MARMARA UNIVERSITY

INSTITUTE FOR GRADUATE STUDIES IN PURE AND APPLIED SCIENCES

A MATHEMATICAL METHOD FOR AGILE SOFTWARE DESIGN: AN APPLICATION

HÜSEYİN ARDIÇ

MASTER THESIS

Department of Industrial Engineering

Thesis Supervisor

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Hüseyin ARDIÇ, a Master of Science student of Marmara University Institute for Graduate Studies in Pure and Applied Sciences, defended his thesis entitled **"A Mathematical Method for Agile Software Design: An Application"** on Jul 22, 2019 and has been found to be satisfactory by the jury members.

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APPROVAL

Marmara University Institute for Graduate Studies in Pure and Applied Sciences Executive Committee approves that Hüseyin ARDIÇ be granted the degree of Master of Science in Department of Industrial Engineering on 04/09/2019 (Resolution no: 2019/18-02).

Director of the Institute
Prof. Dr. Bülent EKİCİ

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ABSTRACT

A MATHEMATICAL METHOD FOR AGILE SOFTWARE DESIGN: AN APPLICATION

Project management approaches play a vital role in the success of projects. Old methodologies like waterfall approach have some problems in meeting customer needs, managing changes in project scope, delivery time and cost effectively. Due to the problems related to the old project management methodologies, agile project management in software engineering projects has become popular in the last years. In almost all of the agile methodologies, a project is split into functionalities, labelled as user stories. Putting these stories in an order secures the completion of the project successfully. Various factors have effects on the excellence of a story plan, such as business value, complexity and affinity of the stories which are processed together. In this paper, a multi-objective integer linear programming model is proposed to find a story plan considering business value, complexity and user experience. The ε-constraint method is used for dealing with the multi objective problem efficiently. The problem is solved by using a general-purpose MIP solver. A numerical example is considered, and outputs are analysed.

ÖZET

AGILE YAZILIM GELİŞTİRME METODOLOJİLERİ İÇİN MATEMATİKSEL BİR MODEL VE UYGULAMASI

Proje yönetim metodolojileri , projelerin başarısında hayati bir rol oynamaktadır. Waterfall türü eski metodolojiler müşteri ihtiyaçlarını karşılama, proje kapsamındaki değişiklikleri, teslimat süresini ve maliyeti etkin bir şekilde yönetme konusunda bazı eksikliklere sahiptir. Eski proje yönetimi metodolojileri ile ilgili problemler nedeniyle yazılım mühendisliği projelerinde çevik (agile) proje yönetim metodolojileri son yıllarda popüler hale gelmiştir. Çevik yöntemlerin hemen hemen hepsinde, bir proje kullanıcı hikayeleri (story) olarak isimlendirilmiş parçalara bölünmüştür. Bu kullanıcı hikayelerinin planlanması, projenin başarıyla tamamlanmasında önemli bir rol oynar. Bir hikaye planının mükemmelliği üzerinde çeşitli faktörlerin etkisi vardır, bunlardan bazıları kullanıcı hikayelerinin müşteri gözündeki değeri, karmaşıklığı ve birbirleriyle ilişkileridir. Bu çalışmada, kullanıcı hikayelerinin müşteri gözündeki değeri, karmaşıklıkları ve kullanıcıların memnuniyeti dikkate alınarak optimum bir kullanıcı hikaye planı bulmak için çok amaçlı bir tamsayılı doğrusal programlama modeli önerilmiştir. Çok amaç fonksiyonlu bir problem ile başa çıkmak için epsilon-kısıt (ε-constraint) methodu kullanılmıştır. Gerçek bir proje modelimize uyarlanıp genel amaçlı bir MIP solver kullanılarak çözülmüştür. Elde edilen sonuçlar incelenip analiz edilmiştir.

SYMBOLS AND ABBREVIATIONS

ASD: Adaptive Software Development

ATM: Automatic Teller Machine

BACKLOG: Agile Work Plan Board

CARDWALL: Kanban Task List Board

DSDM: Dynamic Systems Development Method

EP: Extreme Programming

FDD: Feature-Driven Development

JIT: Just in-Time

KPI: Key Performance Indicator

MIP: Mixed Integer Programming

MILP: Mixed Integer Linear Programming

M/G: Master Group

RA: Risk Analysis

STORY: User Story

SA: System Analysis

SPRINT: Time-boxed Iteration

V: V-model

WIP: Work in Progress Limit

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1. INTRODUCTION

One of the essential business fields in today's world is Software Engineering. From Social Media to Education, from military to economics, almost all sectors are using Software Engineering products. The fact that it is used in almost all business fields increases the need for software products. The complexity of software development processes is another important reality. Therefore, the project management methodology used in software development is vital in terms of customer experience and the quality of software product (Choukou, 2018).

Software engineering is one of the fastest growing commercial areas of our day and continues to grow and develop day by day. Besides, the demand for software products is exceptionally high since technology is almost all areas of our lives. This demand is led by software engineering to achieve great success in both commercial and academic fields (Choukou, 2018). This need and success make the project management methodologies used in software development also valuable. Also triggered the progress of the project management methodology used in recent years (Url-2).

1.1 History of Project Management Methodologies in Software Engineering

Project management methodologies used in software development can be classified under two main titles: Traditional methodologies, also known as "heavyweight software methodologies" and agile methodologies (Lei et al., 2017). These methodologies include practices and procedures to be used to develop effective software products for customers.

Traditional methodologies are creating a software product with a linear and sequential approach. Every stage has to be completed before the next stage starts, and there is no overlapping of the stages because of this when the product is in the testing stage, it is challenging to go back and change something which is left during the

requirement analysis phase (Lei et al., 2017). It is known that these methods are inadequate in meeting customer needs effectively, managing changing project scope, delivery time and cost (Golfarelli et al., 2012). Agile software development methodologies can be called as "lightweight methodologies" are formed to create efficient, adaptable and high-quality software products. Agile methodologies can overcome some of the difficulties like managing to chance requirements faced by traditional methodologies. Agile methodologies can manage the change of customer requirements development process in progress, while traditional methodologies are challenging (Lei et al., 2017).

Agile software development methodologies provide a quick and efficient way to create adaptable software products in an environment with frequently changing customer requirements. Furthermore, while trying to adopt requirement changes trying to release a quality product in a short time. Agile methodologies encouraging to implement a usable product is more important than excellent documentation (Aslam and Farooq, 2011). Agile methodologies can handle complicated or straightforward and significant projects of all sizes.

The main strength of agile software development methodologies over traditional ones is a focus on people's cooperation (developers, project owner and customers) within a project as one of the primary drivers of success (Ohno, 1988). Communication with customers is even more critical than contract agreements (Url-3). It is also necessary that customers are a member of the development team by their feedbacks and tests. Increasing customer experience is another point that is important by providing high quality and quick software product with frequent releases.

1.2 Scope of the Thesis

In this study a multi-objective integer linear programming model is proposed to find a story plan considering business value, complexity and user experience. The ε-constraint method is used for dealing with the multi-objective problem effectively. The

problem is solved by using a general-purpose MIP solver. A numerical example is considered, and outputs are analyzed.

In Chapter 2, the emergence of the agile project management methodologies is described. The varieties and features of agile project methods are explained.

In Chapter 3, we described the kanban method, both industry and software development as two separate sections.

In Chapter 4, related studies for story planning for agile project management methods examined.

In Chapter 5, story planning problem is described. Highlighted concepts of story planning problem are explained. The objectives of the proposed model are given and described. The variables, objective functions and constraints of the model explained. We provide the information about the real project and its stories and relations, which is the proposed model is applied.

Finally, the findings are provided in Chapter 5, and the conclusion is achieved according to these results. It can be said that the last chapter is the summary of the study, and the general statements are given.

2. AGILE SOFTWARE DEVELOPMENT

At the beginning of the 2000s, these lightweight methodologies were reviewed, and the Agile Manifesto was published to determine the structure and objectives of these techniques. Increasing adoption of agile methodologies since Agile Manifesto and the appearance of new agile methodologies continue because of agile methodologies' efficiency. However, some of them never used once, while others are extending their popularity day by day. A general illustration of Agile development pprocess has shown in Figure 2.1.

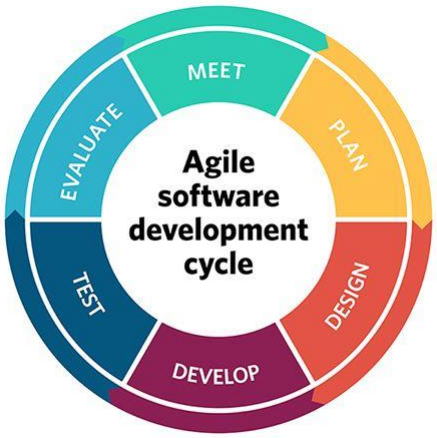

Figure 2.1. General Illustration of Agile Development Process (Url-1)

Examples of Agile methodologies are Kanban, Scrum, Extreme Programming, Dynamic Systems Development Method (DSDM), Feature-Driven Development (FDD) and Adaptive Software Development (ASD) (Highsmith, 2002).

2.1 History of Agile Methodologies

Software development methodologies are one of the earliest disciplines in software engineering. There had been many software development methodologies in the 1950s based on trial-and-error before the rising of "Agile software development". Developers exploited these techniques to detect superior approaches to explaining the project requirements, analyzing the problem, and implementing it systematically. Some of these processes are accumulative and repetitive, others linear and sequential (Larman and Basili, 2003). Linear and sequential ones formed the foundation of the traditional methodologies. Traditional methodologies involve a group of various methodologies such as Waterfall and V model. Because of the traditional methodologies prerequisite full customer requirements and complete design, the professionals called them as heavyweight methodologies (Awad, 2005).

Furthermore, every stage has to be completed before the next stage starts, and there is no overlapping of the stages because of this when the product is in the testing stage, it is difficult to go back and change something which is left during the requirement analysis or design phase. The search for new methodologies has emerged due to varying requirements. A group of engineers announced that agile manifesto includes adaptable methodologies and rules for producing software products in 2001. Some of its significant advantages agile software development methodologies over traditional ones are encouraging people's communication and adopting changing requirements. For these reasons, professionals began to use agile methods in their companies from agile manifesto and number of companies continually increasing.

