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A PROBLEM SOLUTION PROPOSAL IN PROJECT MANAGEMENT: PORTFOLIO PROJECT SELECTION MODELING FOR AIRLINE INFORMATION TECHNOLOGY DEPARTMENTS

Yüksek Lisans Tezi

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MARMARA UNIVERSITY
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İŞLETME (İNGİLİZCE) Anabilim Dalı YÖNETİM VE ORGANİZASYON (İNGİLİZCE) Bilim Dalı TEZLİ YÜKSEK LİSANS öğrencisi MUHAMMED KASIM SARI'nın A PROBLEM SOLUTION PROPOSAL IN PROJECT MANAGEMENT: PORTFOLIO PROJECT SELECTION MODELING FOR AIRLINE INFORMATION TECHNOLOGY DEPARTMENTS adlı tez çalışması, Enstitümüz Yönetim Kurulunun 2.05.2019 tarih ve 2019-12/8 sayılı kararıyla oluşturulan jüri tarafından oy birliği / ~~oy çokluğu~~ ile Yüksek Lisans Tezi olarak kabul edilmiştir.

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ÖZET

PROJE YÖNETİMİNDE BİR PROBLEM ÇÖZÜM ÖNERİSİ: HAVAYOLU BİLGİ TEKNOLOJİSİ DEPARTMANLARI İÇİN PORTFÖY PROJE SEÇİM MODELLEMESİ

Bilgi teknolojisi departmanları günümüz bilgi ve teknoloji çağında kurumlar için hayati öneme sahip departmanlar olarak öne çıkmaktadır. Havacılık sektörü ise teknolojiyi en yüksek seviyeden kullanan ve teknolojik ilerlemeye katkıda bulunan sektörlerden biri olarak göze çarpmaktadır. Rekabet merkezli günümüz iş dünyasında, firmalar ve yöneticiler kısıtlı kaynaklar, nadir yakalanan fırsatlar ve talebi sürekli değişen müşteriler ile karşı karşıya kalmak zorundalar. Buna ek olarak, şartlarının değişmesi ve iş dünyasının yenilenmesi sonucu yeni projeler üretiliyor ve mevcut projeler hükmünü kaybedebiliyor. Sayısı artan ve öncelik sıralaması sürekli değişen bu projelerin yönetilmesi ve önceliklendirilmesi yöneticilerin kabiliyetlerini aşabilmektedir. Teknolojinin ve çevresel faktörlerin öngörülemez bir şekilde sürekli değişime uğraması, pazara çıkmak için gerekli hazırlık süresini kısaltma isteği, pazara olan talebin ve uluslararası rekabetin artması, proje yönetimine ve yöneticilerine duyulan isteği artırmıştır. Projelerin bir bütün olarak ele alınarak önceliklendirilmesi, uygulamaya koyulması ve kazandırdıklarının gözlemlenmesi proje portföy yönetimi olarak düşünülebilir. Portföy yönetimi doğru işlerin yapılması, proje yönetimi ise işlerin doğru yapılması olarak tanımlanabilir. Biraz daha ayrıntılı incelemek

gerekirse portföy yönetimi iki boyuttan oluşmaktadır. Tezimizle alakalı olan kısmı, şirketlerin ilkeleri doğrultusunda belirlenen stratejileri ile uyumlu, sınırlı bütçelerini korumaya yönelik işlere öncelik verilmesini sağlamak için takip edilmesi gerekenlerdir. Proje portföy yönetimi firmaların temel ilkeleri ve stratejileri ile uyum içerisinde olmalıdır. Herkes tarafından kabul edilmiş bir metodoloji bulunmadığı için projelerini bir sıraya koymaya çalışan her şirket benzer aşamalardan geçmektedir. Portföy yönetimi yapılırken en dikkat edilmesi gereken nokta doğru projelerin seçilmesi ve doğru öncelik sıralamasının yapılmasıdır. Tezimizde ulaşmaya çalıştığımız nihai hedef portföy havuzundan kurum için doğru projelerin doğru zamanlarda seçilebilmesini sağlamaktır. Bu hedefe ulaşabilmek için disiplinler arası bir çalışma yapılarak Yöneylem Araştırması Optimizasyon Tekniklerinden faydalanıp Gams üzerinden model çözümü sağlanacaktır. Bu çalışmada, çok amaçlı hedef programlama tekniği içeren yeni bir proje seçimi karar verme modeli sunulmuştur. Kurulan model havayolu bilgi teknolojileri departmanlarından derlenen örnek projeler üzerinden detaylandırılarak somut hale getirilmiştir.

GENERAL KNOWLEDGE

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ABSTRACT

A PROBLEM SOLUTION PROPOSAL IN PROJECT MANAGEMENT: PORTFOLIO PROJECT SELECTION MODELING FOR AIRLINE INFORMATION TECHNOLOGY DEPARTMENTS

Information Technology departments come to the forefront, bearing vital importance for the institutions in today's technological contexts. The aviation industry has been catching the eye, being one of the industries that utilizes technology and contributes to the technological advancements most. In the competition-based business world of this age, companies and managers have to cope with the depletable resources, scarce opportunities and the customers ever changing their demands. Moreover, the changing of circumstances and regeneration of the business world lead the production of new projects and existing projects might suffer a loss of significance.

Management and prioritization of these ever-increasing projects whose priority order constantly shift around might surpass the capabilities of the managers. The fact that technology and the environmental factors constantly, unpredictably undergo change, the desire of shortening the process of opening to the market, the increased amount of competition across borders and firms' willingness to enter to the market boosted the demand to the project management and managers. The prioritization of the projects as a whole, implementation of them and the observation of their outcomes could be regarded as the

portfolio management. Implementing accurate practices in portfolio management is defined as correctly implementing these practices in project management.

To examine in greater detail, portfolio management consists of two aspects. The one that is relevant to my thesis is the one that is necessary to follow in order to prioritize the businesses which comply with the companies' preset strategies aligned with their principles and protect the restricted budgets.

Project portfolio management has to be in line with the strategies and principles of the company. Since there is not a sole methodology appreciated by all every company that plans to order their projects covers similar steps.

Doing the portfolio management, the matter that requires the utmost attention is the accurate picking of the projects and doing the correct priority order. The ultimate target I aim for in my thesis is to help companies correctly pick the projects out of the portfolio pool at the right time. In order to achieve this target, interdisciplinary research will be conducted and Operational Research Optimization Techniques will be utilized and the model solution will be provided through Gams. In this work, a new project selection decision model that includes a multipurpose target programming technique is presented. The established model is concretized by detailing of the sample projects compiled from airlines information technology departments.

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1. INTRODUCTION

Information Technology departments come to the forefront, bearing vital importance for the institutions in today's technological contexts. The aviation industry has been catching the eye, being one of the industries that utilizes technology and contributes to the technological advancements most. Project portfolio management is a process that starts from the project identification phase, including the determination of project selection criteria, the uncertainties encountered in variables and constraints, the project relationships with each other according to the specified criteria, and hence the selection of several projects from the set project. This type of problem is often encountered by all types of organizations such as commercial enterprises, government institutions and non - profit organisations. Decision support tools refer to any means of support used to assist decision making in an organization or company. Tools for decision support include information control, model paradigms, simulation models, selection systems, tools and processes for representation. The aim of this study is to present a novel decision - making model for the problem of selecting the project portfolio found in the departments of airlines information technologics.

Support systems for selecting the project portfolio have a long history of study. When examining the subject in terms of model, it is seen to remain generally within the framework of some types of model. These models include multi-purpose modeling, multi-criteria modeling, and fuzzy modeling.

Goal programming is presented as a model solution in this study. Goal programming is suitable to simultaneously meet the various goals. Goals are determined in the restriction section in this model and linearized in the objective function. Their impact on the model solution was thus distributed evenly. Objective functions, data sets, decision variables, parameters and finally the mathematical model were presented after part of the literature review.

2. LITERATURE REVIEW

2.1. Project Management

Project is a process which continue definite time and aim to reach an exclusive result, output or service. Project's beginning and end time are certain and they are not repeated. Actually, before starting a new project all factors are determined such as resources, project's scope, time and people who study in this project.[1] There some important criteria to attain success in a project:

Team

Every project requires many people in different fields. Selecting and situating people are very important because workers who are less motivated cause to reduce all workers productivity. So, analyzing the team and project assignments carefully, selecting versatile employees and matching right person with right work help success

Planning

Developing a strategy assists how project proceed uninterruptedly as well as how react fast when face with a problem. Therefore, to clean employees' responsibilities and status, to measure approximate time and cost, to refine budget should complete before beginning the project[2]

Communication

Communication in a team is related with how project runs. If communication decline, departments work irrelevantly and project doesn't continue. Setting up meetings which vary department attain, gathering all workers in some event increase communication. Besides, to pick reports and information about departments also increase communication.

The profession which is careful and apply such terms is *Project Management.* Project Management is a new profession and in demand.

[1] Enver Ece, "Proje Yönetimi ve İnsan Kaynakları İlişkisi", "Havacılık ve Uzay Teknolojileri Dergisi", page 75, July 2004

[2] James P. Lewis, "Planning, Scheduling and Control", fourth edition, page 259

Project Management

Project management is planning, applying and controlling all project applications by using tools, ability, information and techniques to success the project. A project manager should manage some scarce resources such as time, human resources and cost as well as communication, risk and value[3]

Time Management

Firstly, project should be analyzed and every unique action should be described. Identifying these actions help to realize scope, size and resources. Thanks to this awareness, risks, supply potential and actions' duration can be estimated. Creating a schedule assistance to manage time. End time and estimated delay can be seen.

Cost Management

Identifying resources such as human resources, equipment, element benefits to arrange right budget. When project continue, cost of resources can be distributed easily. If there was an unpredictable event, allocating funds do not cause an overestimate. Besides, during the project preparing budget reports help to modify the budget and changing the estimated cost. Therefore, do not face with shock.[4]

Human Resources Management

For composing an efficient team there are many situations which should be controlled. Firstly, employees should be known very well in order to match rightly. Besides, identifying every person's job definition, prevents probable disagreement. It is also very important that provide a safe zone helps to opine comfortably. This increases the productivity.[5]

Communication Management

Before to plan communication, it is necessary to evaluate employees' skills and predispositions and project's requirements. Thus, an effective plan can be prepared and applied. After the awareness of these elements, a structure can be established about which

[3] Project Management Institute, "A Guide to the Project Management Body of Knowledge", New Town Square, page 5, 2000

[4] Project Management Institute, "A Guide to the Project Management Body of Knowledge", New Town Square, page 85, 2000

[5] Luis R. Gomez-Mejia, David B. Balkin & Robert L. Cardy, "Managing Human Resources", 6th edition

communication channels are chosen and what kinds of tactic is performed. By regarding these situations, a sustainable communication can be implemented.[6] Otherwise, a disconnection between departments may cause a conflict and even an end of the project.

Quality Management

Planning how much the quality of the project is guide to several circumstances. To examine the benchmark, to aware the aspects of the product or services which makes it unique help to create a brand and decide the quality. Thereby, cost of building a brand, cost of the quality, construction of the project are can be estimated. Besides, controlling the quality which is decided before helps to see if there is a success or not

Risk Management

When preparing the plans of topics above, it is essential to think carefully because thanks to estimating probable problems risk management can be planned effectively. Risk management is one of the most important aspect of project management because if possible risks cannot be seen before the beginning, project may not handle with the first issue and it ends. So, risk management should be planned carefully.

Small Scale Project (Fasttrack)

In these projects, risk level, effect level and connection complexity are low or medium. Estimated project workload is equal to or lower than 20 person/day. These projects can be finished with relatively short and simple processes.

Middle Scale Project

In these projects, risk level, effect level and connection complexity are low or medium. Estimated project workload is bigger than 20 and lower than 100 person/day. These projects can be finished with relatively short and simple processes.

Large Scale Project

In these projects, risk level, effect level and connection complexity are high. Estimated project workload is equal to or higher than 200 person/day. These projects can be finished with relatively long and complex processes.

[6] Project Management Institute, "A Guide to the Project Management Body of Knowledge", New Town Square, page 118, 2000

Milestone is a point or a stage which is very necessary and significant for the project. Their time and resources are not limited.

Project Manager; Whom responsible for advance of project and manage the project. They are hired and settled by project management office department or related department.

Duties and Responsibilities

-They are responsible for identification the project scope

- They are responsible for creating the project team, doing a job share and preparing performance report.

- Allowance planning of employees is developed with resource manager by project manager.

- They prepare a schedule which includes project elements with team members and try to advance the project according to schedule.

- They determine the project stakeholders and present them the project analyses.

