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
		PTRA3	Project executive and project teams have sufficient domain knowledge	6	1	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
		PTRA4	PM ratios and values are realistic	9	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
		PTRA5	Project team members are eligible to work with other projects parallelly	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Prosess Improvement	PTLD1	Project has a potential to increase productivity of the staffs	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
		PTLD2	Project is crucial to create high quality processes	4	1	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1
		PTLD3	Outputs of the project have a great potential to accelerate development period	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
	Interoperability	PTI1	Project has a potential to create a new platform which can be used for other tools	6	1	0	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	0
		PTI2	Project can easily be integrated with the other software projects	6	1	0	1	0	0	1	1	1	1	0	0	0	0	0	1	0	1	1	1	1	1	1	1	0	0
	Extensibility	PTE1	Amendments can easily be implemented to the project based on new needs	8	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0
		PTE2	Architecture enables the madificaitons and maintanence in runtime	6	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
	Quality	PTQ1	Desired level of "error tolerance" is feasible	6	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
		PTQ2	Probability of hardware failures does not affect the continuity of system	6	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
		PTQ3	The effects of any failure may not lead a catastrophic problem	6	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
		PTQ4	The software is not a cost/business critical software	6	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		PTQ5	Level of expected maintainability is feasible	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
		PTQ6	System is easy to use so probability of users' failures does not affect the outputs	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
		PTQ7	The software can be operated with many other systems	4	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
		PTQ8	The software will be used by a very limited amount of users	6	1	0	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		PTQ9	Potential users of the software are experienced; therefore no detailed user manual is required	6	1	0	1	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1
		PTQ10	Detentions and delays caused by software processes can be tolerated	6	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		PTQ11	The software will be migrated from an existing system	6	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
		PTQ12	Maintanence of the software system has a great potential to get profit	6	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
			Technical Total		199	94	199	94	81	199	199	199	199	179	183	183	183	183	167	117	123	123	123	123	219	219	219	173	179

Business Parameters	Strategical Compliance	PBSC1	The project is suitable with the organizational strategies	10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
		PBSC2	The analysis which is done for the strategical compliance is sufficient	8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
	Contribution of Prestige	PBCP1	The project may contribute a positive value to the organization	10	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
		PBCP2	The project has the advantages or superiority comparing to others	9	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
	Legality	PBL1	Legal confirmation or special licence do not needed for the project	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		PBL2	Project is suitable with the software development standards	9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Innovation Value	PBIV1	The project has a great innovation potential	8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
		PBIV2	Project may lead to create new processes or new products	8	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
		PBIV3	Project may take the place of product which is provided from outsources or imported	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Competitive Advantage	PBCA1	Organization may gain superiority and prevent the opponent companies with the project	8	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
		PBCA2	Project is the key for being successful in the competitive area	8	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
	Patent Opportunity	PBPO1	Project contains patent opportunity	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Target Market Share	PBTMS1	Organization may have higher market share value with this project	7	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1
		PBTMS2	New usage area or new market can be originated via outputs of project	8	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
	Organization Suitability	PBOS1	Organization is totally ready for the implementation of the project	8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		PBOS2	Organization does not have problems about project adaptation	9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
		PBOS3	Organization may have an opportunity of use of free technologies	4	1	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
		PBOS4	Organization may improve current strategies of the company	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1
	Risk Value	PBRV1	Possibility of longer implementation time is low	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1
		PBRV2	Estimated staffs turnover rate is low	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
		PBRV3	Up to %20 increase in project's budget can be tolerated	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PBRV4	Up to %50 decrease in ROI is acceptable	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
		PBRV5	The marketing and working environment is not volatile	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0
		PBRV6	Variance on the financial services and markets may not affect the budget and phase planning of project	6	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0
		PBRV7	Up to %20 additional new technological equipments is acceptable	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PBRV8	Providing necessary technologies and staffs is simple	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0
		PBRV9	Integration problems stem from different software platforms or products can be tolerated	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Constraint	PC1	Project is suitable with the updated laws and regulations	1/0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		PC2	Project is suitable with the ethical rules	1/0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Business Total		78	64	78	64	64	78	78	78	72	80	116	116	116	116	127	48	59	64	53	52	120	120	120	123	120
			Total Score		277	158	277	158	145	277	277	277	271	259	299	299	299	299	294	165	182	187	176	175	339	339	339	296	299
			Rank Score		60	55	60	65	60	90	90	95	85	90	70	65	70	70	75	35	40	45	40	40	80	80	80	90	80
			Grand Total		337	213	337	223	205	367	367	372	356	349	369	364	369	369	369	200	222	232	216	215	419	419	419	386	379
			Grand Score		1315					1811					1840					1085					2022				

E#1, E#2, E#3, E#4, E#5 denote the evaluators 1,2,3,4 and 5 respectively.