2.2 Agile Manifesto

The term agile software development was first pronounced in 2001 by a group of engineers led by Kent Beck. A photo of the engineers while working on the agile manifesto has shown in Figure 2.2. The group states that they are declaring agile

methods to describe better software development methods for guiding others (Url-2). The agile manifesto has four important principles (Aslam & Farooq, 2011):

1. Interaction between stakeholders is more valuable than adhering to rules and methods, and this means human interactions should be relied upon instead of strictly following the rules to reveal quality software products.
2. Instead of complete documents, executable software should be preferred. Releasing an executable software and giving it to the customer for testing is reliable than full documentation. Agile methodologies encouraging to implement a usable product is more important than excellent documentation.
3. Communication with customers is even more critical than contract agreements. The customers should be involved in all software development processes, including test and feedback phase rather than just talking the contract before starting the project.
4. Modifications requested by both customers and the development team should be acceptable. It is better to answer to the modification requests than to follow the fixed plan, consequently improving the quality and efficiency of the software product. In the end, it emerges a more applicable output with all modifications.

Apart from these four principles, twelve rules support these essential principles. These rules have two main objectives: The first objective is to define agile methodologies in a better and reasonable way, and the second objective is to support supervision to the project team.

The followings are the twelve supporting rules of agile methodologies (Url-3):

- Our highest priority is to increase customer experience within quick and continuous delivery of valued software.

- Even if late in development, welcome modifying demands. Agile processes provide modification to support the customer's competing advantage.
- Release operating software products periodically, preference within short time intervals.
- During the project, developers and business people must work collectively with daily meetings.
- Create projects with motivated people. Give them the environment and assistance they require and trust them to get the project completed.
- The most effective and practical way of conveying knowledge within a development team is a face-to-face conversation.
- Executable software is the primary measure of process.
- Agile processes support continuous development. The sponsors, developers, and end users should be able to keep a consistent movement forever.
- Constant attention to technical perfection and good design improves agility.
- Simplicity, the art of not doing useless tasks is fundamental.
- The best designs, specifications, and plans arise from self-organizing groups.
- At periodic intervals, the team returns on how to become more efficient, then tunes and adapts its behaviour respectively.

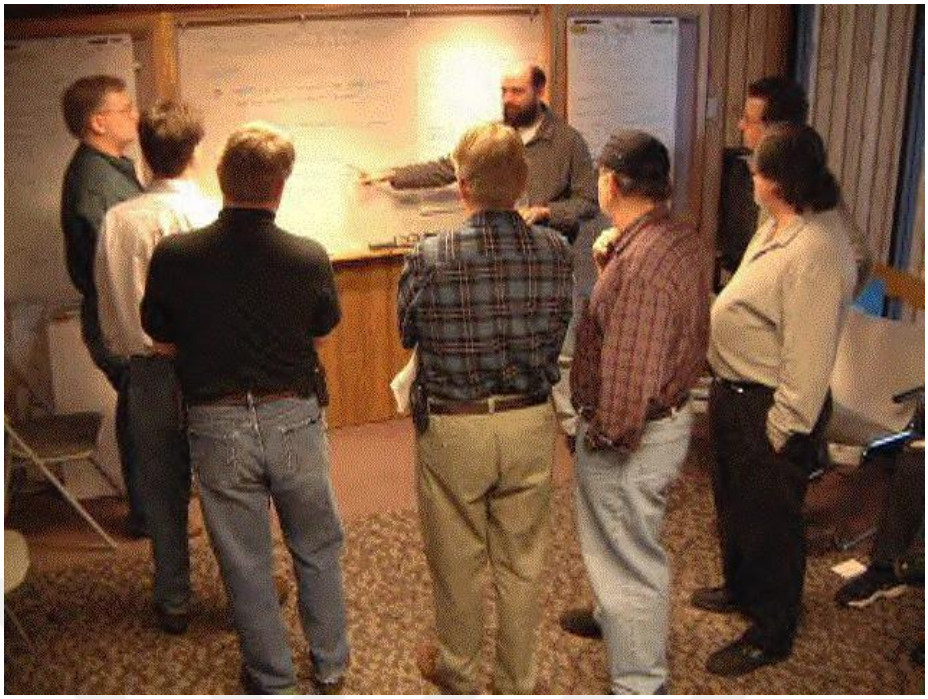

Figure 2.2. Founding Engineers at Agile Manifesto Meeting in 2001 (Url-2)

3. KANBAN

Kanban is a method of ensuring just-in-time (JIT) production; becomes the decision-making part of the production line. Kanban gives the decision-making responsibility to employees and presents simply the managers and executives what needs to be done. Kanban supports improvement in process and tools (Ohno, 1988). It encourages to the studies for eradicating waste points. In a production environment, Kanban is a powerful tool for reducing labour and stock needs, eliminating defective product and preventing continuous faults (Ohno, 1988). Just-in-time production implies producing the needed components at the required time in the most economical way at every step of the production process. Ideally, there is the same production process both within the corporation and at supplier factories. Product-oriented placement, one-piece flow production systems, multiple process handling and flat/mixed production help to generate such a process (Suzaki, 2005).

When there is a physical distance between processes, or there is a long manufacturing time in some processes, the way of combining processes should be considered. These processes must operate as if they were connected by hidden conveyors (Suzaki, 2005).

3.1 History of Kanban

Kanban means “description card” in Japanese and is one of the production control mechanisms. The efficient operating of Kanban is performed only if it is combined with other elements of Just-in-time production, such as flat/mixed production, proper production environment planning and process type production (Suzaki, 2005). Kanban explained above is a production control tool that emerged with the discovery that the operation of an American supermarket in the 1950s can be applied in the factory environment by Taiichi Ohno who is a manager from Toyota those days.

Figure 3.1. Stocked Goods with Kanban Card in Warehouse (Url-4)

The supermarket process can be explained shortly as follows. Before customers pick up the goods on the shelves, the goods have kanban cards. A sample good with kanban card has shown in Figure 3.1. While the customers pay the bill at the checkout, all the kanban cards are collected, so it is recognized which goods how much sold in a certain period. The collected cards are taken to the purchasing department, and the goods in the amount indicated on the cards are pulled from the warehouse and placed on the shelves again. Considering that there is a supplier factory connected to the warehouse, the production card is attached to the stocked goods in the warehouse. Before withdrawing the goods from the warehouse, the production cards must be separated and matched with the right moving cards. At this stage, there is an equal number of production cards to the sold goods. When these cards are transferred to the production area, the amount of production on the cards will be made, and the cards are matched with goods. When the produced goods are sent to the warehouse together with

the cards, the cycle is completed. Full supermarket process illustration with kanban cards has shown in Figure 3.2.

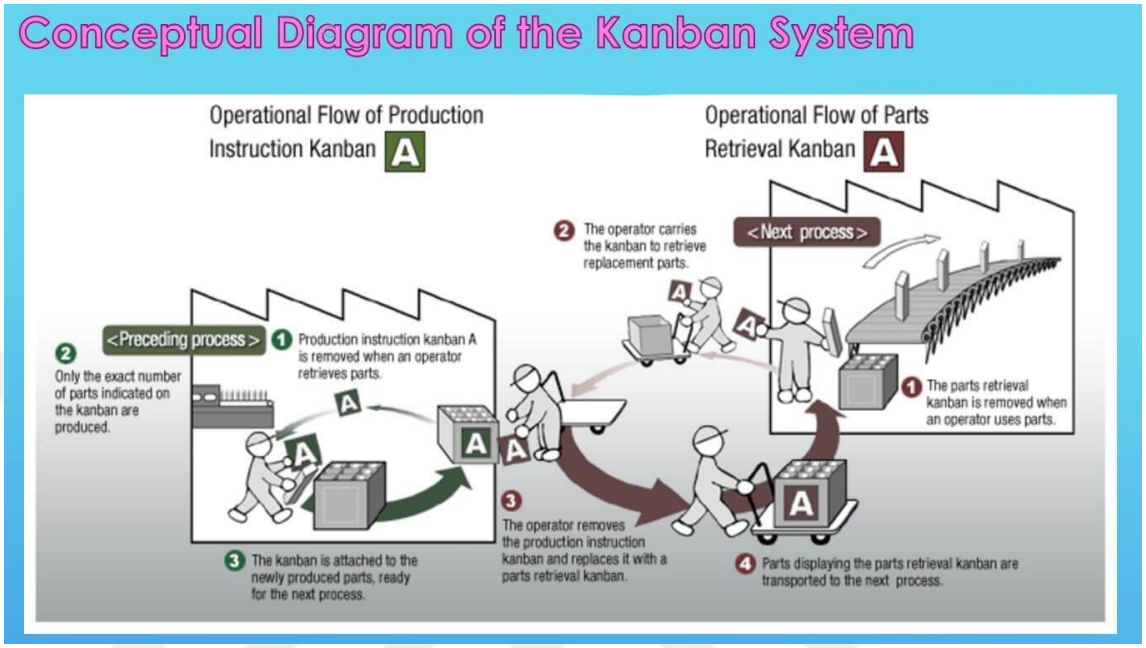

Figure 3.2. Kanban Card Process Illustration (Url-5)

With this supermarket process stock management and production activities, all programming and dispatch jobs can be reduced, material movement and production can be controlled by each of the employees with control the of cards. Thus, the role of programming and dispatchers can change, and the whole process becomes a monitoring and updating system.

3.2 Kanban in Software Engineering as an Agile Methodology

David J. Anderson proposed kanban for software engineering as an agile software project management methodology in 2004. It has been introduced to remove the limitations of never-ending tasks assigned by the executives (Alqudah and Razali, 2017). Software Engineering Specialists first performed kanban in 2007 (Shinkle, 2009). Kanban process aims to prioritize essential tasks called story in most agile methods to increase the attention to important ones and to decrease the tension on the remaining stories (Lei et al., 2017). Prioritization of essential tasks also improves the flexibleness of other stories while decreasing the completion uncertainty of essential stories. The visualization of the workflow is a vital attitude of Kanban method.

Kanban method used in software development is based on the following principles (Lei et al., 2017). Some of these principles' illiustration has shown in Figure 3.3.

- Limiting Working in Process (WIP).
- Pulling value through the development process.
- Making the development process visible.
- Increasing throughput.
- Using a fixed backlog.
- Embedding quality.
- Valued feedback notion both by team and customers.