- A project manager should decide and claim how much resources are necessary and how they should be distributed.

-They administer the meetings about with project

-They prepare the project statement analyses report and present it to project management department.

- They should control the risk management activities and take precautions for these risks.

- One of the most important duties of a project manager is scheduling and managing the project final sitting. He/she should inform the stakeholders about process, project, results of project, product which is created end of project in this meeting. He should prepare and introduce the final report to stakeholders.

2.2. **Project Portfolio Management**

In order to achieve specific business strategic goals, companies manage portfolios and then identify, prioritize, authorize, manage and control those programs and projects. The central management of these entire process is what we call Project Portfolio Management.

There are simple distinctions between the concepts project and portfolio. Projects are characterized by the following aspects.

- Projects' scope is rather narrow and projects have special delivery items.
- Project managers aims to preserve the changes at a minimal level.
- A project is deemed successful based on criteria like budget, delivery by products and on-time delivery
- Project managers direct the technicians and experts that are going to work in a particular project.

Portfolios are, on the other hand, contrasting in many fashions.

- Portfolio's business scope might vary according to the strategic objectives of the company.
- Portfolio managers continuously monitor changes within a large environment.
- A portfolio is deemed successful if the overall sum of the portfolio components performs well.
- A portfolio manager coordinates and manages all portfolio workers. This includes project managers in the portfolio, as well.
- Portfolio management is also special with regard to its focus.
    - Focuses on the organization in order to guarantee the selected projects are parallel with the strategy of the company. (Organizational Focus)
    - Focuses on managing projects to finish the projects in an efficient fashion and contribute to portfolio.

Creating transparent, simple, encouraging processes are very important to put together as many project proposals as possible in order that company do not miss any opportunity. Building up a clear individual proposal system is going to increase the quantity of project suggestions in the company and, of course, the good project portfolio will be granted a prerequisite.

In that stage, project proposals have to focus on the added value to the provider rather than focusing on the projects' costs and potential hardships during the evaluation step. So, project proposals must have a clear statement of those ideas' potential benefits to the company.

Every project, program or any other work in the portfolio is a *component* of the portfolio. Those components could be measured via specifically designed metrics that are sorted by predetermined criteria and each could be prioritized.

What we mean by *metric* is actually a measure to digitize the organizational performance or the work such as sales return ratio, costs, market share percentage, ROI etc.

These metrics are useful tools to measure past and predict future performances. The parameters used to evaluate, prioritize or select projects are the criteria here. Financial criteria is, for example, one of our goals in this model.

It is the vision and mission of the company that derives the strategies the company is going to implement and the goals to achieve the strategies. In order to implement a strategy, strategic management systems, tools and processes have to be identified and developed. This leads to the project related and operational activities' tactical implementation. We consider portfolio management as a triangle that has three layers. At the top, goals and objectives that aim achieving and sustaining vision, mission, strategy and objectives of the company which manage all actions of the company.

At the center, the processes that possess the proper actions required to achieve the objectives are illustrated by the management, operational planning, project portfolio planning and the management layer. All those are actually in interaction with the lower part of the triangle. Activities set the create value are the management of authorized programs and projects that enhance the value of the capacity of the company's production and the management of ongoing jobs. These events are pertinent to guarantee the company to execute its operations and portfolios. The management of continuing operational works and

authorized programs and projects' management under project portfolio planning are at the triangle's bottom.

In order to achieve strategic goals, companies have to undertake project and programs. Each of these projects and program is a strategy implementation tool. This connection is provided by portfolio management application through sharing goals and resources.

The identification of financial resources to be allocated to the portfolio will be guided by the vision, strategic objectives and prioritization of project of the company. The vision and the strategic objectives of the company are comprehensively planned in the shape of projects and/or programs on the components of the portfolio. Company manages these components according to the portfolio management principles. Each strategic objective of the company is corresponded by programs and project clusters, and there is no project or program that do not correspond. The portfolio's contribution to the company's strategic purpose define each project, and each project is managed according to project management principles.

There is another point of focus in the project portfolio management layer which is the portfolio or strategic layer. The processes, tools and the organizational structure required to tie the strategies of the firms to their projects are all included in the portfolio. At the portfolio level, corporate management's focus is on the capability to pick and give priority to the projects to help implement their scarce resources to meet their strategies.

Life cycle of project portfolio starts with the approve of the portfolio management by the company which includes certain activities of decision making like selecting and authorizing the components as a part of annual planning or updating periodic strategic plans.

Generally, project life cycle is accepted as the period that starts with authorization of the project and ends with completion of it. However, some models start this period with

proposing of the project. Project portfolio management accepts this period longer by including pre and after project processes.

This includes;

Recognize needs and opportunities

• Selection of the best projects

• Project planning and administration

• Product presentation, adoption and use of project results

• Realization of advantages

The second stage is the stage that centered on this thesis in which the best set of projects are selected.

In fact, this is where project portfolio management begins. It can be said that the first actions of this stage are defining the priority of candidate projects and proposals according to rational criteria and the selection the projects that will be included in the portfolio. The proposed candidate project will be evaluated against a set of criteria, or the scope of these projects will be modified to meet the criteria. If a proposed project does not exceed the minimum criteria, it is not necessary to list it for selection. However, the project in question can be put on hold since environmental conditions may change over time, the company's criteria may change and a project that is not appropriate at this time may be necessary and appropriate for the company after some time.

Portfolio management includes the following processes to assess the functioning of portfolio components in accordance with key indicators and the strategic plan: collecting project data, identifying projects to be evaluated, categorizing identified projects, evaluating categorized projects. , select appropriate projects from the projects evaluated, prioritize the

allocation of resources to selected projects, balance projects among the company's objectives, authorize the implementation of projects and review their implementation.

Vision, which is the overall strategy of the company, is determined by the broad involvement of management. The strategic goals are defined to make the vision possible. In order to guarantee that the portfolio components are met the objectives of the company, these objectives which are described are sent to the functional unit dedicated to portfolio management. Portfolio management picks the proposed components, gives priority to them and accept them, relying on the defined objectives of the company of course. The agreements are negotiated with the proper strategic stakeholders by the portfolio management and it also should review the portfolio balance. Project management's responsibility begins when a program or a project within the portfolio is authorized.

There are two sub-phases of project portfolio management. The focus of the first is prioritization and selection of projects. The focus of the other one is the projects' management in a portfolio. We can express the first sub-phase in the following way: To determine the right mix of projects to achieve the company's strategic objectives.

Component determination process has the following inputs: the strategic plan, definitions of the component, component templates and key identifiers, inventory of all present components and inventory of new component recommendations. And the key identifiers for each component, the component list and the list of rejected components are the outputs.

The long-term goals of the company, objectives definitions and plans to attain strategic objectives are all included in the strategic plan, vision and mission statements.

In the component list for the initial filtering phase, component definitions are pretty useful. For instance, a component has to be bigger than a predetermined minimum size and has to be in agreement with key strategic objectives in order to be a part of a portfolio.

In order to evaluate, categorize and pick components, component key identifiers and templates are used within the portfolio management process: Component name, number definition, class, strategic targets it supports, quantifiable benefits (i.e. new income, cost reduction, etc.), the qualitative benefits (which are strategic compliance, risk reduction, legal requirement, platform development), sponsor and component customer information, required resources (cost), key stakeholders, key delivery items, timing, business unit, market risk level estimation, market effect and definition

The current component inventory is an ongoing components list which has been authorized previously, directed by the process of program or project management, or components that were put on waiting list at the end of the previous portfolio cycle.

And, the new component inventory is a proposed new components list of which are put in use after the previous portfolio cycle.

After listing components of the portfolio, they are categorized. After that, the evaluation phase receives the components list.

The aim of the portfolio component evaluation process is evaluating the components, the collection of all information appropriate. Information on each component in the portfolio is collected and then summarized. This information can be quantitative or qualitative, and this information can be obtained from a variety of sources within the company. Outputs of portfolio component evaluation process are the list of components considered is the values for each component and the recommendations of the evaluation process. (Typical evaluation criteria are: Strategic adaptation, process improvement, productivity, business impact competitive advantage, employee satisfaction, customer satisfaction, cost avoidance, intellectual property rights, income growth, risk criteria (for example technology risk, business risk, py risk, application risk, reputation risk))

Subsequent to the process of evaluation, the project selection process starts from the list of components. At the evaluation stage, a list was prepared to determine the value of each

project and prioritize them. The inputs to the portfolio components selection process are the list of assessed components, strategic plan, and the list of values for each component. The output of this process is actually a list of selected components ready to prioritize.

After the selection of the project stage, the prioritization phase starts. The main activity of this phase is to determine which component is going to be prioritized higher within the portfolio.

In addition to projects that involve research, development projects should be balanced against projects that are involving risk, projects involving rewards, and development projects against maintenance projects.

In project portfolio management, we can talk about 4 main objectives:

- Maximizing the portfolio's value (expected business value, etc.)
- Creating balance in the project portfolio (long-term / short-term, low / high risk)
- Ensuring strategic alignment in the portfolio
- Choosing (restricting) the correct number

2.3. Project Portfolio Selection Problem in Project Management

Studies in Project portfolio selection in airline information technology organizations not a popular subject among researchers. Only a few studies can be observed in the literature. One of them is focus on hierarchical decision in this specific subject and its called Wang et al. (B. N. Wang 2013). Constrained Weighted Factor Scoring Model which related to Mission-Objective-Goal-Strategy-Action(MOGSA) Model and the Expectancy Theory, is key element while proposing a project selection model for the organizations. Dehouche (Dehouche 2015) adopted the multi criteria decision modelling in his approach. In his model, partly SWOT analysis was used to criteria evaluation and constrained knapsack method was used to solve the problem. One other study sustained by Pereira et al. (Pereira 2009) and by considering applications and technological areas of the projects/activities, their approach was allocating a research and development (R&D) program budget. Markowitz portfolio

selection model preferred in order to preform budget allocation decisions including risk estimation and return/benefit. Markham et al. (Markham 1999) proposed a qualitative manner. This was a catch-up approach that took into account resource management in accordance with the decision-making process and the conditions of success in organizations. Several government project portfolio selection problems and models are similar to organizations. In this regard, Huang et al. (Chi-Cheng Huang 2008), proposed a model including fuzzy AHP application in government sponsored R&D project selection activities.

2.4. Classification of Portfolio Selection Models

It is seen that the multi-purpose programming model, which is one of the models used in project portfolio selection decision support systems, has changed as modeling structure and solution method as time goes by. As the modeling structure, uncertainties are more prominent recently and fuzzy logic hybrid models stand out. Coping with vagueness, it is seen that robust method and fuzzy modeling solution methods are used. Although it is seen that most of the project portfolio selection models have a determinative structure, stochastic and fuzzy models have been studied especially after 2000s.

The stochastic models of Birge and Louveaux (J.R. Birge 1977) are examples of this field. In the 2000s, we can see that these studies have increased. Gabriel et al. (S.A. Gabriel n.d.), Abdelaziz et al. (F.B. Abdelaziz n.d.), Medaglia et al. (A.L. Medaglia n.d.) and various studies exist with similarities. The development of literature is similar, point of view with fuzzy models,. Some of the recent fuzzy models with stochastic models are studied by Tolga (Tolga 2008), Aryanezhad et al. (M.B. Aryanezhad 2011), Bhattacharyya and Kar (R. Bhattacharyya 2011)and Lapunka (Łapuńka 2012). Fuzzy models were investigated more than stochastic models, in the studies conducted in the last five years. Consequently, a rapid increase in the variety of fuzzy models and solution methods has been observed.

The articles reviewed in this study are Alvarez-García (Alvarez-García 2018), Mohagheghi et al. (V. M. Mohagheghi, new optimization model for project portfolio selection under interval-valued fuzzy environment 2015) (V. M. Mohagheghi, A new multi-objective optimization approach for sustainable project portfolio selection: A real-world application

under interval-valued fuzzy environment 2016) and Perez et al. (Perez 2016). Jafarzadeh et al. (Jafarzadeh 2018) emphasizes the literature review of the multi-criteria methods in deeply. In addition, the "System Dynamics" approach to the project portfolio selection problem successfully adapted according to researchers. The system dynamics approach has recently been used in multi-purpose models. ON the other hand its usage in multi-criteria methods is deeper. One of the striking models in the articles in this study is the robust models.

Gabriel et al. (V. Gabrel 2013) emphasizes an interesting finding in the literature. The use of intuitive and meta-heuristic methods of multi-purpose models with Robust techniques is quite common.

The other part of the project portfolio selection problem study is the use of new Fuzzy Model techniques. These new techniques offer a more efficient solution for models. Some of these methods are Fuzzy GRAY, FUZZY IVF, FUZZY QFD and resemble. Similar with multi-objective programming models, usage of uncertainty in the model and the interaction of the projects with each other stand out. Among the articles we reviewed, there are the works of Jafarzadeh et al. (Jafarzadeh 2018) and Arratia-Martinez et al. (Arratia-Martinez 2018) regarding this topic.

Multi Objective Programming: The following articles reviewed concentrated on the usage of multi-objective decision-making model. Haghighi Rad et al. (Haghighi Rad 2018) have incorporated the system dynamics with the multi objective decision-making method. The model that aims at the strategic contribution and financial outputs of the projects has been designed by Gue et al (Guo 2018). The fuzzy logic is utilized to solve the uncertainty in the model. By revealing the interrelations of the projects, Alvarez-García et al. (Alvarez-García 2018) aimed to create a dynamic solution. In the article declared by Mohagheghi et al. (V. M. Mohagheghi 2016), the sustainability target was added to the selected objectives. Besides the sustainability criterion, this model also contains some other criteria such as project risk, organizational preparation, strategic compliance, non-financial benefit. A three-step solution that contains fuzzy IVF technique is presented in the solution of the model. The differentiating point of the article presented by Xidonas et al. (Xidonas 2016) is the inclusion

of environmental consciousness of the company and the concept of energy in the decision-making model. In the bi-objective model, optimization is performed within the framework of current value analysis of the projects and their EECRs (energy and environmental responsibilities of companies). Perez et al (Perez 2016) attempted to solve the multi-objective model by defining the model in a non-linear form. Hassanzadeh et al. (Hassanzadeh 2014), targeted to be able to make R&D project portfolio selection by utilizing binary integer programming. In their paper, there is a decision-making situation between competing targets. in the solution of the model, the Robust method is presented, because both objective functions and constraints are formed in an uncertain formation. Gomede et al. (Gomede 2014) presented a model consisting two stages. The multi-purpose decision-making model is benefited in the first stage whereas multi-criteria decision-making technique is utilized in the second stage.

Multi Criteria Decision Making: Multi-criteria modeling is the most extensively used models in project portfolio selection decision support systems. The acceptance of this model is entirely former method. The idea is stated that formerly multi-criteria decision-making models were generally placed on the logic of prioritization among works (to maximize an accurate benefit) in a study handled by Jafarzadeh et al.(Jafarzadeh 2018). The researchs about how the works are pointed occur in recent years. One of the most outstanding methods is concurrent existence of projects interaction and uncertainty. This topic is still very popular in scientific literature. Tavana et al. (Tavana 2015), Jafarzadeh et al. (Jafarzadeh 2018) and Abbassi et al. (Abbassi 2014) has still argued the model of removed uncertainties and combined the tie between works in the model.

Multi-criteria decision-making model is the most widely handled way in the articles that are reviewed to determine the usage amount of this new model. Jafarzadeh et al. (Jafarzadeh 2018) defended a new model via three points which are relationship among projects, prioritizing measures and dealing uncertainties. Considering the probabilistic optimization structure, Tinoco et al. (Tinoco 2018) have explained similar model which have ability to

evaluate the project portfolio option in his studies. On the other hand, Tervonen et al. (Tervonen 2017), have created a new frame which provides decision-maker to cut in tradeoff among principles creating qualifications assessment. Debnath et al (Debnath 2017) also analyzed the model in different perspective which is about the buying GM crops while there are agricultural product scarcity.

Multi-criteria decision-making model is used in a launching project for a new good by Relich et al. (Relich 2017). In such projects, quality, quantity or both of them can be the specialties and distinctiveness. These types of projects benefit from fuzzy methos as an explanation. Another diverse method is also improved by El-Kholany et al. (El-Kholany 2017). Simulation method has been applied as well as multi-objective binary Cuckoo Search method in this study. Razi et al. (Faezy Razi 2017) approved to highlight in the usage of artificial neural networks fot the clarification of the method. Nestico et al. (Nestico 2017) highlighted a study which help to choose renew projects rightly. He performed a study in cities which his method was used. Markowitz method was applied to the model by Dobrovolskiene et al. (Dobrovolskiene 2016). He targeted a tenable conclusion. Mokhtarzadeh et al. (Mokhtarzadeh 2016) evaluated the model in three extent in choice of R&D. He added new criteria which is not used before.

In this article, Carnero et al. investigate the model which is performed to building industry. Separate evaluation methods have been published by Jeng et al. (Jeng 2016). He looked evaluation of projects from different perspective according to National Research Institutes that this institution's papers are influential on the field. Carnero et al. (Carnero, M.C. 2015) also performed in the sustenance area the paper they have to the project portfolio selection model. Taguchi Loss solution method was also applied. Linhart et al. (Linhart 2015) applied their study to the process flexibility. To disqualify the ambiguity of demand companies appeal this method.

Multi-criteria decision-making model was used to voluntary agencies by Dehouche (Dehouche 2015). Mira et al. (Mira 2015) also used same method on energy sector. The

model is performed to civil project by Arratia et al. (Arratia 2016). Razi et al. (Faezy Razi 2017) tried to find a new explanation method by applying PROMETHEE II and NSGA methods.

The difference of the multi attribute decision-making method from the multi-criteria decision-making method is principle which is appealed. Multi attribute decision-making method's criteria is qualitative when the multi-criteria decision-making method' criteria is quantitive. Liesiö J. et al. (Liesiö 2015) and Arratia et al (Arratia 2016) administer a multi attribute decision-making model in their search.

Fuzzy Modeling: It was found that fuzzy modeling was usually used to describe values that were not certain in the papers studied. Someone were referred before in division of other models such as Jafarzadeh et al. (Jafarzadeh 2018), Guo et al. (Guo 2018), Alvarez-García et al. (Alvarez-García 2018), Relich et al. (Relich 2017) and Perez et al (Perez 2016). Another paper in this subject is from Takami et al. (Takami 2018). The Unstable Fuzzy set method was demonstrated by him which includes ambigious and connection between projects. Mohagheghi et al. (V. M. Mohagheghi 2016) defined the model as the Atanassov Fuzzy Set Ceiling, Tavana et al. (Tavana 2015) performed a mixed system which include three stage and Data Envelopment Analysis, TOPSIS and linear integer programming in their system. Mohagheghi et al. (V. M. Mohagheghi, this is an optimization approach which combines a lot of goals for reliable project portfolio management: A usage in real-world under interval-valued fuzzy environment 2016) organized by using the interval valued fuzzy set the fuzzy model. Wang et al. (J. &. Wang 2015) used the Quantum Algorithms in order to deal with the fuzzy model. Razi et al (Faezy Razi 2017) apply a methot which located the GRAY in his own fuzzy model.

2.5. Methods Used For Different Models

This part aims to classify the models and methods used. It is clear that, some models are composed forms of multiple applied models . Likewise, in some cases models are solved with more than one method. This happens when one method is not enough for the solution and the other is necessary, when solutions should be compared or when extra solutions required.Applications and application areas also classified along with the models and methods.

38% of the models used in the 65 article analyzed are multi-criteria models while 16% of them are multi-purpose models. The modeling difference between multidimensional models and multi-criteria models also should be considered while analyzing the data. 6% of the models are multi attribute models while 23% of them are fuzzy models and 5% are durable (Robust). The last part that occupies 12% is non-linear models which do not have a specific model or some other types of modeling(Figure-1).

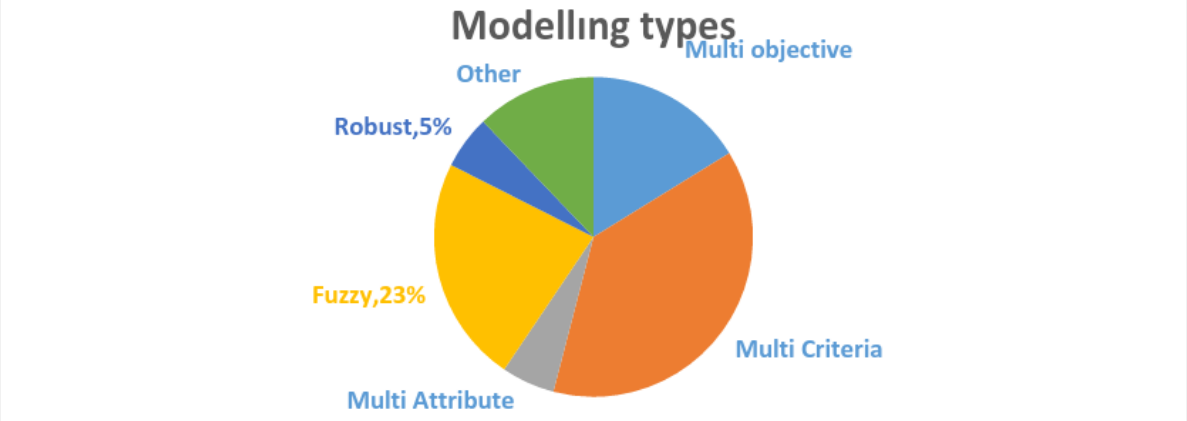


Figure 1-Modelling types

Heuristic methods are the most common methods with a percentage of 25% when the classification of the methods examined, Methods such as artificial neural networks, meta-intuitions, Gray analysis, and similar ones are the most common methods among the heuristic methods. Fuzzy model solution methods are the second common methods after the heuristic methods.DEMATEL, PROMETHEE, AHP, GRAY, IFV, TOPSIS etc. are various solution methods of fuzzy modeling, that have been used in solutions. The rate of the solutions are

related to fuzzy modeling is approximately 24%.The third most commonl used methods which come after the fuzzy modeling solutions are simulation and robust solution methods. Monte Carlo simulation and scenario-based simulation are two of the Simulation solutions. Weighted Tchebycheff method and the pareto optimal method are included in Robust solution methods(See Figure-2).

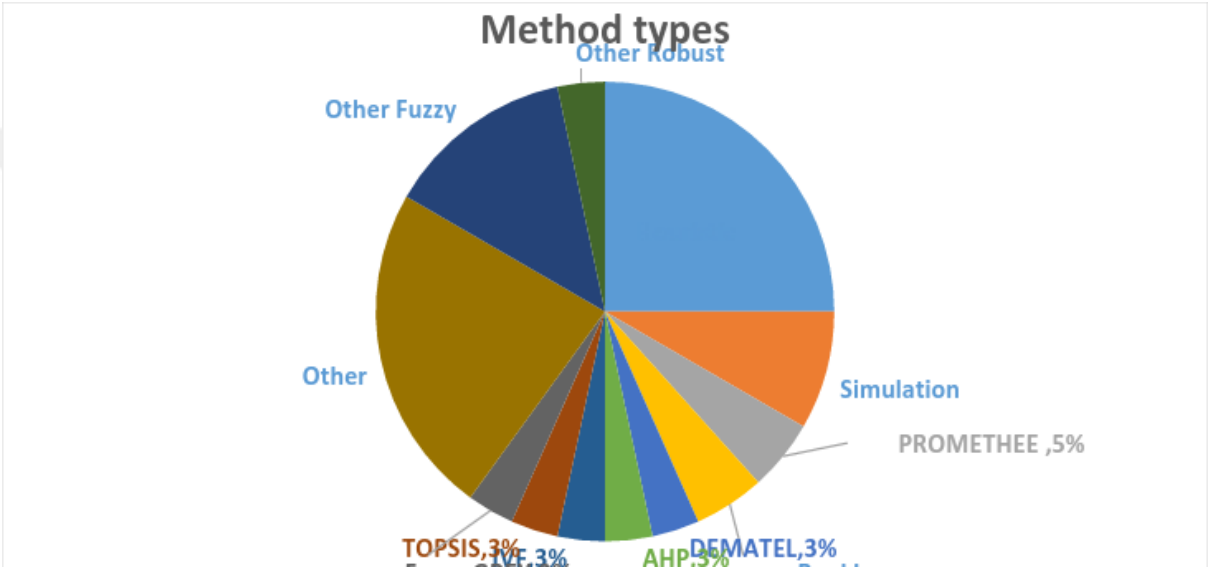
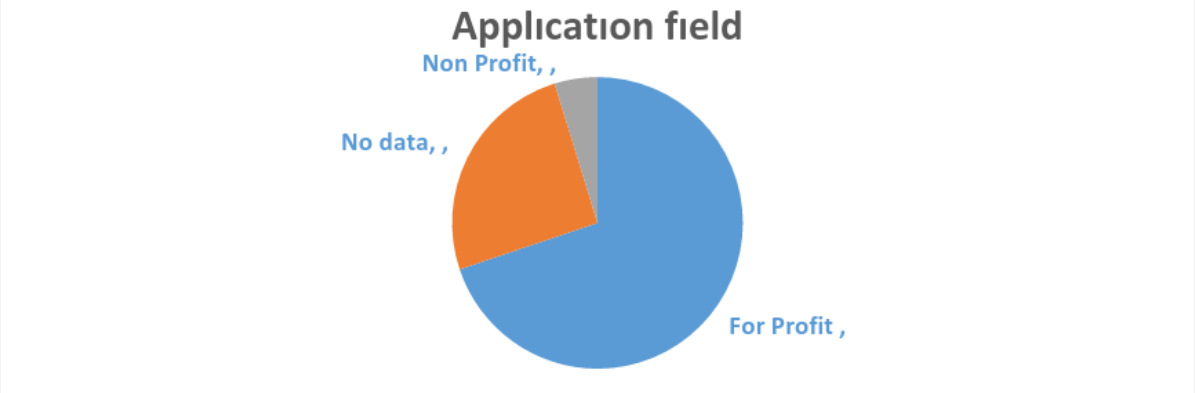


Figure 2-Method Types

While the studies based on commercial enterprises are the biggest part of the studies that are exxamined from a perspective of application areas, there are several different areas that the studies applied. While the studies that conducted for-profit enterprises occupies almost 70% of the chart, the studies classified as non-profit studies have ratio of only 5% of the articles reviewed. No data could be found from the remaining part that is 25% of the articles. This can be understood with the information that 20% of the studies are theoretical (See Figure-3).