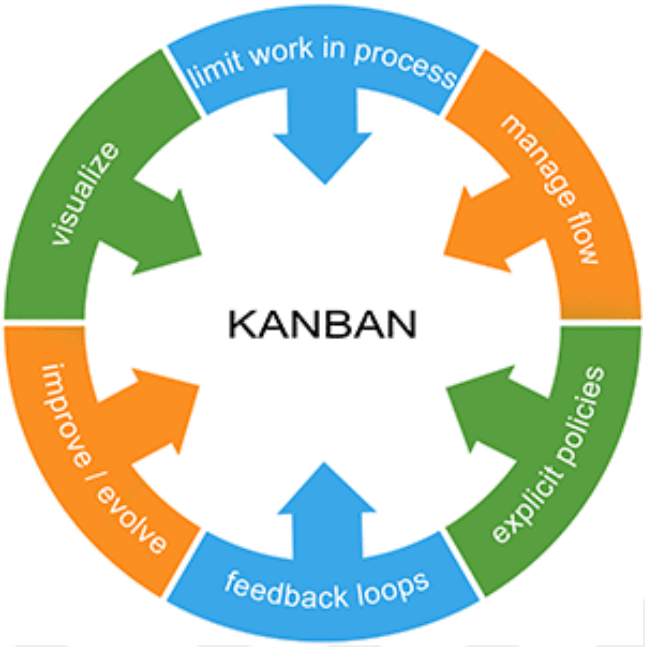

Figure 3.3. Kanban Basic Principles Illustration (Url-6)

The visualisation of the workflow is a considerable attitude of Kanban theory. In Kanban for software development, the “card wall” is used to reflect the process, stories, and goals in a more understandable way. All stories needed for completing the project are accurately described, and all required tasks are written onto cards or sticky notes and added to the Kanban backlog part of the card wall. When a story is completed, it goes to the next step, and another story from the backlog is pulled (Joyce, 2009).

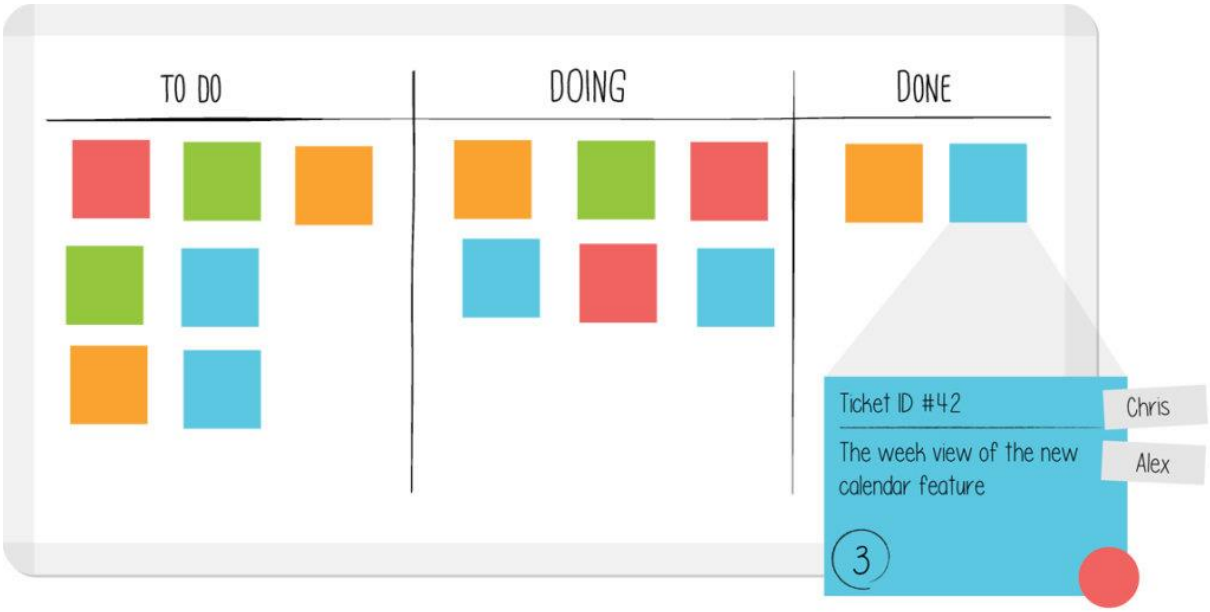

Figure 3.4. Simple Card-wall Example (Url-7)

The tasks in the backlog go through various steps until they are completed. Which story on which step clearly shown on card-wall. Thus, it becomes simpler to implement the work in progress limit, which is one of the basic principles. A simple card-wall process illustration and an intricate card-wall process illustration with sub-steps, as shown in Figure 3.4 and Figure 3.5.

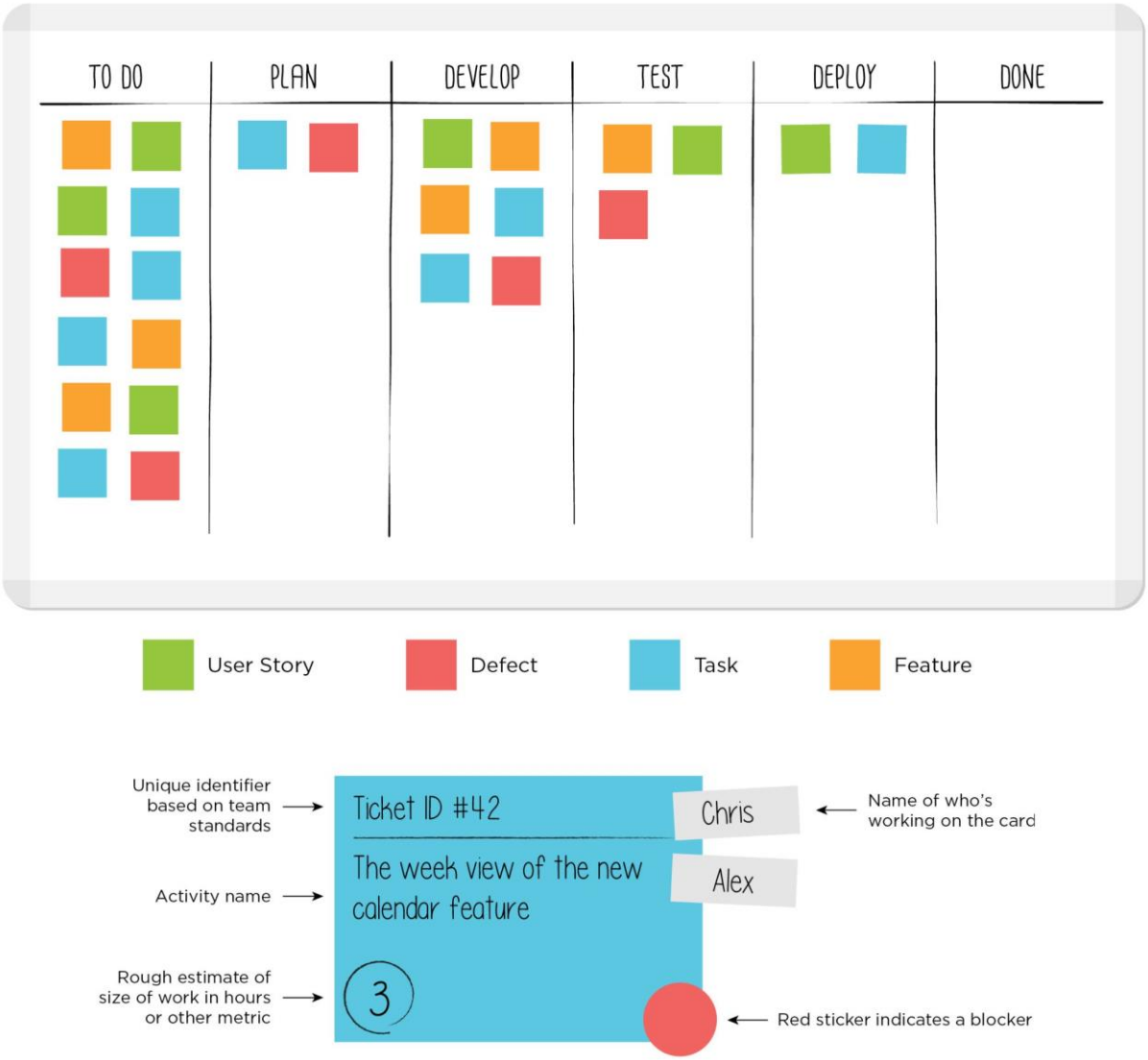

Figure 3.5. Complex Card-wall Example with Sub-steps (Url-7)

Not implementing non-necessary features in the project is another characteristic of kanban. In this way, the complexity of the project is reduced, and the waste of the workforce is prevented. Breaking down the project into smaller stories, having self-organized teams, focusing on providing frequent software releases swiftly, adapting changes faster, limiting WIP and having all visible process are other significant points of kanban.

Improving customer experience is one of the fundamental aspects of kanban as all the other agile methodologies; it is even more important than contract negotiations, as stated in the previous sections. Story planning has a primary impact on this subject. Additionally, it secures the completion of the project successfully (Ertugrul et al., 2019). Various factors have effects on the excellence of a story plan, such as business value, complexity and affinity of the stories which are processed together. Team members perform story planning based on their experience by default. In this thesis, a multi-objective integer linear programming model is proposed to find a story plan considering business value, complexity and user experience. The ε-constraint method is used for dealing with the multi-objective problem effectively. The problem is solved by using a general-purpose MIP solver. A numerical example is considered, and outputs are analyzed.

4. RELATED LITERATURE

Software engineering is one of the fastest growing commercial areas of our day and continues to grow and develop day by day. Besides, the demand for software products is exceptionally high since technology is almost all areas of our lives. This demand is led by software engineering to achieve great success in both commercial and academic fields (Choukou, 2018). This need and success make the project management methodologies used in software development also valuable (Alqudah, 2017). Also triggered the progress of the project management methodology used in recent years (Anderson, 2003).

We can classify project management methodologies used in software development under two main titles: Traditional methodologies, also known as "heavyweight software development methodologies" and agile methodologies also known as "lightweight software development methodologies" (Lei et al., 2017). These methodologies include practices and procedures to be used to develop effective software products for customers.

Traditional methodologies are creating a software product with a linear and sequential approach. Every stage has to be completed before the next stage starts, and there is no overlapping of the stages because of this when the product is in the testing stage, it is challenging to go back and change something which is left during the requirement analysis phase (Lei et al., 2017). Agile software development methodologies are formed to create efficient, adaptable and high-quality software products. (Lei et al., 2017).

Agile software development methodologies provide a quick and efficient way to create adaptable software products in an environment with frequently changing customer requirements. Furthermore, while trying to adopt requirement changes trying to release a quality product in a short time. Agile methodologies encouraging to implement a usable product is more important than excellent documentation (Aslam and Farooq, 2011). Agile methodologies can handle complicated or straightforward and significant projects of all sizes.