Appendix-1 includes a detailed classification of this 65 studies. The information from the table in the Appendix is used when the analysis above was done and the figures were generated.

2.6. Goal Programming for Project Portfolio Selection

Suboptimal values in goal programming technique that match the determined goals are confirmed as a solution. In this technique searching for better results is not necessary. The gap variables are determined according to some selected goals. These gap variables are minimized by the model which has an aim to catch the goal or a point near the goal. In goal programming, the possibility of reaching the target for more than one solution is likely. As a result, selection algorithms could be implemented. Goal programming technique is used by Sampson (Sampson 2006) when solving the voluntary academic staff assignment problem. This technique is also used by Falasca and Zobel (M. Falasca 2012) in the voluntary assignment problem after the disaster as an alternative to other solutions. However, according to the authors, it was a hard issue to apply the model because of the characteristic of the problem.

2.7. Dynamics of Airline Information Technologics Departments Projects

It is well known fact that the usage of technology in aviation industry is very prevalent. Besides, aviation industry helps the advance of technology. Because airline information technologic departments have very a large-scale customer whom are in company and out of company, there are many sub-portfolios in their portfolios. Even the size of the department

is the indication that this state is necessary. For example, one of the world's leading airline company employs approximately 1000 employee in information technologic department. Every sub-portfolio corresponds to a business unit which is served by information technologic department. Basically, these sub-portfolios can be evaluated under 4 different heading.

- The sub-portfolio containing portfolio components for the passengers served by the airlines
    - Reservation and ticket processes
    - Technological solution processes for agency and ticket sales offices,
    - Online channels (website and mobile applications)
    - Checkin / counter processes
- The sub-portfolio that provides the technological infrastructure in the airline and includes the sustainability of the operation
    - System support solution processes
    - Network and security solutions and processes.
    - Database management and maintenance solution processes
    - Communication and data communication processes
    - End-user service and communication processes
    - Data center management processes
- The sub-portfolio created for the solution of airline employees and flight-related operations
    - Processes for flight operation solutions
    - Solutions for ground operations solutions, baggage and checkin management
    - Cargo operation solution processes
    - Solution processes for the demands of the teams
    - Processes for ERP solutions
- The sub-portfolio containing portfolio components related to strategy and management of airline information technology departments
    - Processes for project management solutions
    - Processes for business intelligence solutions

- Processes for strategy and architectural solutions
- Processes for reporting and data management solutions

In the modeling we applied to our example airline company, the sub-portfolio which includes projects for the passengers served by the airline has been taken under the spotlight.

3. METHODOLOGY

3.1. Proposed Model

Goal programming is presented as a model solution in this study. Goal programming is suitable to simultaneously meet the various goals. Targets are determined in the restriction section in this model and linearized in the objective function. Their impact on the model solution was thus distributed evenly. Objective functions, data sets, decision variables, parameters and finally the mathematical model were presented in this part of the proposed model assumptions.

3.2. Assumptions

The main assumptions about the model are:

1. The decrease in the expected revenues of the projects is due to 10 year depreciation linear decrease.
2. Minor losses in projects were neglected.
3. Projects with legal imperatives are not included in the candidate portfolio pool. Since these projects were selected as mandatory, they were not included in the modeling.
4. All project resources, manpower and project inputs are evaluated under cost constraint. Since the purpose of modeling is not to place in the calendar, human resources are assumed to be unlimited and the appropriateness of appointments and calendars are ignored.
5. The increase in project costs over time is due to the increase in inflation and exchange rate.
6. It is assumed that the budget is limited and this limit is stated in the cost constraint.
7. It is assumed that the human resources to be employed in the projects are sufficient within the cost constraints.
8. Each project can only be launched once, and the model must be established with this assumption.

9. The portfolio period is thought to be 3 years, 5 years is considered as a long period for IT projects, rapid progress in technology makes 5 year portfolio planning impossible, 1 year portfolio period is determined as a short period for airline company. Planning, analysis, development, functional testing, user acceptance testing are generally considered as 3 years on average for mega projects. Moreover, it is considered that the number of candidate projects in 1-year or two-year portfolio planning is not sufficient for selection.
10. For some projects that do not require special expertise, outsource costs are lower and it is assumed that they will be supplied by Indian companies. For projects requiring special expertise, human resources will be covered by European and American technology companies and the related costs are relatively higher.
11. Internal customers represent business units that can request projects from information technology departments. External customers can be expressed as passengers who purchase services from the airline.

3.3. Objective Functions

Since the target programming model is used in this thesis, the objective function of the model is to minimize the total difference between the determined targets and the current situation. In this respect, the same applies to the same objective function as the model has four purposes. The first term is to maximize the expected growth of revenues. The second term aims to select the most demanded projects by internal and external customers. As the second objective constraint shows, the model will try to select projects as much as possible. If the budget constraint is removed, the model selects all projects. The third term of the objective function is related to the strategic purpose performance, and it is aimed to select projects that are suitable for the strategic objectives derived from the vision and mission of the airline company. The fourth term represents the degree of potential risk.

Strategic Business Performance: Indicates how much the goal is to make the components a strategic goal of the company.

Financial contribution provided: The investment's return on investment, its net present value, the distribution of financial support between the components of the portfolio within the framework of strategic objectives.

Asset Maintenance and Development: Indicates to what extent the components contribute to the maintenance and development of company-specific assets.

Satisfaction of the product / service against the end user, Portfolio Stakeholder Satisfaction

Stakeholder Risk Profiles: Indicates the business risk of the component.

3.4. Data Sets

Sets used in the model are as follows

P: project set

i: Index represents projects in portfolio pool project set (1-11)

j: Index represents the beginning years of projects (1-3)

3.5. Decision Variables

Decision variables used is the model are as follows:
$\boldsymbol{x_{ij}}$: Number of project i started at j year
$\boldsymbol{y_{ij}}$**:** 1 if model choose project i as inhouse, 0 otherwise
$\boldsymbol{a}$: gap variable for first goal
$\boldsymbol{b}$: gap variable for second goal
$\boldsymbol{c}$: gap variable for third goal
d: gap variable for fourth goal
k: gap variable for fifth goal

3.6. Parameters

Parameters used in the model are as follows:

ERGij : Amount of expected revenue growth for project-i and when started in year-j

One of the objectives of the project is to maximize the expected revenue growth. Some income calculation methods used in the projects are given below. Expected revenue values for the airline company we work for are specified in the solution section for the individual projects. These values are obtained from the airline company. The reason why the expected

income level changes according to the years is that the technology projects are outdated according to years, for example, if the project is not realized in the year it is popular, the expected income is decreasing and it loses its fashion. On the contrary, in some projects, there is no loss of popularity as the years pass by, infrastructure projects, update projects etc. There is no risk of missing technology The relevant parameter for all projects is explained under individual projects.

Net Present Value: The result which is calculated by adding all amount in this method shows the value of the project. If result is positive, project is profitable. That is, revenue is higher than the investment. If result is negative, project is not profitable. Revenue is lower than the investment and project causes loss of money. If result equals zero, project is not profitable and not to cause a loss. It shows that project is in breakeven point.

Benefit Cost Ratio: Thanks to this ratio, projects which take nearly same time can be prioritized. It is equal to ratio between benefits of the project and investment of the project.

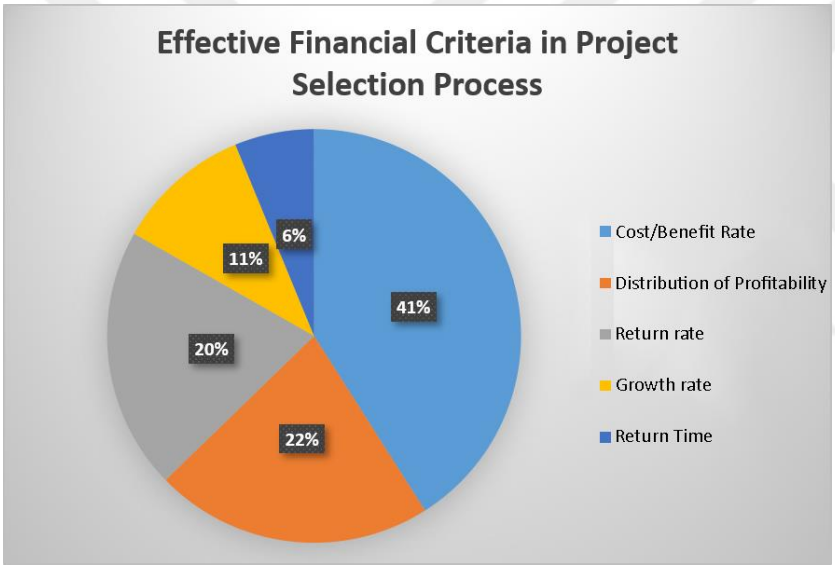
B/C Ratio: B/C ratio is mustn't smaller than 1 in order to do cause loosing money. When it equals 1, money which is invested in the project or anything is equals to benefit from this project. If B/C ratio increases, then project begins to take money and if it decreases, project begins to lose money.

Internal Rate of Return: Internal rate of return is using when a project choice is made. Ratio is found by making some calculations that is more complexity than other ratios with project's expenses and estimated benefits. This ratio gives how much project provides benefit in percentage. According to this ratio, it's logical to choose which have bigger ratio.

Payback Period: Payback period show the time which benefits of the project exceed expense of the project. From this time project begins to profit. Therefore, companies choose the

projects which have smaller payback period because the less a project's payback period is, the shorter company begins to benefit.

Oppourtunity Cost: Opportunity cost is a project's benefits which is given up for the project putting the action. This proves the important of saying no because to sacrifice a project may cause to gain more favor.



Şekil 1 Effective Financial

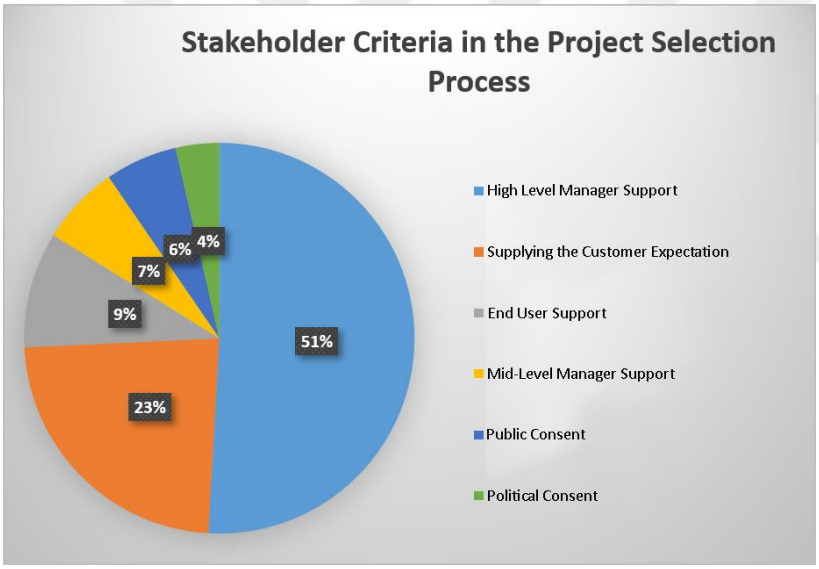
Project Selection Survey – Suresh Balivada – PMI/Aspentech

CDRij : Number of customer demand rate for project-i and when started in year-j

Customer demand rates were obtained through some in-house and external surveys. External customers, ie passengers using the airline company, were reached via the website and mobile application. After the ticket purchase, pop-ups were shown and short surveys were conducted to determine the expectations of the customers from the airline company. Demand ratios of specific and specific projects of internal and external customers were evaluated over hundred

fraction and transferred to the customer demand ratio table. The demand rates of external customers and internal customers for certain projects were multiplied by a specific rate and balanced and consolidated.

The relevant parameter for all projects is explained under the individual projects. The related demand collection process for internal customers was realized through the project and portfolio management tool. The collected requests were re-evaluated by the managers and superiors. The results and the results of the questionnaires were consolidated and converted into percentages and the values in the table were obtained.



Şekil 2 Project Selection Survey- – Suresh Balivada – PMI/Aspentech

SARi : Number of strategic alignment rate for project-i

The strategic purpose of a company's strategic planning efforts is its strategic purpose. Objectives are derived from the company's vision and mission by the top management.
Then the effort of the company's project management business processes to ensure compliance with these objectives begins.
Projects are an implementation tool of the strategic plan and realize strategic objectives. Nowadays it is essential for a company to realize a project for its survival and growth. Because the project creates value for it.
Projects are of strategic importance for the company to create value by allowing the company to survive first and then to grow. Therefore, project selection and project portfolio creation, strategic approach should be approached.

In individual projects, the relevant parameter for all projects is explained.

- It is not enough to manage the projects carried out within the company from the bottom up in the company hierarchy.
- There are many unimportant projects carried out by various units of the company, which unfortunately do not create added value for the company.
- The resources allocated by the company to the projects have a strategic value for the company. Each of these resources has certain capacities, they are not unlimited.

The third limit is the compliance criterion for strategic goals. The mission and vision of the company, derived from the strategic objectives of the most suitable projects, attempt to provide the selection. To this end, a board determined by the company's top management and evaluated the projects by scores 1 to 5.

Project Selection Survey – Suresh Balivada – PMI/Aspentech

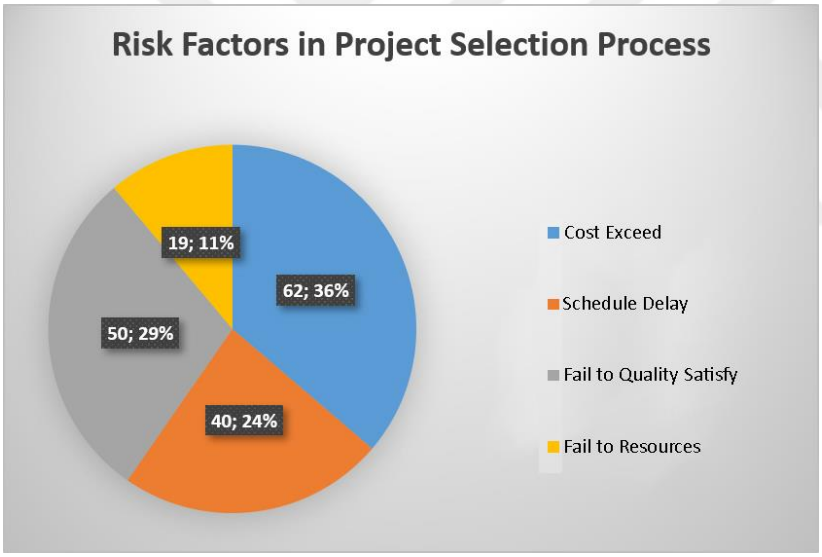
PRRij : Number of project risk rate for project-i and when started in year-j

When project planning stage continue, extrinsic elements should be regarded because they affect the project's implementation importantly. Risk is known as extrinsic situations which influence the project's advance. Project management is configurated by risks and this enure to

activities and command of project management (Yentürk ve Aksakoğlu, 2006:87).

Risks which related with the project is interested in future. Uncertainty and ambiguity are

statement of risk. Risk influence the process of the project with many ways such as scope of project, time of project, cost of project and quality of management. To acquire a consent might take more time than assumed from a related institution. So, try to examine and assume the risks are very important and crucial. It is not possible to proactively perform changeable risks in which a coincidence plan should be developed by the project team. (PMBOK, 2008:275). Postpones in schedule are the most ordinary risk type in our case airline because of 3rd party business and the enlargement of obtainment processes the projects to be bought. Therefore, the inspections on the projects that include purchase or third-party firms show that they higher risk rates than other projects.



Project Selection Survey-2012 – Suresh Balivada – PMI/Aspentech

IHCij : Cost of project i when started in year-j as inhouse

Projects carried out within the company are preferred more than projects conducted outside the company. The reason is that technology knowledge remains within the company and risks arising from external firms are minimized.

OSCij: Cost of project i when started in year-j as outsource

Due to some requirements, companies need outsourcing support. For example, if outsourcing costs are obtained from India, the cost of human resources can be reduced to reduce the cost of human resources, from Europe or the United States, to obtain consultancy support, or to eliminate missing information for the project, in which case it may be necessary to bear high costs.

3.7. Mathematical Model

Proposed Mathematical model is as follows:

1) $z = min\ \ \mathrm{a}/1.000.000 + \mathrm{b} + c/5 - d/5 + k/100$

such that

2) $\sum_i \sum_j x_{ij} \times ERG_{ij} + \mathrm{a} = \$\ 15$ million

3) $\sum_i \sum_j (X_{ij} \times CDR_{ij}/100) + \mathrm{b} = \ 0{,}70 \times \sum_i \sum_j X_{ij}$

4) $\sum_i \sum_j X_{ij} \times SAR_{ij} + \mathrm{c} = \ 5 \times \sum_i \sum_j X_{ij}$

5) $\sum_i \sum_j X_{ij} \times PRR_{ij} + \mathrm{d} \ = 3 \times \sum_i \sum_j X_{ij}$

6) $\sum_i \sum_j Y_{ij} + \mathrm{k} = \ \sum_i \sum_j X_{ij}$

7) $\sum_i \sum_j Y_{ij} \times IHC_{ij} + \sum_i \sum_j (X_{ij} - Y_{ij}) \times OSC_{ij} \leq \$\ 7{,}5$ million

8) $\sum_j X_{ij} \leq 1\ \forall_i$

9) $Y_{ij} \leq \ X_{ij}\ \ \forall_i \forall_j$

The formulas used in the model are as follows:

(1) it is used goal programming, the objective function (1) is constructed accordingly. The aim is minimizing the gap between goals and the realized situation.

(2) The first restriction in our model is the one that restricts expected income is increased. In the model, the x(i,j) the decision variable of the projects to be done is going to be valued “1” when project is decided to be executed and “0” when it is not. The aimed expected income

is tried to be attained by multiplying the corresponding decision variable with their related values on the table. In order to attain the expected target income the space variable “a” is tried to be minimized. Since the expected income values are expressed in millions, in order not to disrupt the aim function the gap variable “a” is divided by a million before placing to the table.

(3) The second restriction is the one which aims to push the customer demand ratio towards the customer demand ratio that the airline firm expects. The aimed customer demand ratio is tried to be attained by multiplying the corresponding decision variable with their customer demand values in the related year on the table. In order to attain the expected aimed customer demand ratio, the space variable “b” is tried to be minimized in the objective function.

(4) The third restriction the “compliance with the strategical aims” criterion. We endeavor to provide the projects that are most suitable to the strategical aims produced out of vision and mission of the airline company. Therefore, the projects are rated between 1-5 by a committee which senior management appointed. We will try attain the expected score by multiplying our project selection decision variable with the project’s strategic aims and compliance score. To reach the expected score, the space variable “c” is ensured to get minimum value. Strategic compliance points, unlike other parameters, does not contain variables that varies according to the years; since mission and vision are not expected to budge in the short term, this criterion is regarded time-independent.

(5) Our fifth restriction is the expected risk ratio which tries to minimize the portfolio risk originating from projects. Risks arise from different reasons, what are most important ones for the projects are the ones like dependencies for third party firms, the risk of exceeding the cost, date delay risk. The airline company’s Project Management Office team evaluated 11 projects in terms of their risks and graded them 1 to 3; 1 being low risk, 2 medium risk and 3 high risk. In our risk restriction formula, project selection decision variable will be multiplied with risk scores and the aimed expected risk score is tried to be reached. In order

to attain that score, we will try to maximize the space variable “d”. Unlike other restrictions, the risk parameter is tried to be minimized. In other restrictions, we were maximizing the expected income, customer demand ratio and strategical compliance ratio. Thus, the space variable “d” is represented with minus sign in the aim function.

(6) Thanks to this restriction, we will try to make projects as in-house as possible. In order to approximate projects done in-house to total project quantity, the space variable “k” is tried to be minimized.

(7) One of the most determinative restrictions in our model is the cost restriction. The cost restriction is designed in a way that it varies whether the project is to done in-house or it is to be outsourced. The in-house and outsourced cost restrictions represent these variables. y(i,j) is the decision variable representing projects done in-house. If a project is being done in-house this variable gets the value “1” for that year and that project, and it gets “0” otherwise. In our cost formula the project decision variable is multiplied with the in-house costs. Outsourced project quantity is obtained by subtracting in-house project decision variable y(i,j) sum from our main project decision variable x(i,j) sum. This obtained result, then, multiplied with project cost values and added to the in-house costs sum. We expect this final sum to be equal to or lesser than the total budget allocated for the projects.

(8) This restriction restrains the project from being selected in multiple years, a project could only be started once. This is a model control restriction.

(9) For each project and year the quantity of in-house projects selection could not, in any way, exceed the quantity of main project selection. This is a model control restriction.

4. MODEL SOLUTION&ANALYSIS

4.1. Sample Projects Informations

The projects that will be used for the model, the projects of the sample airline IT and their dynamics affecting the model are given below.

4.1.1. Project 1: Website renewal project

The website, which only serves in three languages, will be designed in 12 languages including Turkish, English, Arabic, Japanese, Korean, Italian, Spanish, Portuguese, French, Russian, Chinese and German. Users from these countries will now be able to use the user-friendly interface of the new website. Moreover, the infrastructure of the new website is designed to support more languages in the long term.

- A number of innovations will be provided with the new website, and will contribute to the goals of the airline company in the digital platform.
- The website design is to be completely renewed, and it is demanded to be developed to ensure accessibility standards.
- "Reissue, cancel, refund, adding baby to reservation" functions are required to be added to the new website. These processes can only be done from sales offices and call center channels.
- An infrastructure to support new payment methods will be established; new payment methods will be offered gradually.
- It will be ensured that the content is displayed to the customer in accordance with the loyalty program membership.
- Ancillary service sales processes that will generate more revenue will be developed. Additional functions such as saving card information, registering frequently accompanied passengers, saving APIS information, and finding the nearest airport to the destination port will be implemented.

- More modern infrastructure and monitoring systems will be designed to support the increase in usage in the web channel. The web service infrastructure will be changed.

Evaluation of the parameters of the project: This project appears to be one of the largest projects in the portfolio pool. Expected revenue growth after completion of the project varies according to the year in which the project started. Progress in technology reduces the level of revenue growth expected from the project by the year. The internal and external customer demand rates for this project are also quite high. The ineffective and dysfunctional interface of the old website is one of the factors that cause this rate. This ratio shows an increasing graph as of the year. The project risk ratio is considered to be of high risk due to the extent of the scope and the risk of calendar delay due to the inclusion of many teams from the IT department. The cost of outsourcing costs of the project is higher than inhouse costs. As it is a project that requires expertise and experience, it is foreseen that the outsourcing resource supply will be provided from the companies of European / American origin, which stands out as the factor increasing the outsource cost. The ratio of the project to the strategic objectives is at the highest level. The senior management aims to reduce the costs of the agency commission by reducing the costs of the agency commissions to self-service channels, and the self-service channels to respond to all demands are among the most important strategic targets.

4.1.2. Project 2: Loyalty project for agencies

In the first phase of the project, it is requested to eliminate the deficiencies in the existing structure, to plan and implement the sales and marketing activities, to establish the corporate memory by registering the relations with the agency (negotiation, demand and complaint, incentive agreements etc.) and to save time by means of mobile access. While creating the project proposal, it has been given importance to be user friendly and applicable in the field. Support has been received from domestic and international sales offices.