The main strength of agile software development methodologies is a focus on people's cooperation (developers, project owner and customers) within a project as one of the primary drivers of success (Ohno, 1988). Communication with customers is even more critical than contract agreements (Url-3). It is also necessary that customers are a member of the development team by their feedbacks and tests. Increasing customer experience is another point that is important by providing high quality and quick software product with frequent releases. At the beginning of the 2000s, these lightweight methodologies were reviewed, and the Agile Manifesto was published to determine the structure and objectives of these techniques. Increasing adoption of agile methodologies since Agile Manifesto and the appearance of new agile methodologies continue because of agile methodologies' efficiency. However, some of them never used once, while others are extending their popularity day by day. After the Agile Manifesto David J. Anderson proposed kanban for software engineering as an agile software project management methodology in 2004. It has been introduced to remove the limitations of never-ending tasks assigned by the executives (Alqudah and Razali, 2017). Software Engineering Specialists first performed kanban in 2007 (Shinkle, 2009). Kanban process aims to prioritize essential tasks called story in most agile methods to increase the attention to important ones and to decrease the tension on the remaining stories (Lei et al., 2017). Prioritization of essential tasks also improves the flexibleness of other stories while decreasing the completion uncertainty of essential stories.

Providing high quality and quick software product with frequent releases is a fundamental principle shared by all agile methodologies, including kanban. The order in which task called story is delivered, including in which release is also an important issue that directly affects the customer experience. Besides, story planning supports the effective use of the workforce and the successful completion of the project. Conceptual work for release scheduling in agile software projects has been proposed by Szoke (2011). The work presents a conceptual method for agile scheduling and a novel multiple knapsack-based optimization model with a branch-and-bound optimization algorithm for agile release scheduling. It is aimed to provide maximal customer-valued features are selected for earlier releases. However, it is concerned with which stories in

which releases, rather than the detailed sequence plan of stories. It lacks detailed resource allocation and plan of stories daily basis.

Even though some practical software programs such as AgileFant, Mingle and ScrumWorks support agile project management, they do not provide any support for optimal release and story planning. They transfer kanban cardwall or scrum board to online. They allow getting dynamic reports, for example, story, general project and resource status reports.

Golfarelli et al. (2012) propose a model for the sprint (release) planning problem for specifically data warehouse projects in agile methods. They formalized the problem as a multi-knapsack problem with constraints. They offer a model to solve the formalized problem that taking into account estimated complexity, business value, and affinity of the stories which processed together. The objective function of the model which they proposed has shown in Equation 4.1. The goal of the proposed model is maximizing the customer experience. However, it lacks detailed resource allocation and plan of stories daily basis and specifically for data warehouse projects.

$$Z = Max \sum_{k=1}^{m} \sum_{i=1}^{k} \sum_{j=1}^{n} u_j \left(r_j^{cr} x_{ij} + a_j \frac{y_{ij}}{|Y_j|} \right) \quad (4.1)$$

The objective function of proposed model z states that the optimal plan maximizes the cumulative utility function. They used indice k for re-adding early placed stories risk,utility and affinity degrees, thus encouraging an early placement of critical stories. They managed the affinity using a, the affinity degree increaes proportionally to the fraction of similar stories included in same sprint, this also increaes the objective function value. Since it encouraging both together assingment and early assignment of affine stories.

Another model proposed by Golfarelli et al. (2013) adding smooth replanning support to the previous solution with increasing the use of space to cover all software projects using Scrum. The objective function of the model which they proposed has

shown in Equation 4.2 and 4.3. The goal of the suggested model is maximizing the customer experience as the previous model.

$$Z = Max \sum_{k=1}^{m} cu_k \quad (4.2)$$

$$cu_k = \sum_{i=1}^{k} \sum_{j=1}^{n} u_j \left(r_j^{cr} x_{ij} + \sum_{l=1}^{|G|} a_l \frac{y_{ijl}}{|A_l|-1} \right) \quad (4.3)$$

The objective function of proposed model z states that the optimal plan maximizes the integral of the cumulative utilities. They used indice k for re-adding early placed stories risk,utility and affinity degrees, thus encouraging an early placement of critical stories. They managed the affinity using a, the affinity degree increaes proportionally to the fraction of similar stories included in same sprint, this also increaes the objective function value. Since it encouraging both together assingment and early assignment of affine stories. However, it lacks detailed resource allocation and plan of stories.

Boschetti et al. (2014) propose a model for the sprint planning problem for generally all agile methods. The objective function of the model which they proposed has shown in Equation 4.4.

$$Z_p = Max \sum_{k=1}^{m} \sum_{i=1}^{k} \sum_{j=1}^{n} u_j \left(r_j^{cr} x_{ij} + a_j y_{ij} \right) \quad (4.4)$$

The objective function of proposed model states that the optimal plan maximizes the cumulative utility function. They used indice k for re-adding early placed stories risk,utility and affinity degrees, thus encouraging an early placement of critical stories. For the affinity managent the objective function increases for each affine story included in the same sprint.

The proposed model supported by using a Lagrangian heuristic based on relaxation and some greedy and exchange algorithms because of solving the model takes too much time. Besides, it improves the operational use of the model. However, it lacks detailed resource allocation plan for all stories daily basis.

The story planning phase of agile methods is an essential part of a project which effects business value and completion of the project successfully. Various factors have effects on the excellence of a story plan, such as business value, complexity and affinity of the stories which are processed together. To the best of our knowledge, no research prototypes have been developed to this purpose for kanban as an agile methodology. In this thesis, a multi-objective integer linear programming model is proposed to find a story plan for kanban covering detailed resource allocation plan for all stories.

The ε-constraint method is used for dealing with the multi-objective problem effectively. Besides the weighted sum approach, the ε-constraint method is probably the best-known technique to solve multicriteria optimization problems (Ehrgott, 2005). There is no aggregation of criteria, instead only one of the original objectives is minimized, while the others are modified to constraints. It was presented by Haimes et al. (1971), and an extensive discussion can be found in Chankong and Haimes (1983). The method can overwhelm some of the convexity problems of the weighted sum technique and easy to implement (Ehrgott, 2005). This involves minimizing a primary objective and representing the other objectives in the form of inequality constraints. When converting objective functions to constraints epsilon values assigned to another side of the inequality. The assigned epsilon values represent the worst value of the converted objective functions allowed to take. The direction of inequality is assigned whether the converted objective function is minimizing or maximizing. If the converted objective function is minimizing the sign of inequality is less than or equal, else if the converted objective is maximizing the sign of inequality is greater than or equal. It has

been shown that if the solution to the ε-constraint method is unique, then it is efficient (Marler and Arora, 2004). One issue with this method is that it is essential to preselect which objective to minimize and the epsilon values.

5. A MATHEMATICAL METHOD FOR AGILE SOFTWARE DESIGN: AN APPLICATION

Increasing customer experience is one of the fundamental aspects of kanban. The story planning phase of the project has a primary influence on this topic. Several factors have impacts on the excellence of a story plan, such as business value, complexity and affinity of the stories which are processed together. Team members perform story planning based on their experience by default. In this thesis, a multi-objective integer linear programming model is proposed to find a story plan considering business value, complexity and user experience. Our model of the story planning problem takes into account the significant variables that impact user stories prioritization and resource allocation of stories. The highlighted concepts are:

- Plan: Order of stories with resource allocations daily basis. According to the requirement of the project, it can be modified by adjusting the dependent variables.
- Time Interval: The time interval that smallest unit of time to assigning stories. In our study, this period was designed as one day. According to the requirement of the project, it can be easily adapted by modifying the dependent variables.
- Story: A small executable part of the project to be determined by the team and customer together.
- Priority: The priority degree of a story as it is defined by the customer and the team unitedly. It is quantified through a positive numerical number between 0 and 1.
- Required Work: The workforce needed for every single story. According to their expertise and knowledge, the team assign required work. It is quantified through a positive numerical number with a measure of a person hour.
- Risk: The risk degree of every individual story. Including the importance of the story in the whole project also involves the probability of being different from what was initially indicated. It is defined by the customer

and the team together and quantified through a positive numerical number between 0 and 1.

- Continuity: The status of all the time intervals assigned to a story is sequential. In theory, all time intervals assigned to a story must be sequential, but in practice, it must be different for some reasons.
- Relevant Story Group: Related stories have higher efficiency if they are released together because of releasing relevant functionalities together improves customer experience. The same time assignment means that they will be released close to each other. They are determined by the customer and the team together based on their experience.
- Affinity: The impact of assigning all members of the relevant story group to the same time interval. It is decided by the customer and the team unitedly based on their expertise. It is quantified by a positive numerical number between 1 and 10.
- Prerequisite: A general constraint among two stories, meaning that a story cannot start before the other one is finished. Unlike the other business sectors in software development, they are few but still exists.
- Capacity: The calculated amount of workforce the team can deliver per time interval. It is quantified through a positive numerical number with a measure of a person hour. It can change among time intervals.

5.1 Aim of the Proposed Model

The proposed model is developed for the sake of aims given below:

1. Improving customer experience. It can be achieved by selecting risky and vital stories in earlier releases and releasing stories with relevant functionalities together.
2. Resource management. It can be achieved by deciding resource allocations of assigned stories with taking into account the remaining resource of the time interval.

3. Continuity management. It can be achieved by encouraging sequential assignment stories to time intervals.
4. Affinity management. It can be achieved by assigning stories with relevant functionalities to same time intervals.

5.2 The Proposed Model

The problem of preparing an optimal story plan that satisfies these goals can be converted into a continuous generalized assignment problem. It can be modelled as a multi-objective integer linear programming model for assigning stories to time intervals and deciding manpower allocation of the assigned stories.

For obtaining the objective 1 we used the objective function 1. The objective function 1 tries to minimize the result by adding the risk degree and significance coefficients of the stories and multiply them by the time interval number. In this way, the model encourages the early placement of high priority and risky stories.

For obtaining the objective 2, we used a decision variable S_{it}. It states resource allocations of assigned stories. Additionally, constraint 2 is used for balancing assigned S_{it} decision variables with resource capacity of time intervals.

For obtaining the objective 3 we used the objective function 2. The objective function 2 tries to minimizing the result by the absolute value of subtracting the assignment value of stories with the next time interval and multiplying it with the priority degree of the story. In this way, the model encourages the sequential placement of stories and it encourages high priority stories' continuity more than low ones.

For obtaining the objective 4 we used the objective function 3. The objective function 3 tries to maximize the result by dividing the number of assigned stories from a relevant story group to member count of the story group and multiplying it with the affinity coefficient of that group. In this way, the model encourages together procession of relevant stories.