Target items followed by SAP (Sales Activity Platform) before the application will be kept in a registered environment after the processes are completed. The quality of the data entered

in this field cannot be measured, and the relations with the agency cannot be tracked because it cannot be registered.

After the project is completed, sales offices, sales president, vice presidents and experts will use the product. An environment will be created where the sales office teams within the airline company can manage their agent visits, the communication with the agencies and view the history of this communication. With the application, it will be possible to have an easily communicated, transparent and traceable agency communication environment where information can be easily shared.

The main purpose of the project is to create a single application by bringing together the different platforms used by Sales Offices. The ability to handle all the tasks from a single application without wasting time on different platforms between busy work tempo will provide a significant time saving. In addition to this, it is easier to adapt to the new office and work flow and operational efficiency will be increased due to the rotations in the airline company.

Evaluation of the parameters of the project: One of the sales channels of our example airline is sales of tickets through agents. The reporting system of the relations and transactions with agencies will be developed with the project, and the similar loyalty program management for passengers will be developed for agencies. The demand for the project is mostly derived from in-house customers, so it can be assumed that when demand consolidation is made, a relatively lower rate of demand in the website renewal project can be met. Risk rates for the project appear to be moderate. Integration with agencies also reveals the risk of calendar delay. The projected outsource costs seem to be lower. The project is moderately coherent with strategic objectives, and as a result of strategic objectives, it is desired to refer to self-service sales channels rather than agencies, while on the other hand they require sales transactions with agents to be reportable and traceable. In this way, it will be possible to choose among the agencies and provide more advantages to the agencies that show loyalty.

4.1.3. Project 3: Cargo operations management project

The demanded system is a state-of-the-art, dynamic, integrated, user-friendly system that will increase the competitive capacity of airline cargo systems by increasing the service quality.

A user-friendly interface is requested for the application. Some of the most important features that will provide convenience to the users according to the current system are that the system is browser based and allows multiple operations at the same time and eliminates the need for code memorization with mouse operation thanks to its advanced interface.

In addition, some processes that will bring serious innovations to the sales, accounting and operation processes will partially change some processes.

Some changes requested in the project proposal are as follows;

• Fee information will be determined and displayed in sync with the reservation.
• External stations will manage their own flights and will enter the booking information themselves at the point of departure from their destination. The system will determine the approved and redundant status for reservation according to certain parameters.

• Errors will be minimized by automatic fee control with a Rate Audit •

• All movements of cargoes within the tank and on the ramp side will be carried out by hand terminals, thus reducing losses and user errors.

• Thanks to the warehouse management system, the location tracking of the cargoes can be done instantaneously and the past movements can be displayed.

• All operations will be carried out by automatic work orders, from the acceptance of the cargo to the aircraft, from the aircraft to the delivery to the customer.

• Several manual actions are performed automatically, such as the calculation of cost savings, NOTOC printing, and the import manifest after a check in (break down) operation.

• Thanks to the parametric structure, errors due to manual inputs and their effect on processes will be reduced.

• More accurate reporting than data quality will increase.

• Capacity planning can be made by EDI messages sent by post offices. In response to EDI messages, postal messages will be sent to the postal authorities in response to their status.

• ULD messages will be generated automatically and the station stocks will be updated in airplane take-off and landing. In this way, effective inventory tracking can be made.

The aims of the new cargo operation management system, the development of business processes in general (reduction of manual operations), improving the quality and reliability of the service in terms of customer satisfaction, optimizing the revenue generation potential, providing strategic decision support and reporting easily, reducing the use, development and maintenance costs of new technologies, to ensure that the personnel work more efficiently with ease of use.

The system will provide the most advanced technological infrastructure for air cargo transportation to the airline company with the mentioned improvements.

Evaluation of the parameters of the project: One of the strategic goals of the airline is to improve the cargo operation and to get a larger share of the potential air cargo transportation capacity. For this reason, the requested project is highly consistent with strategic objectives. The outsourcing costs of the project are higher. In addition, it is preferred that the inhouse be made due to its characteristic. The rate of customer demand is considered as an increasing project every year. Expected revenue growth is also expected to increase due to capacity increase in the cargo sector.

4.1.4. Project 4: Web Payment Methods Integration

With the new website, innovations in the online payment step to support the global airline brand image are demanded. It will be able to continue to explore customers using the currency and new payment methods of their choice from anywhere in the world by following the airline, which is a global brand. New payment methods and new functions are underway.

New payment methods and innovations requested:
UnionPay: UnionPay is a local card brand that is widely used in Chinese and Hong Kong markets by Chinese banks. UnionPay cards can be traded in contracted banks in various countries. With the integration of UnionPay, it is aimed to present Chinese local credit card which is common in China and Hong Kong market as an alternative payment method to Master / Visa cards in online sales channels and to increase sales in these markets which are strategic countries for airline company. In these countries where the rate of successful payments with a credit card is low, it is of great importance to offer an alternative payment method other than Visa / Master card payment.

Diners Club: It is an American based credit card organization that can receive payments in 200 different countries around the world. The payment methods supported in these regions will be diversified, especially with the Diners Club card used in America and Europe.

Shetab Card: In Iran, which is restricted to international credit card and debit card usage due to the embargo, it will be ensured that the cards of the Iranian banks (Shetab Card) can be used with the integration of Samanbank. With this integration, Iranian Riyal will be added among the currencies that can be sold. Our Iranian-based flights do not pay for our online sales is very low. It is aimed to increase the share of our online sales through integration with Samanbank. Thus, the work intensity in our sales offices will be reduced and customer satisfaction will be ensured. In addition, the Samanbank agreement will provide a commission cost advantage.

Payment in Different Currency: Now the fees of foreign flights can be paid on the new website with the foreign currency requested by the customer. In addition, in some cases, our customers can continue their transactions with the first ticket in the reissue and refund transactions. Our passengers can get their payments online and they don't have to come back to our offices and get refunds.

Evaluation of the parameters of the project: New payment methods are planned to be added to the website. Due to the increase in the sales capacity through online channels, the expected increase in income increases due to time. Accordingly, customer demand ratios also increase. Project risks are reduced over time, as the risk of integration with banks decreases in proportion to the increasing experience of banks in the payment method. Outsource costs are lower, because it is a non-competing project, support from Indian-origin outsourcing sources will be available. The project also complies with the strategic objectives, and development of self-service sales channels is among the strategic objectives.

4.1.5. Project 5: Mobil reissue

With the project, customers are on the booking menu:
One touch return tickets without needing to call the sales office or the call center, and can raise their tickets with one touch to the business cabinet. They will be able to update the person who needs to be contacted about their flights with one touch.

In addition, tickets and reservations can be done through the sales office and the call center but not via the mobile application. The mobile app will be added as a ticket return / cancellation, reservation cancellation features, contact person information update, upgrade to Business Cabinet, and my bookings menu will be updated.

The project aims to contribute to the digital transformation of the airline company and increase customer satisfaction, return / cancellation through mobile application, and increase sales revenue through Business Cabinet Upgrade feature.

Evaluation of the parameters of the project: Mobile application is one of the airline's online sales channels. Reissue, the date of the ticket or reservation and the change of the course is required to be added to the mobile application. It is a project with a high level of compliance with strategic targets in terms of ensuring customer satisfaction and increasing the capabilities of online channels. Costs and expected revenue growth are relatively low project demand compared to other projects. The risk ratio is low.

4.1.6. **Project 6: Ticket database modernization project**

In the present, the query of the past tickets (vouchers that have reached the last status) can only be made through the Mainframe terminals. The new fields and EMD fields added to the ticket information could not be shown due to the technical difficulties and sustainability problems of the current system. With increasing flight volume, there is a risk of access to 5 year old tickets, 5 years of ticket data is legally required to be archived. The database on the mainframe does not have integration with open systems. With the implementation of the project, it is aimed to be integrated with other open systems through Webservices. It is aimed to reach new information fields that are added to electronic tickets and EMD. It will be ensured that the tickets can be backed up without storage problems. It is also possible to continue the query of tickets from the current terminal screens. When it is analyzed in terms of requirement, the past ticket database on mainframe will be rid of the risk of accessibility and the sustainability will be guaranteed. In terms of operational efficiency, it can be used by other open system applications and integrated into the reporting environment. Quick access to data and flexibility in use will have come. With the support of modern backup procedures, maintenance support costs will decrease. Other possible mainframe software tools for modernization and relocation projects will be tried. After the project is completed, the users of the agency sales channel, sales offices and check-in processes will be able to use the team.

Evaluation of the parameters of the project: The project requested to modernize the ticket database is only an infrastructure project requested by internal customers. The risk ratio is low. It is considered as a project that can be carried out with low cost outsource resources.

For this reason, the costs are lower than those of costs. The Company's compliance with its strategic objectives is lower.

4.1.7. Project 7: E-Visa project

E-visa sales service is requested in sales offices. Within the scope of the project, an application that provides access to Ministry of Foreign Affairs services via proxy service will be written. With the implementation of the project, all foreign sales offices will be able to arrange entry visas for the country. The Ministry of Foreign Affairs has extended the e-Visa application and facilitated the travels of our foreign passengers to the country, and it is requested to provide additional income to the airline company with the requested project. You will be offered a visa by offering an additional service when you are selling tickets to passengers arriving at the sales office to buy tickets. This service will be charged to the airline company service fee. For each e-visa to be issued from the sales offices, it is targeted to receive a service fee per transaction and thus to provide additional income. After the project is completed, the e-visa passengers, all foreign nationals need a visa to all overseas trips will be arranged in Turkey and sales offices can benefit from this service.

Evaluation of the parameters of the project: Evisa project, airline ticket sales from the after-sales offices located abroad, Turkey aims to improve the evisa issue services for input. Compliance with strategic objectives is relatively low. It is demanded by sales office employees and related business offices. There are also demands by foreign passengers. Project risk is considered low, outsourcing costs are lower. Expected revenue growth is a rising graph compared to years, increasing passenger capacity and increasing awareness of evisa service cause this.

4.1.8. Project 8: Mobil site design project

A mobile site which is capable of directing traffic to web page is requested from mobile devices without using mobile application.

In this context, mobile application design and workflows will be completely renewed considering the user experience and new design concepts. IOS / Android applications and

HTML5 mobile site suitable for renewed designs and flows will be developed. Within the scope of performance improvement, mobile middleware will be renewed and web services will be improved.

With the implementation of the project;

Mobile application user experience and design will be completely renewed. The new app will be published in the Apple Store. The mobile application will be upgraded to the Android mark for ticket sales and online services. Multiple passenger check-in and promotional display will be added as a new feature. The traffic from the mobile devices to the website will be directed to the mobile site.

With the diversification of sales channels, customers will have easier access to services. The number of sales and transactions in mobile channels is estimated to increase by 4 times within a month.

It is expected that the number of sales of tickets and turnover in mobile channels will triple in the first weeks of the applications. The number of turnover and ticket sales will continue to increase due to the widespread use and increase in usage. In other online services, the number of transactions increased in a similar way.

With the updating of mobile applications, customers will be able to increase their revenue through easy access to sales and services, and operational efficiency will be ensured through the increase in the number of uses of online services, as in the case of check-in operations, operational costs will decrease. The contribution of mobile applications to the organization in terms of advertising and prestige is also important.

Evaluation of the parameters of the project: Users who do not want to download a mobile application to their phones want to buy tickets or to book their booking via the mobile browser applications via the airline's website. It is a project that is compatible with strategic objectives to develop self-service channels. The risk ratio is moderate and high, because it is a project that affects many teams and has dependencies on design firms. Outsource costs are higher, because it is a project that requires expertise.

4.1.9. Project 9: Standardization of payment infrastructure project

Currently, all sales channels generate a bank reference number over a database of their own using a different algorithm. This requires the establishment of different scenarios for the production of reference numbers in different applications. In addition, due to the fact that the payment command is not a standard in the reservation system, there are difficulties in data transfer in the Mutual Bank Reconciliation application. Applications work under the same virtual pos for some banks. Parallel to the increase in the volume of transactions in the virtual environment, it is predicted that the reference numbers of these sales channels can start to overlap in a term and the number production of 6 digits can be obstructed. In addition, 3D Secure traded sales channels forward their own reference number when routing from the payment page to the 3D address. In order to prevent the sales channels and the payment layer from sending different references to the banks, it is planned to establish the central number production mechanism. Within the scope of the project, a central reference number generation mechanism will be established on the payment layer side and this structure will be connected to the sales channels. In addition, the reservation system, payment and return commands will be rearranged as standard and the effect will be determined on all related applications and necessary arrangements will be made in these applications. With the start of the production of the central reference number on the payment layer side, a standardized structure can be created by eliminating the unnecessary conditions coded in the applications originating from the non-standard structure. The centralized number will be sent to all banks. Due to the fact that the payment command is not standard, problems that may occur in the reconciliation file production in time are prevented; This command is intended to be standardized in terms of all units.

Evaluation of the parameters of the project: The project for the standardization of the payment infrastructure is demanded especially by the internal units at a high and strong rate. The risk ratio is considered to be low. It is a project that is moderately compatible with strategic targets and it is useful to complete the development of self-service sales channels. Outsource costs are higher, because it requires a lot of coordination within the company, it would be more costly for an outside firm to manage these relationships.

4.1.10. Project 10: Check-In Kiosk Renovation Project

Currently, passengers can get boarding passes using the Checkin app from the kiosks at the airports where check-in services are provided. In this application, when installing from scratch or installing new versions, each kiosk needs to be loaded locally. This means time and labor costs. In addition, the screens used by passengers do not reflect the old and modern lines of design and functionality. In project scope; services that offer common check-in functions will be developed. In accordance with these services, the application will be written from the beginning. Design agency will be used for interface design. Design with modern lines will be used in the new application. New kiosks will be purchased to increase the new application and self-service in general, and new applications will be provided to more passengers through these kiosks. Version management and new kiosk installations will be centralized. Thus, kiosk software management can be made easily from a single center. The rate of use of the kiosk will be increased with the change of the interface. It is aimed to increase the activity of the passenger on his / her own by the baggage label printing feature beside the boarding pass. The increase in the rate of self-check-in will increase passenger satisfaction while the check-in staff at the airports will reduce the labor cost.

Evaluation of the parameters of the project: Checkin kiosk renovation project is a project that will be carried out at all airport terminals including kiosks and where the airline is flying. Although the impact network is very wide, the expected revenue increase due to the fact that checkin transactions do not generate income is estimated at a low level according to the project scope. The risk ratio is considered to be high due to the dependence on design agencies. The expected revenue growth source for the project is the increase in profits due to the reduction of costs. It has been communicated with the strategic objectives at an intermediate level.

4.1.11. Project 11: Interline sales reporting project

When the project is live, the ratio of interline transport volume to total transport volume of the airline company can be determined systematically and accurately. Thus, the contribution of interline flight revenue to the total airline passenger income can be analyzed, and the

results will be obtained and the proactive actions required to increase the contribution can be taken by the relevant units.

Currently, each presenter conducting interline income analysis according to their needs creates manual reports using his own methodology, and there is no common method adopted by the relevant units. Since each unit uses its own formulation, the results are not consistent. In addition to the time spent, the process also increases the risk of errors.
Following the research of the methods used by the other actors in the aviation sector, a joint interline contribution formula (retained) will be created upon which all the participants agree, and the information in the Revenue Accounting System database is processed according to this formula. Dashboard will be available.

The project aims to minimize mis-reporting, time savings, support for decision-making, inter-unit data / analysis consistency, efficiency and revenue growth through taking necessary actions.
Evaluation of the parameters of the project: The project, which aims to standardize Interline ticket sales, can be considered as an infrastructure project. The increase in income due to the decline in current costs is expected. Only in-house customers are requested. The risk ratio is estimated to be low. It is comparatively less compatible with strategic objectives. Outsource costs are estimated to be lower.

4.2. Model Solution

In this section, the proposed model was resolved. This section includes three main compone nts, one of which is data collection, the other is solution results and the last of which is sens itivity analysis for certain constraints and variables.

4.2.1 Data Collection

In this section, the data used in modeling is explained and the data are shown in the tables. The project information of the sample airline company information technology department and the impact of these projects on modeling are explained in detail in the previous section.

You will find detailed information about each parameter and purpose function in the following sections.

Amount of expected revenue growth for projects and the years of start: Projects and expected income increases are as follows. If the values in the tab are started in a three-year portfolio period for each project, how much revenue growth is expected. The values are represented in the US dollar currency. As the sector dynamics in the information technology sector agreed on the dollar currency, our example airline company shared the expected income growth values in dollar terms. As can be seen in the table, for some projects, the amount of expected increase in income increases in the 2nd and 3rd years. The reason for this is that due to the characteristics of the related projects, due to their high sensitivity to technology changes, as explained in the parameters section. The rapid changes in technology lead to a decrease in the amount of expected revenue growth of these projects. A substitution technology can become a threat to the project.

Projects	Year 1	Year 2	Year 3
Project 1	5.000.000	4.750.000	4.500.000
Project 2	1.700.000	1.700.000	1.700.000
Project 3	3.000.000	3.500.000	4.000.000
Project 4	300.000	250.000	200.000
Project 5	60.000	55.000	45.000
Project 6	100.000	100.000	100.000
Project 7	55.000	65.000	75.000
Project 8	1.000.000	1.300.000	1.500.000
Project 9	100.000	100.000	100.000
Project 10	2.000.000	2.200.000	2.400.000
Project 11	500.000	500.000	500.000

Number of customer demand rate for projects and the years of start: Demand rates of internal and external customers for the projects are given in the table below. By internal customers, we mean units that demand work from the airline information technology department.Through the project and portfolio management tool, the associated demand coll

ection process for internal customers was realized. Managers and superiors reassessed the c ollected requests. Some in-house and external surveys obtained customer demand rates. External customers were reached through the website and mobile application, i.e. passengers using the airline company. Following the purchase of the ticket, pop-ups were shown and short surveys were carried out to determine the airline company's customer expectations. Demand ratios were evaluated over a hundred fractions of specific and specific projects of internal and external customers and transferred to the table of customer demand ratios. The demand rates for certain projects were multiplied by a specific rate and balanced and consolidated by external customers and internal customers. As can be seen in the table, the demand ratio values of some projects have increased over the years. The reason for this is an indication that the need for related projects has increased depending on the progress of technology. On the other hand, it is understood that the demand rate values remain constant for some projects. This is a sign that the need for related projects remains stable within the 3-year portfolio period.

Projects	Year 1	Year 2	Year 3
Project 1	60%	65%	70%
Project 2	43%	45%	51%
Project 3	41%	45%	53%
Project 4	30%	35%	40%
Project 5	15%	15%	15%
Project 6	10%	10%	10%
Project 7	15%	20%	25%
Project 8	40%	45%	50%
Project 9	70%	70%	70%
Project 10	50%	53%	55%
Project 11	35%	37%	40%

Number of strategic alignment rate for projects: The ultimate goal of a company's strategic planning efforts is to achieve its strategic goals. The strategic objectives of the company are determined by the senior management. The top management takes the guidance

and mission of the company as the criterion and point of departure when determining these goals.

After the targets are set, the company initiates the necessary work to ensure that the project management and business processes comply with these objectives.

In this respect, projects are an implementation tool for achieving strategic objectives, and achieving strategic goals depends on the execution of projects. Today, organizations are required to plan and implement projects to maintain their existence and to make growth sustainable. In our mathematical model, we did not consider the strategic adaptation score as dependent on years. Vision and mission do not change in the short term and in this respect, we can say that strategic goals do not show significant differences over the years. In the table below, you can see the strategic compliance scores of 11 projects in our portfolio of sample airline companies. These points are determined by a board authorized by the senior management or senior management.1 The value can be considered as the most distant project to the strategic targets, and 5 is the most compatible with the strategic objectives.

Projects	Points
Project 1	5
Project 2	3
Project 3	5
Project 4	4
Project 5	4
Project 6	2
Project 7	1
Project 8	5
Project 9	3
Project 10	3
Project 11	2

Number of project risk rate for projects and the years of start:

Risk management in projects is one of the most important topics to be managed. If the project is tried to be managed by ignoring the risks, it is likely that the project will fail for any reason.

The main risk factors for projects in our sample airline are as follows: Time-related risks (Expansion of the scope of the project, extension of procurement processes, cost-related risks (exceeding the planned budget, the expected amount of revenue increase below expectations), strategy-related risks (with third-party firms) Because of these risks, we expect the risk rate of projects involving procurement processes to be higher, for example. The risk scores obtained from our sample airline company are the risk scores of the many risks mentioned above. It varies according to years. 1 = low risk, 2 = medium risk, 3 = high risk.

Projects	Year 1	Year 2	Year 3
Project 1	2	3	3
Project 2	1	2	2
Project 3	2	3	3
Project 4	2	1	1
Project 5	1	1	1
Project 6	1	1	1
Project 7	1	1	1
Project 8	2	3	3
Project 9	1	1	1
Project 10	3	2	2
Project 11	1	2	2

Cost of projects in regarding years as inhouse:

One of the most critical issues in the project selection is the criterion for the total costs of the projects to be selected not exceeding the budget allocated for the projects. If we want to make projects in our sample airline company as inhouse, the costs are estimated as follows. As time goes by, due to the reasons such as inflation, some projects are expected to increase in costs, and some projects are expected to decline due to the developments in technology.

	Year 1	Year 2	Year 3
Project 1	3.500.000	3.700.000	4.000.000
Project 2	1.000.000	1.100.000	1.200.000
Project 3	2.300.000	2.550.000	2.800.000
Project 4	150.000	165.000	180.000
Project 5	40.000	42.000	44.000
Project 6	20.000	20.000	20.000
Project 7	40.000	50.000	60.000
Project 8	400.000	440.000	480.000
Project 9	70.000	75.000	80.000
Project 10	900.000	910.000	930.000

Project 11	200.000	210.000	220.000

Cost of projects in regarding years as outsource:

If the projects are to be outsourced, the costs are estimated as follows.

	Year 1	Year 2	Year 3
Project 1	3.800.000	4.300.000	4.500.000
Project 2	400.000	500.000	600.000
Project 3	2.800.000	3.100.000	3.400.000
Project 4	50.000	55.000	56.000
Project 5	50.000	52.000	53.000
Project 6	17.000	17.000	17.000
Project 7	35.000	43.000	51.000
Project 8	500.000	520.000	550.000
Project 9	75.000	80.000	83.000
Project 10	400.000	500.000	600.000
Project 11	170.000	190.000	210.000

4.2.2 Solution Results

In this part of our thesis, the problem of which we do mathematical modeling and create data sets is solved by using Gams solver. The solution was reached using CPLEX with MIP minimization. The data set was modeled as described in the previous section. Relevant codes are written (see Appendix-1). When the model is solved, the projects selected and the years of selection are as follows.

Project Number	Project Name	Year 1	Year 2	Year 3	Inhouse	Outsource
Project 1	Website renewal project	X			X	
Project 2	Loyalty project for agencies	X				X
Project 3	Cargo operations management project		X		X	
Project 4	Web Payment Methods Integration		X			X
Project 8	Mobil site design project			X	X	
Project 10	Check-In Kiosk Renovation Project		X			X

	Value
Variable a	850.000
Variable b	1,34
Variable c	5
Variable d	6
Variable k	3
Used budget	7.485.000

According to the model solution, GAMS Solver chooses 1st,2nd,3rd,4th,8th,10th projects. Projects 1,3 and 8 will be carried out as inhouse projects, 2,4 and 10th projects have been selected as outsourcing.

Website renewal project, cargo operations project and mobile site design projects are selected as inhouse projects, we have given the parameter details in the project descriptions, these projects are among the projects to be built by the airline company. Restrictions have been added to our model in such a way that they try to select the inhouse.

$ 7.485m given for projects and we observe that the entire budget is used. In addition, $ 14.15m was achieved for $ 15m.

If we evaluate the projects by years, 1st and 2nd projects were chosen to start in the 1st Portfolio year. 3rd, 4th and 10th projects have been selected in the second portfolio year, and finally 8th project will be launched in third portfolio year.

Thanks to our modeling, the highest number of projects with the highest added value will be selected from the portfolio pool. Besides, the most demanded projects were selected by taking into consideration the demand ratios of the customers as well as the expected revenue growth. In addition to these, the projects with the lowest probability of risk and the selection of the projects with the highest rate of compliance with the strategic targets were guaranteed. The total budget allocated for the projects has been used in the most efficient way and the technological demands of the airline company have been transferred to the project stage in the optimal way with this model and solution.

4.2.3 Sensitivity Analysis

In this section, we will observe how to remove some targets and parameters from the model and how they affect the result through sensitivity analysis. Thus, we will realize how important the objectives are in terms of portfolio selection criteria. In addition, we will analyze how the project selection is affected by changing the weight in the function for some gap variables.

4.2.3.1 Scenario-1: Removal of strategic alignment rate goal

In this scenario, we aim to see the effect of the strategic alignment goal on the model. We will remove the gap variable related to the strategic alignment from the objective function and re-run the model solver and evaluate the result. We'll see how important the strategic alignment parameter for the model is. You can see the result in the following table.