5.3 The Mathematical Model

Given a set of i stories I and a set of t time intervals T, let:

Decision variables:

x_{it} = 1 if story *i* is included in time interval *t*, 0 otherwise;

S_{it} the allocated resource for story *i* in time interval *t*;

Parameters:

p_i the priority degree of story *i*;

Z_{it} the number of work points needed for story *i* at the beginning of time interval *t*;

r_i the risk degree of story *i*;

w the work in progress limit of all time intervals;

C the capacity limit of all time intervals;

a_g the affinity of group *g*;

M the static big integer

$R_i$the prerequisite group of story *i*;

$|N_g|$ the number of stories in group *g*;

Objective Functions:

Objective Function 1:

$$Z_1 = Min \sum_{t=1}^{T} \sum_{i=1}^{I} (p_i + r_i) * t * x_{it} \qquad (5.1)$$

The objective function 1 tries to ensure that the optimal plan minimized when higher priority and risky stories placed early time intervals, thus encouraging an early placement of critical stories. The objective function 1 tries to minimize the result by adding the risk degree and significance coefficients of the stories and multiply them by the time interval number. In this way, the objective function 1 encourages the early placement of high priority and risky stories.

Objective Function 2:

$$Z_2 = Min \sum_{t=1}^{T} \sum_{i=1}^{I} p_i * |x_{it+1} - x_{it}| \qquad (5.2)$$

The objective function 2 tries to minimize the result by the absolute value of subtracting the assignment value of stories with the next time interval and multiplying it with the priority degree of the story. In this way, the objective function 2 encourages the sequential placement of stories, and it encourages high priority stories' continuity more than low ones.

Objective Function 3:

$$Z_3 = Max \sum_{t=1}^{T} \sum_{g=1}^{G} \frac{\sum_{i \in g} x_{it}}{|N_g|} * a_g \qquad (5.3)$$

The objective function 3 tries to maximize the result by dividing the number of assigned stories from a relevant story group to member count of the story group and multiplying it with the affinity coefficient of that group. In this way, the objective function 3 encourages together procession of relevant stories.

Constraints:

Constraint 1:

$$\sum_{t=1}^{T} S_{it} = Z_{i1} \quad \forall i \in I \qquad (5.4)$$

The constraint 1 forces that all needed workforce for all stories is assigned.

Constraint 2:

$$\sum_{i=1}^{I} S_{it} \leq C \quad \forall t \in T \tag{5.5}$$

The constraint 2 ensures that the sum of the assigned workforce of a time interval does not exceed the time intervals capacity.

Constraint 3:

$$M * x_{it} \geq S_{it} \quad \forall i,t \in I,T \tag{5.6}$$

The constraint 3 ensures that if a story assigned to a time interval, a resource must be assigned to that story too.

Constraint 4:

$$S_{it} \geq x_{it} \quad \forall i,t \in I,T \tag{5.7}$$

The constraint 4 is the complementary inequality of the constraint 3.

Constraint 5:

$$Z_{it} = Z_{i1} - \sum_{p=1}^{t-1} S_{ip} \quad \forall i,t \in I,T \tag{5.8}$$

The constraint 5 provides the remaining resource needed for all stories at the beginning of all time intervals.

Constraint 6:

$$M * (1 - x_{it}) \geq \sum_{j \in R_i} Z_{jt} \quad \forall i, t \in I, T \qquad (5.9)$$

The constraint 6 ensures that a story cannot start before the other one is finished for prerequisite constraint.

Constraint 7:

$$\sum_{i=1}^{I} x_{it} \leq \mathrm{w} \quad \forall t \in T \qquad (5.10)$$

The constraint 7 secures that the total number of stories assigned for a time interval cannot exceed work in progress limit.

5.4 Application

To confirm the effectiveness of the model, we practised it on a sample project with five stories. The execution completed in a few seconds and provided an excellent story plan similar to the teams. For small and not complex projects like this one, the team can make proper plans. However, as the number of stories increases and the project becomes more complex with prerequisite and affinity relations, it is harder to make better story plans for the team. We applied our model to a real project, which is a banking company's changing ATMs project's related life insurance development project. The stories and dependent variables obtained with the team and the customer together. Stories with Story Points, Priorities and Risks is shown in Table 5.1. The

project consists of 21 stories. The stories with dependent variables, relative story group matrix and prerequisite matrix as follows.

Table. 5.1. Stories with Story Points, Priorities and Risks

Story#	Story	Story Point	Priority D.	Risk D.
1	Remote access channels dev.	125	0.5	0.6
2	Aquila and Tucana functions dev.	150	0.3	0.4
3	Mobile terminal dev.	70	0.5	0.5
4	Account book printing	55	0.4	0.2
5	Hand vessel trace authentication integration	130	0.2	0.6
6	Reporting and KPI screens	80	0.4	0.1
7	Process session relation	95	0.7	0.2
8	Improving customer experience, quality and performance in existing menus	130	0.3	0.2
9	Personal loans screens	65	0.4	0.2
10	Customer Acquisition dev.	80	0.5	0.4
11	Expense infrastructure dev.	90	0.6	0.3
12	Tucana read/understood section dev.	50	0.2	0.3
13	Approval rules of Aquila operation menus	60	0.2	0.3
14	M/G calls	125	0.1	0.3
15	Notonus customer processes	95	0.3	0.2
16	Self-service processes expansion	120	0.5	0.6
17	Rounding up on reimbursements dev.	75	0.5	0.5
18	Debit card cancellation screen	100	0.4	0.3
19	Debit/credit card password screens	110	0.3	0.2
20	SA and RA monitoring screens	80	0.2	0.1
21	Terminals money state screen for operational planning	75	0.4	0.2

Table. 5.2. Relative Group Membership Matrix*

Story#	Group 1	Group 2	Group 3
1	0	0	0
2	1	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	1
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	1	0	0
13	0	0	0
14	0	0	0
15	1	0	0
16	0	0	0
17	0	0	0
18	0	1	0
19	0	1	0
20	0	0	1
21	0	0	1

(*) 1 means the story in row is inside the affinity group

Table. 5.3. Groups with Affinity Points

Group#	Affinity Point
1	5
2	4
3	6

Table. 5.4. Story Prerequisite Matrix*

Story#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
7	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(*) 1 means the story in row is prerequisite to story in column

After obtaining the variables of the real project with the customer and the team, the next step is the find the solution. We have three objective functions; the first one is the priority and risk, the second one is continuity, and the third one is affinity. The most significant one is the first one. We used the ε-constraint method for dealing with the multi-objective problem effectively. First of all, the model is solved for each objective function one by one. Then, since the first objective function was the most important, the first objective function was set to be the only objective function. We converted the two other objective functions to constraints with epsilon values collected from multiple runs and their importance. Seven different epsilon values set for converted objective functions. The epsilon values have shown in Table 5.5. We got seven different models with these epsilon values. Then these models are solved by using a general-purpose MIP solver. The models produced the results, and the executions completed different times between 15 minutes and 2 hours. Although this time is considerable, the process can be assent since it runs only once at the beginning of the project.

Table. 5.5. Epsilon Values Table of Real Project

	Contuinity Objective Function	Affinity Objective Function
Epsilon Value of Model #1	50	100
Epsilon Value of Model #2	60	150
Epsilon Value of Model #3	55	135
Epsilon Value of Model #4	50	200
Epsilon Value of Model #5	65	200
Epsilon Value of Model #6	57	75
Epsilon Value of Model #7	70	155

The results generated from executions were compared from different aspects. The first comparison is the objective function one value comparison. It has shown in Figure 5.1.

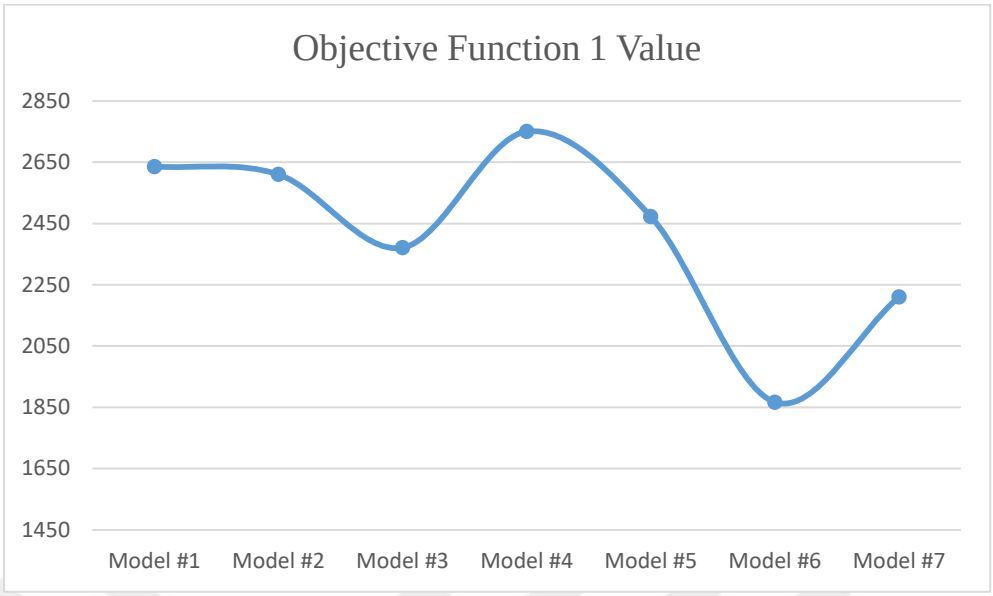

Figure 5.1. Values of the Objective Function 1 in Solution of Models

The best Objective Function 1 value obtained from model #6 because of its epsilon values. The affinity constraints reduced importance (it has shown in Table 5.5) lead to a better solution of objective function 1's value.

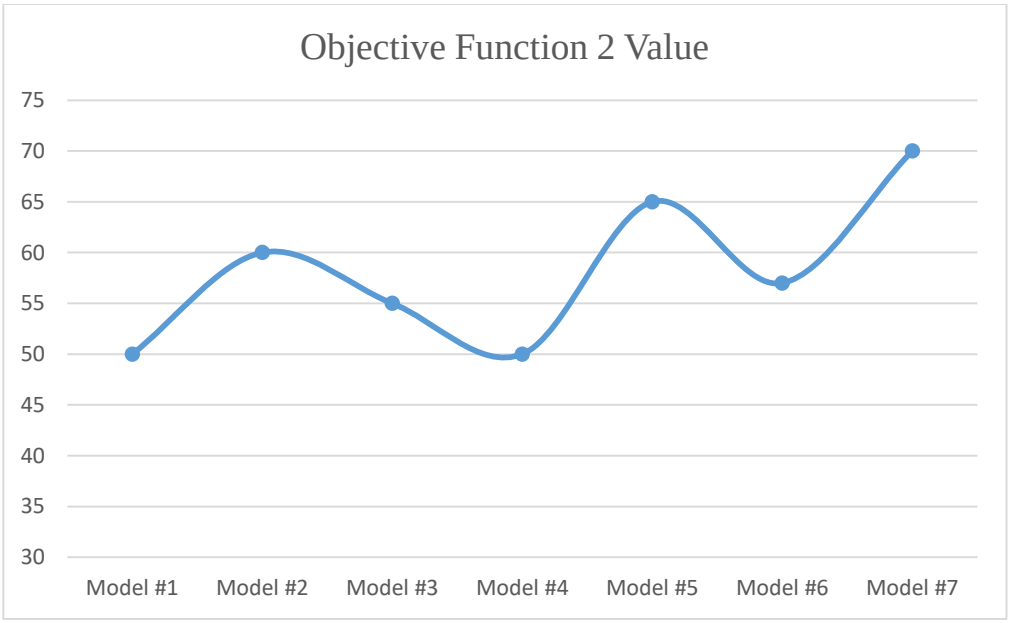

Figure 5.2. Values of the Objective Function 2 in Solution of Models

The best objective function 2 value obtained from model #1 and #4 (it has shown in Figure 5.2) because of its epsilon values. The solution values directly related to epsilon values because of the continuity objective converted to a constraint. Besides, better continuity objective function values mean increased importance of continuity objective function.

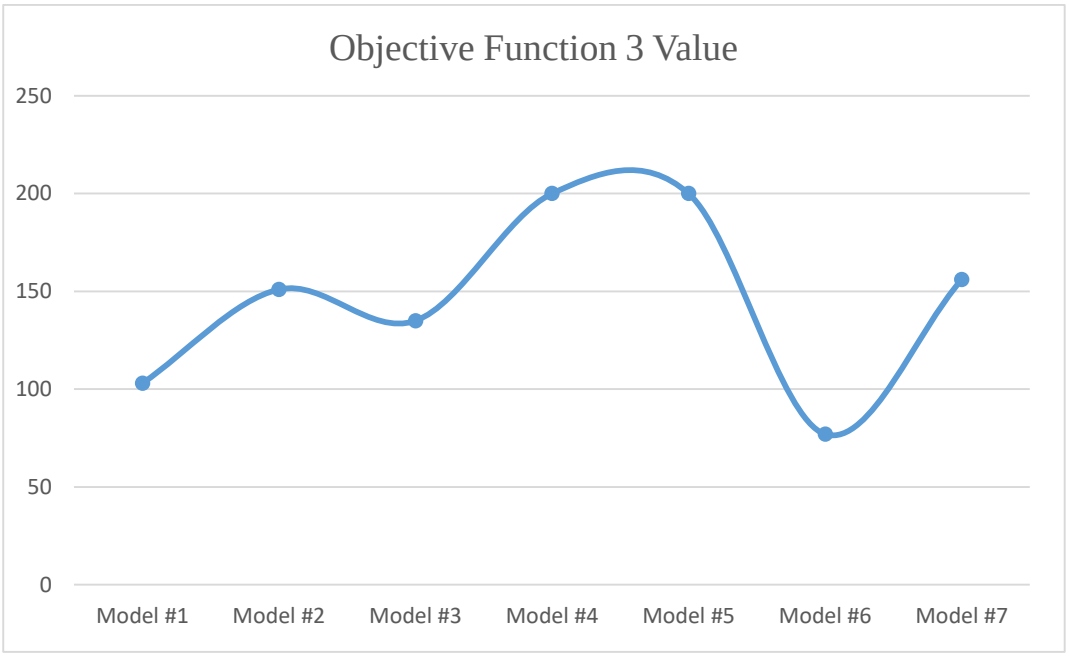

Figure 5.3. Values of the Objective Function 3 in Solutions of the Models

The best objective function 3 value obtained from model #4 and #5 (it has shown in Figure 5.3) because of its epsilon values. The solution values directly related to epsilon values because of the affinity objective converted to a constraint. Also, better affinity objective function values mean increased importance of affinity objective function.

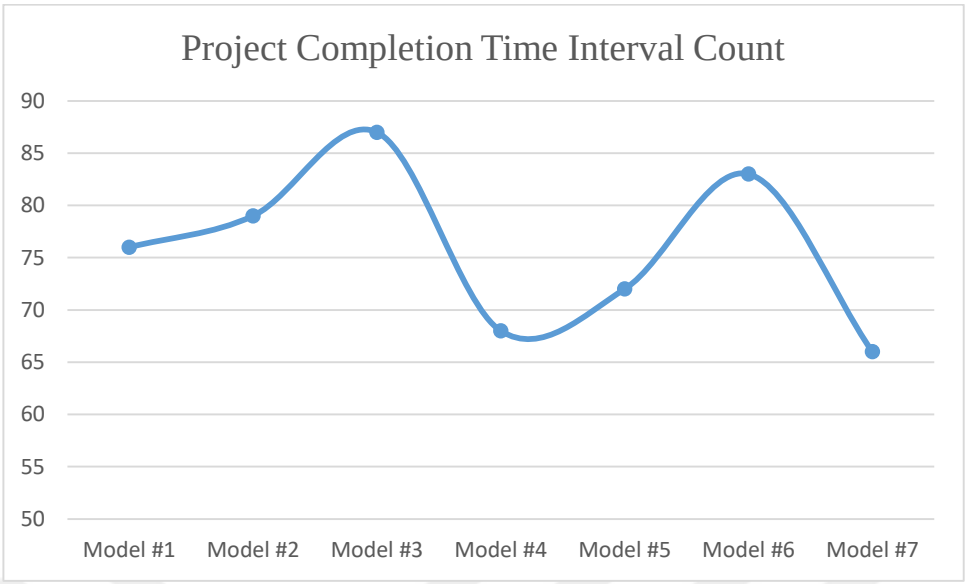

Figure 5.4. Project Completion Time Interval Counts in Solutions of the Models

The completion time is a significant aspect of a project plan. The model with the lowest time interval count is the fastest completed project plan. It is model #7 (it has shown in Figure 5.4). While choosing the best solution, the completion times of models are considered too.

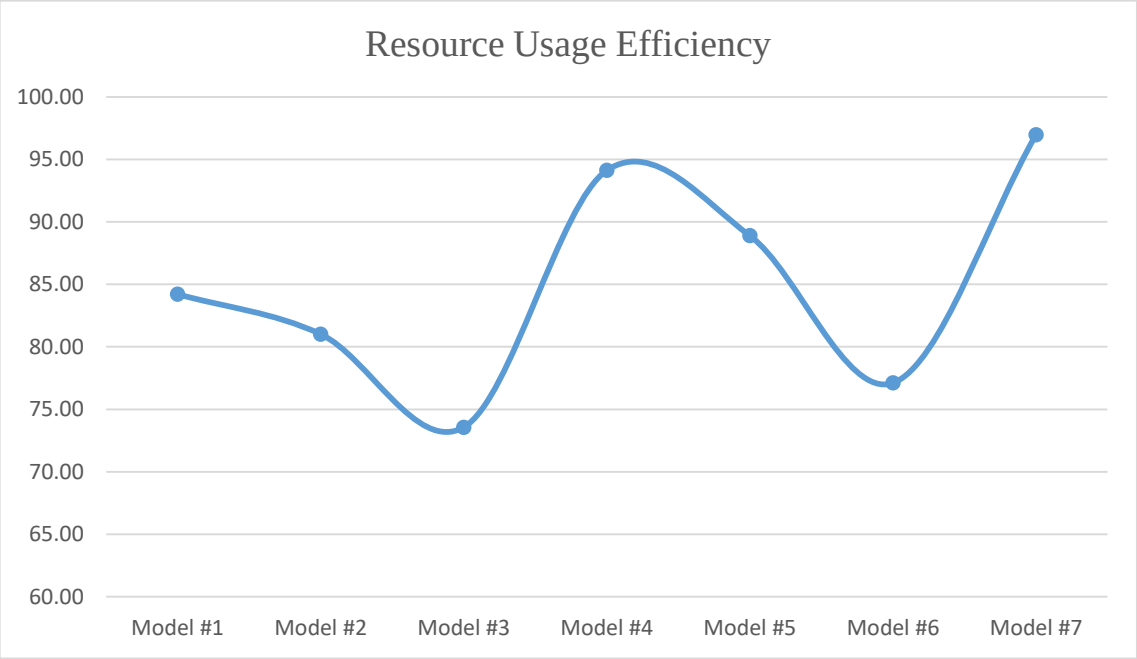

Figure 5.5. Resource Usage Efficiencies of Solutions of the Models

The resource usage efficiency is the considerable feature of a project plan. The model with the highest resource usage efficiency is model #7 is shown in Figure 5.5. Higher resource usage efficiency means lower waste of development resources. While choosing the best solution, resource usage efficiency is considered too.