Project Number	Project Name	Year 1	Year 2	Year 3	Inhouse	Outsource
Project 1	Website renewal project	X			X	
Project 2	Loyalty project for agencies	X				X
Project 3	Cargo operations management project	X			X	
Project 4	Web Payment Methods Integration		X			X
Project 8	Mobil site design project			X	X	
Project 9	Standardization of payment infrastructure project	X				X
Project 10	Check-In Kiosk Renovation Project		X		X	
Project 11	Interline sales reporting project	X				X

	Value
Variable a	750.000
Variable b	1,73
Variable d	11
Variable k	4
Used budget	7.475.000

According to the model solution, GAMS Solver chooses 1st,2nd,3rd,4th,8th,9th,10th and 11th projects. Projects 1,3,8 and 9 will be carried out as inhouse projects, 2,4,10 and 11th projects

have been selected as outsourcing.$ 7.475m given for projects and we observe that the entire budget is used. In addition, $ 14.25m was achieved for $ 15m.

We see that the budget used decreases and the expected growth in income increases. Although the number of projects has increased, the reason for the less use of the budget is that the 3rd project has been shifted from the second portfolio year to the first year. This is because 9th and 11th projects with lesser compliance to strategic targets are selected from the portfolio and added to the projects to be implemented. We have seen the deviation from vision and mission when we subtract the strategic target parameter. If we evaluate the projects by years, 1^{st},2^{nd},3^{rd},9^{th} and 11^{th} projects were chosen to start in the 1st Portfolio year. 4th and 10th projects have been selected in the second portfolio year, and finally 8th project will be launched in third portfolio year.

4.2.3.2 Scenario-2: Removal of customer demand rate goal

In this scenario, we aim to see the effect of the customer demand rate target on the model. We will remove the gap variable related to the customer demand rate from the objective function and re-run the model solver and evaluate the result. We'll see how important the customer demand rate parameter for the model is. You can see the result in the following table.

Table 1-Removal of customer demand rate

Project Number	Project Name	Year 1	Year 2	Year 3	Inhouse	Outsource
Project 1	Website renewal project	X			X	
Project 2	Loyalty project for agencies	X				X
Project 3	Cargo operations management project	X			X	
Project 4	Web Payment Methods Integration		X			X
Project 5	Mobil reissue	X			X	
Project 8	Mobil site design project			X	X	
Project 9	Standardization of payment infrastructure project	X			X	
Project 10	Check-In Kiosk Renovation Project			X		X

	Value
Variable a	990.000
Variable c	8
Variable d	11
Variable k	3
Used budget	7.445.000

According to the model solution, GAMS Solver chooses 1st,2nd,3rd,4th,5th,8th,9th and 10th projects. Projects 1,3,5,8 and 9 will be carried out as inhouse projects, 2,4 and 10th projects have been selected as outsourcing.$ 7,445m given for projects and we observe that the entire budget is used. In addition, $ 14.01m was achieved for $ 15m. We see, projects 5 and 9 are added in addition.

We see that the budget used decreases and the expected growth in income decreases. Although the number of projects has increased, the reason for the less use of the budget is that the 3rd project has been shifted from the second portfolio year to the first year, anda also 10^{th} project from 2^{nd} year to 3^{rd} year.

Project 10 was shifted from the second portfolio year to the third portfolio year, while the project 3 was shifted to the first portfolio year with lower customer demand ratio from the second portfolio year. Likewise, the fifth project, which is newly selected, is a project with low customer demand. We think that the removal of the customer demand rate parameter is the result. In contrast, project 9 was included in the portfolio despite one of the projects with the highest demand ratio, which is due to the increase in the weight of other gap variables by subtracting the demand rate gap variable from the function. Project 9 is included in the portfolio as one of the lowest risk projects.

If we evaluate the projects by years, 1^{st},2^{nd},3^{rd},5^{th} and 9^{th} projects were chosen to start in the 1st Portfolio year. Project 4th have been selected in the second portfolio year, and finally 8th and 10^{th} project will be launched in third portfolio year.

4.2.3.3 Scenario-3: Reducing weight of expected revenue growth gap variable

In this scenario, weights of goal changed, and model was run again. The aim of this scenario is give decision maker opportunity to lean over some goals more than the others. First, the first goal gap variable(expected revenue growth) was multiplied by 0.5.

Project Number	Project Name	Year 1	Year 2	Year 3	Inhouse	Outsource
Project 1	Website renewal project	X			X	
Project 3	Cargo operations management project	X			X	
Project 9	Standardization of payment infrastructure project			X	X	

	Value
Variable a	6.900.000
Variable b	0,39
Variable c	2
Variable d	4
Variable k	0
Used budget	5.800.000

In this scenario, because the priority given to the first target was reduced, the model headed to maximize other targets. Projects 2, 4, 8 and 10 are excluded from the portfolio and project number 9 is included in the portfolio.

4.2.3.4 Scenario-4: Increasing weight of project risk rate goal

In this scenario, we aim to see the impact of the project risk ratio target on the model. When we increase the weight of the project risk ratio value by multiplying with two, we will observe how the model is affected.

Project Number	Project Name	Year 1	Year 2	Year 3	Inhouse	Outsource
Project 1	Website renewal project	X			X	
Project 2	Loyalty project for agencies	X				X
Project 3	Cargo operations management project	X			X	
Project 4	Web Payment Methods Integration		X			X
Project 5	Mobil reissue	X			X	
Project 6	Ticket database modernization project		X		X	
Project 7	E-Visa project	X				X
Project 8	Mobil site design project	X			X	
Project 9	Standardization of payment infrastructure project	X			X	
Project 10	Check-In Kiosk Renovation Project		X			X
Project 11	Interline sales reporting project	X				X

	Value
Variable a	1.035.000
Variable b	3,53
Variable c	18
Variable d	18
Variable k	5
Used budget	7490000

According to the model solution, GAMS Solver chooses all projects. Projects 1,3,5,6,8 and 9 will be carried out as inhouse projects, other projects have been selected as outsourcing.$ 7,490m given for projects and we observe that the entire budget is used. In addition, $ 13,965m was achieved for $ 15m.

4.2.3.5 Scenario-5: Removal of inhouse projects encouragement goal

In this scenario, we aim to see the effect of the inhouse project encouragement target on the model. We will remove the gap variable related to the inhouse project encouragement from the objective function and re-run the model solver and evaluate the result. We'll see how important the inhouse project encouragement parameter for the model is. You can see the result in the following table.

Table 2-Removal of inhouse encouragement goal

Project Number	Project Name	Year 1	Year 2	Year 3	Inhouse	O
Project 1	Website renewal project	X			X	
Project 2	Loyalty project for agencies	X				
Project 3	Cargo operations management project	X			X	
Project 4	Web Payment Methods Integration		X			
Project 8	Mobil site design project			X	X	
Project 9	Standardization of payment infrastructure project		X			
Project 10	Check-In Kiosk Renovation Project			X		

	Value
Variable a	1.050.000
Variable b	1,36
Variable c	7
Variable d	9
Used budget	7.415.000

According to the model solution, GAMS Solver chooses 1st,2nd,3rd,4th,8th,9th and 10th projects. Projects 1,3 and 8 will be carried out as inhouse projects, 2nd,4th,9th and 10th

projects have been selected as outsourcing.$ 7,415m given for projects and we observe that the entire budget is used. In addition, $ 13.95m was achieved for $ 15m. We see that the only nineth project has been added.

The third project is shifted from the second to the first year. In addition, the tenth project shifted from the second to the third year. The 9^{th} project was not added as inhouse and added as an outsource. The Inhouse project support parameter serves to insure the selection of inhouse projects despite low outsource costs.

5. CONCLUSION

In this study, a mathematical model has been developed which can be used in project selection from the airline information technology departments portfolio. As mentioned in the literature, there is not much work done for the airline IT departments. In addition, no target programming approach was found among the solution methods of multi-purpose linear programming models in this area.

Target programming is evaluated in accordance with the portfolio project selection problem and the model is explained in the proposed model section. The proposed model has four main objectives. They maximize the expected revenue growth, try to select the most demanded projects among the internal and external customers among all projects, try to select the projects with the lowest risk, try to select the projects that are most compatible with the strategic targets and try to realize the projects as inhouse as much as possible. Apart from these targets, budget constraint has been added to the established model and the costs of the selected projects have been prevented from exceeding the determined budget.

The model was analyzed with the data obtained from the sample airline. The relevant data were obtained from the teams responsible for the relevant data in the airline company. When the model is resolved with this data, it is seen that the solution is the best choice for some goals, among others good ones that are close to the best. After the main solution, some scenarios were produced and sensitivity analyzes were conducted with these scenarios and the model was re-run and the analysis results were shared according to these scenarios. It was seen that all targets correctly affected the model as intended.

This model focuses on the selection of the most efficient and optimal projects according to the budget given. In the current model, the most suitable projects are selected. The model can be updated and used by adding different targets and constraints for different sectors.

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7. APPENDIX

```
sets i project /1,2,3,4,5,6,7,8,9,10,11/
     j year /1,2,3/;

table ERG(i,j)
          1           2           3
1       5000000     4750000     4500000
2       1700000     1700000     1700000
3       3000000     3500000     4000000
4       300000      250000      200000
5       60000       55000       45000
6       100000      100000      100000
7       55000       65000       75000
8       1000000     1300000     1500000
9       100000      100000      100000
10      2000000     2200000     2400000
11      500000      500000      500000;

table CDR(i,j)
          1         2         3
1       60        65        70
2       43        45        51
3       41        45        53
4       30        35        40
5       15        15        15
6       10        10        10
7       15        20        25
8       40        45        50
9       70        70        70
10      50        53        55
11      35        37        40;
```

```
*PRRij : Number of customer demand rate for project-i and when started in year-j

table PRR(i,j)
        1         2         3
1       2         3         3
2       1         2         2
3       2         3         3
4       2         1         1
5       1         1         1
6       1         1         1
7       1         1         1
8       2         3         3
9       1         1         1
10      3         2         2
11      1         2         2

*IHCij : Cost of project i when started in year-j as inhouse

table IHC(i,j)
        1              2              3
1       3500000        3700000        4000000
2       1000000        1100000        1200000
3       2300000        2550000        2800000
4       150000         165000         180000
5       40000          42000          44000
6       20000          20000          20000
7       40000          50000          60000
8       400000         440000         480000
9       70000          75000          80000
10      900000         910000         930000
11      200000         210000         220000;
```

```
*OSCij : Number of customer demand rate for project-i and when started in year-j

table OSC(i,j)
        1               2               3
1       3800000         4300000         4500000
2       400000          500000          600000
3       2800000         3100000         3400000
4       50000           55000           56000
5       50000           52000           53000
6       17000           17000           17000
7       35000           43000           51000
8       500000          520000          550000
9       75000           80000           83000
10      400000          500000          600000
11      170000          190000          210000;


*SARij : Number of customer demand rate for project-i and when started in year-j

parameter SAR(i) /1 5, 2 3, 3 5,4 4,5 4,6 2,7 1,8 5,9 3,10 3,11 2/;
```

```
*objective
variable z;
*Whether project i is selected in year j
binary variable x(i,j);
*Whether the project i is inhouse
binary variable y(i,j);

positive variable a;
positive variable b;
positive variable c;
positive variable d;
positive variable k;

equations goal_ERG
          goal_CDR
          goal_SAR
          goal_PRR
          goal_MIHP
          model_check1
          model_check2
          cost
          objective;

objective.. z=e= a/1000000+b+c/5-d/5+k/100;

goal_ERG..sum((i,j),(ERG(i,j)*x(i,j)))+a=e=15000000;
goal_CDR..sum((i,j),(CDR(i,j)/100*x(i,j)))+b=e=sum((i,j),x(i,j)*0.7);
goal_SAR..sum((i,j),(SAR(i)*x(i,j)))+c=e=sum((i,j),x(i,j)*5);
goal_PRR..sum((i,j),(PRR(i,j)*x(i,j)))+d=e=sum((i,j),x(i,j)*3);
goal_MIHP..sum((i,j),(y(i,j)))+k=e=sum((i,j),(x(i,j)));
model_check1(i)..sum(j,x(i,j))=l=1;
model_check2(i,j)..y(i,j)=l=x(i,j);
cost.. sum ((i,j),y(i,j)*IHC(i,j))+sum((i,j),(x(i,j)-y(i,j))*OSC(i,j))=l=7500000;

model airlineIT /all/;
OPTION LIMROW = 50;
solve airlineIT using MIP minimizing z;
display x.l,y.l,a.l,b.l,c.l,d.l,k.l,cost.l;
```