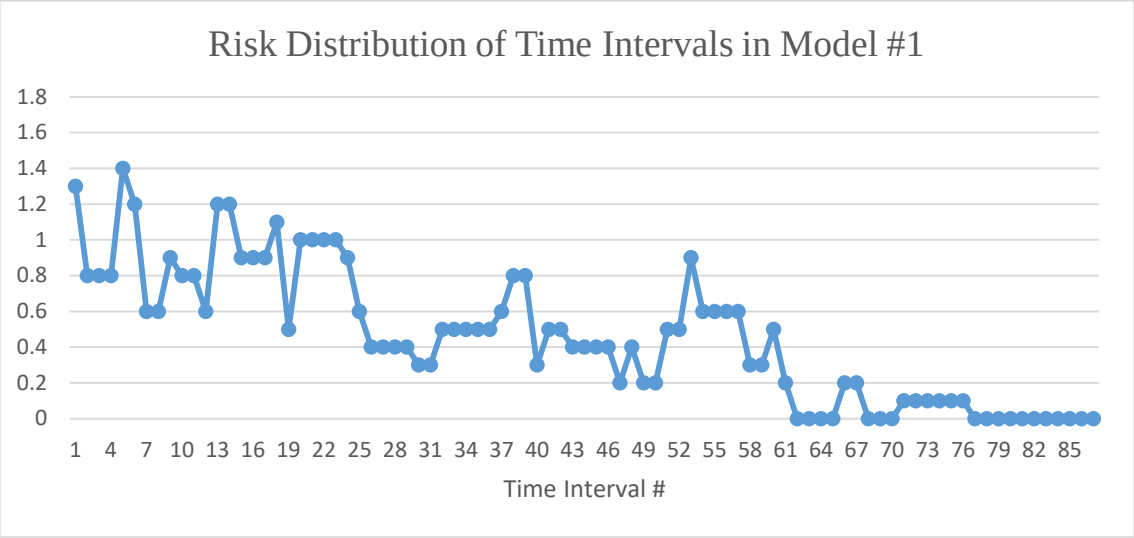

Figure 5.6. Risk Distribution of Time Intervals in Model #1

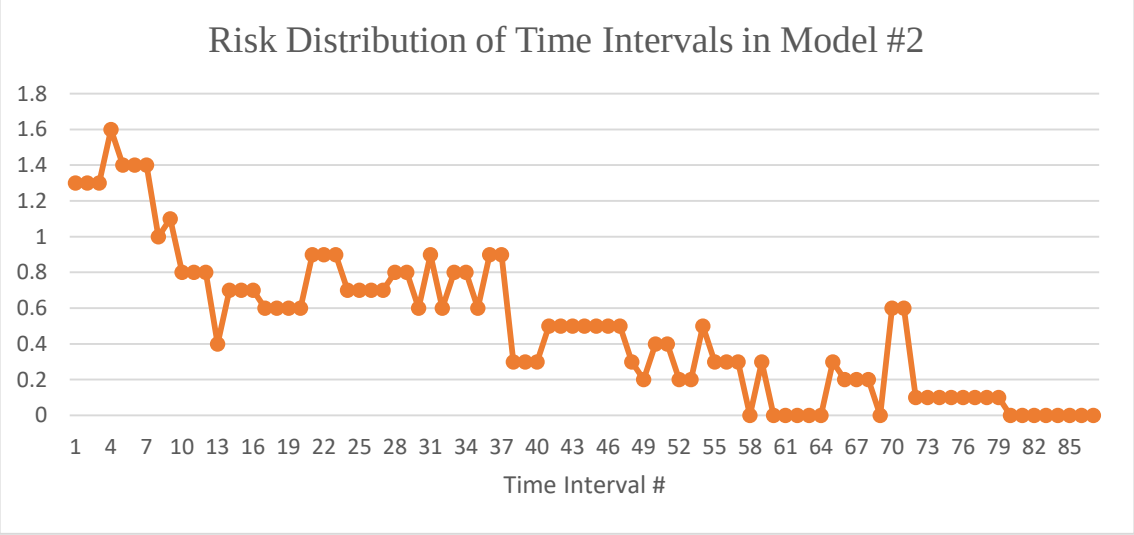

Figure 5.7. Risk Distribution of Time Intervals in Model #2

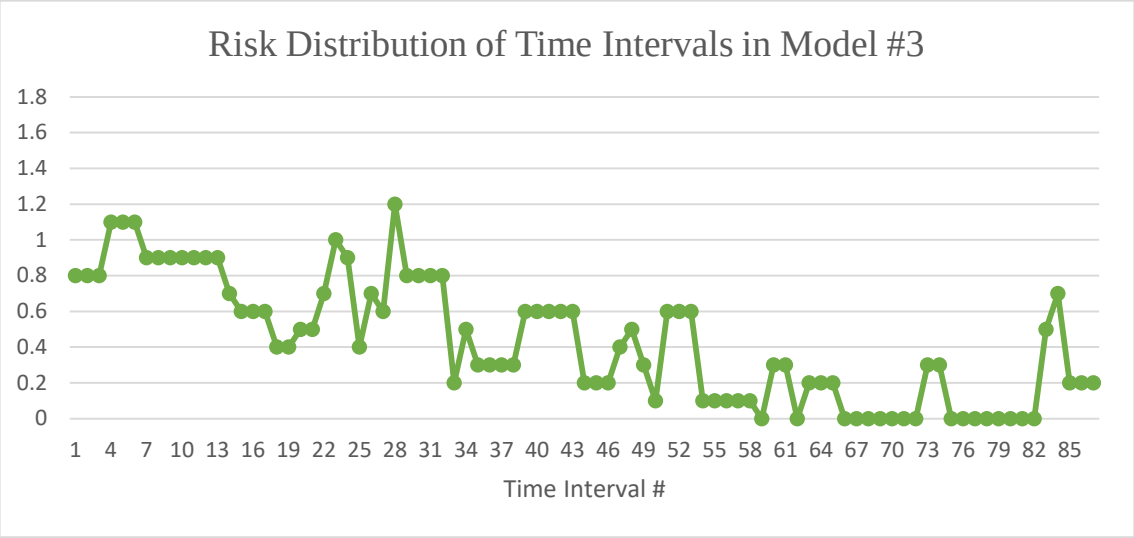

Figure 5.8. Risk Distribution of Time Intervals in Model #3

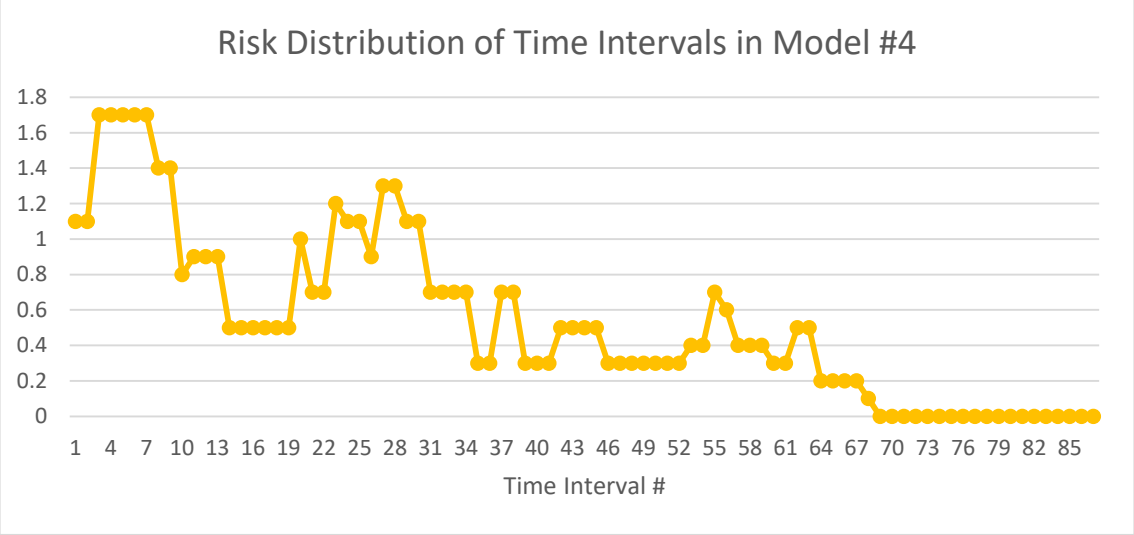

Figure 5.9. Risk Distribution of Time Intervals in Model #4

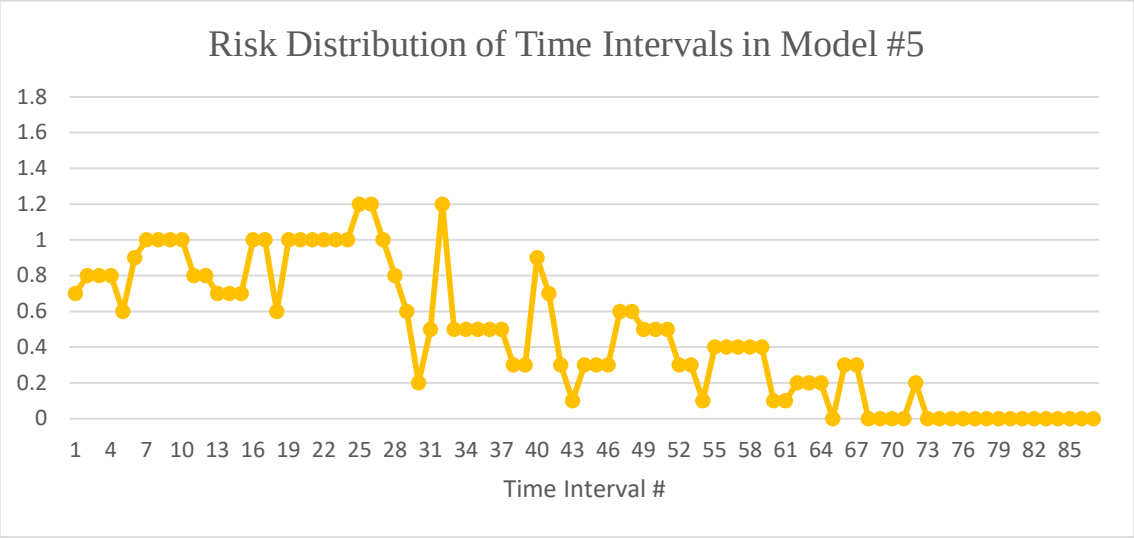

Figure 5.10. Risk Distribution of Time Intervals in Model #5

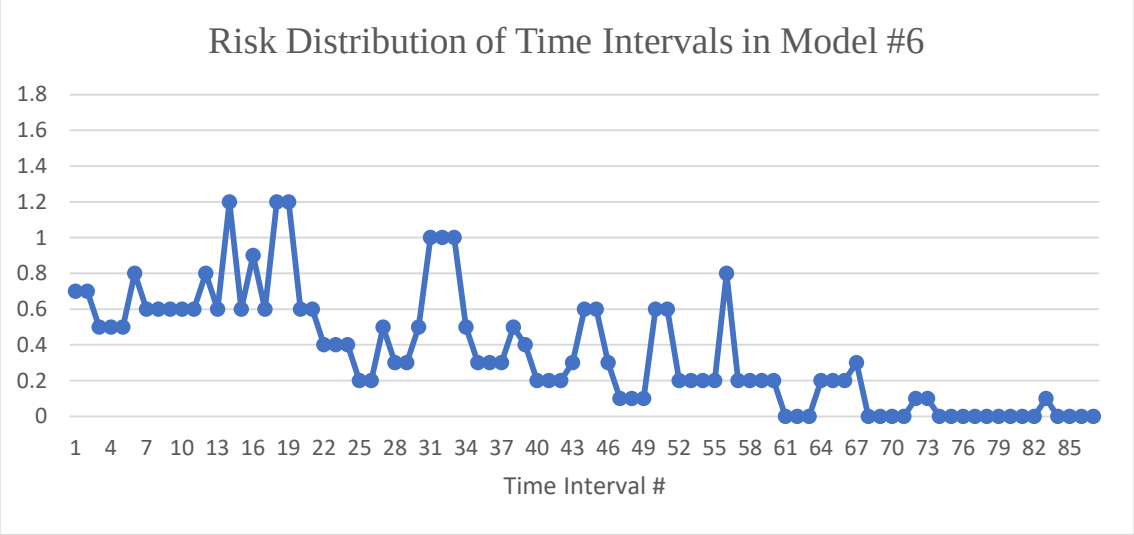

Figure 5.11. Risk Distribution of Time Intervals in Model #6

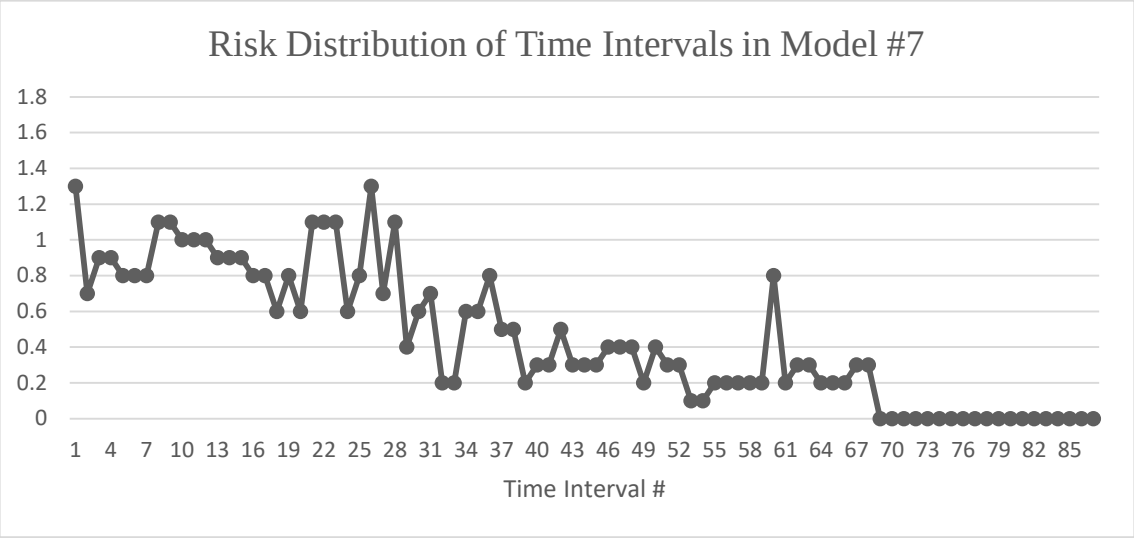

Figure 5.12. Risk Distribution of Time Intervals in Model #7

The risk management is a significant feature of a project plan. Putting risky stories in same interval increases uncertainity of that time interval and insecures successfully completion of the project. The model #6 has the best distiribution of risks is shown in Figure 5.6 to Figure 5.12 consecutively. Distributing uncertain stories in different time intervals and postponing them to reduce the risk that protects successfully completion of the project and prevents disruption of the plan.

Finally, after all comparisons and analysis the team chooses model #6 because of objective function 1 value, continuity objective function value and risk distribution. Altough the model has shortness for affinity objective function value. As in every multi-objective model, we gain some objective values while loosing the other objectives. After the team choosed the best solution, we created a method to determine the best solution from using objective function values. Firstly, the objective function values scaled between 0 and 10. Then, we assigned importance percentages the sum to be 100 to them. The objective function 1 is 50, the objective function 2 is 30, the objective function 3 is 20. After that, we calculated the cumulative objective function values using these percentages for our seven models. The calculated cumulative objective function values has shown in Table 5.6. The GAMS codes of model #6 has shown in Appendix A and output of execution has shown in Appendix B.

Table. 5.6. The Calculated Cumulative Objective Function Values of Real Project

	Calculated Cumulative Objective Function Values
Model #1	3.84
Model #2	4.09
Model #3	4.67
Model #4	4.53
Model #5	4.77
Model #6	5.29
Model #7	4.84

As it is seen in the Table 5.6, the maximum valued model is the model #6. Then, to proving effectiveness of our model in other projects, we changed story number, priority, risk and affinity values of our project, and created 10 new projects. The new 10 projects stories with story points, priority and risk degrees is shown in Table 5.7 to 5.16 consecutively.

Table. 5.7. Stories with Story Points, Priorities and Risks of New Project #1

Story#	Story	Story Point	Priority D.	Risk D.
1	Remote access channels dev.	125	0.5	0.6
2	Aquila and Tucana functions dev.	150	0.3	0.4
3	Mobile terminal dev.	70	0.5	0.5
4	Account book printing	55	0.4	0.2
5	Hand vessel trace authentication integration	130	0.2	0.6
6	Process session relation	95	0.7	0.2
7	Improving customer experience, quality and performance in existing menus	130	0.4	0.2
8	Personal loans screens	65	0.3	0.2
9	Customer Acquisition dev.	80	0.5	0.4
10	Expense infrastructure dev.	90	0.6	0.3
11	Tucana read/understood section dev.	50	0.2	0.3
12	Approval rules of Aquila operation menus	60	0.2	0.3
13	M/G calls	125	0.1	0.3
14	Notonus customer processes	120	0.5	0.2
15	Self-service processes expansion	90	0.3	0.6
16	Rounding up on reimbursements dev.	75	0.5	0.5
17	Debit card cancellation screen	100	0.4	0.3
18	Debit/credit card password screens	110	0.3	0.2
19	SA and RA monitoring screens	80	0.2	0.1
20	Terminals money state screen for operational planning	75	0.4	0.2

Table. 5.8. Stories with Story Points, Priorities and Risks of New Project #2

Story#	Story	Story Point	Priority D.	Risk D.
1	Remote access channels dev.	125	0.5	0.6
2	Aquila and Tucana functions dev.	150	0.3	0.4
3	Mobile terminal dev.	70	0.5	0.5
4	Account book printing	55	0.4	0.2
5	Hand vessel trace authentication integration	130	0.2	0.6
6	Process session relation	95	0.7	0.2
7	Improving customer experience, quality and performance in existing menus	130	0.4	0.2
8	Personal loans screens	80	0.3	0.2
9	Customer Acquisition dev.	65	0.5	0.4
10	Expense infrastructure dev.	90	0.6	0.3
11	Tucana read/understood section dev.	85	0.4	0.3
12	Approval rules of Aquila operation menus	60	0.5	0.3
13	M/G calls	100	0.1	0.2
14	Notonus customer processes	120	0.5	0.2
15	Self-service processes expansion	90	0.3	0.5
16	Rounding up on reimbursements dev.	75	0.5	0.5
17	Debit card cancellation screen	100	0.4	0.3
18	Debit/credit card password screens	110	0.3	0.2
19	SA and RA monitoring screens	80	0.2	0.1
20	Terminals money state screen for operational planning	75	0.4	0.2

Table. 5.9. Stories with Story Points, Priorities and Risks of New Project #3

Story#	Story	Story Point	Priority D.	Risk D.
1	Remote access channels dev.	70	0.5	0.6
2	Aquila and Tucana functions dev.	150	0.3	0.4
3	Mobile terminal dev.	125	0.5	0.5
4	Account book printing	75	0.4	0.2
5	Hand vessel trace authentication integration	140	0.2	0.6
6	Process session relation	95	0.7	0.2
7	Improving customer experience, quality and performance in existing menus	130	0.4	0.2
8	Personal loans screens	65	0.3	0.2
9	Customer Acquisition dev.	80	0.5	0.4
10	Expense infrastructure dev.	90	0.6	0.1
11	Tucana read/understood section dev.	50	0.2	0.3
12	Approval rules of Aquila operation menus	60	0.2	0.3
13	M/G calls	125	0.1	0.3
14	Notonus customer processes	120	0.5	0.2
15	Self-service processes expansion	90	0.3	0.6
16	Rounding up on reimbursements dev.	75	0.5	0.5
17	Debit card cancellation screen	100	0.6	0.3
18	Debit/credit card password screens	110	0.3	0.2
19	SA and RA monitoring screens	80	0.1	0.1
20	Terminals money state screen for operational planning	75	0.4	0.6

Table. 5.10. Stories with Story Points, Priorities and Risks of New Project #4

Story#	Story	Story Point	Priority D.	Risk D.
1	Remote access channels dev.	125	0.5	0.6
2	Aquila and Tucana functions dev.	150	0.3	0.4
3	Mobile terminal dev.	70	0.5	0.5
4	Account book printing	55	0.4	0.2
5	Hand vessel trace authentication integration	130	0.2	0.6
6	Process session relation	95	0.7	0.2
7	Improving customer experience, quality and performance in existing menus	130	0.4	0.2
8	Personal loans screens	65	0.3	0.2
9	Customer Acquisition dev.	80	0.5	0.4
10	Expense infrastructure dev.	90	0.6	0.3
11	Tucana read/understood section dev.	50	0.2	0.3
12	Approval rules of Aquila operation menus	60	0.2	0.3
13	M/G calls	125	0.1	0.3
14	Notonus customer processes	120	0.5	0.2
15	Self-service processes expansion	90	0.3	0.6
16	Rounding up on reimbursements dev.	75	0.5	0.5
17	Debit card cancellation screen	100	0.4	0.3
18	Debit/credit card password screens	110	0.3	0.2
19	SA and RA monitoring screens	80	0.2	0.1
20	Terminals money state screen for operational planning	75	0.4	0.2

Table. 5.11. Stories with Story Points, Priorities and Risks of New Project #5

Story#	Story	Story Point	Priority D.	Risk D.
1	Remote access channels dev.	125	0.5	0.6
2	Aquila and Tucana functions dev.	150	0.3	0.4
3	Mobile terminal dev.	70	0.6	0.5
4	Account book printing	55	0.5	0.2
5	Hand vessel trace authentication integration	130	0.2	0.6
6	Process session relation	95	0.7	0.2
7	Improving customer experience, quality and performance in existing menus	130	0.4	0.2
8	Personal loans screens	65	0.3	0.2
9	Customer Acquisition dev.	80	0.7	0.4
10	Expense infrastructure dev.	90	0.6	0.3
11	Tucana read/understood section dev.	50	0.2	0.1
12	Approval rules of Aquila operation menus	60	0.2	0.3
13	M/G calls	80	0.1	0.1
14	Notonus customer processes	150	0.5	0.2
15	Self-service processes expansion	120	0.3	0.7
16	Rounding up on reimbursements dev.	75	0.5	0.5
17	Debit card cancellation screen	100	0.4	0.3
18	Debit/credit card password screens	110	0.3	0.2
19	SA and RA monitoring screens	125	0.2	0.1
20	Terminals money state screen for operational planning	75	0.4	0.2

Table. 5.12. Stories with Story Points, Priorities and Risks of New Project #6

Story#	Story	Story Point	Priority D.	Risk D.
1	Remote access channels dev.	125	0.7	0.6
2	Aquila and Tucana functions dev.	55	0.5	0.4
3	Mobile terminal dev.	70	0.5	0.5
4	Account book printing	150	0.4	0.5
5	Hand vessel trace authentication integration	130	0.2	0.2
6	Process session relation	95	0.7	0.2
7	Improving customer experience, quality and performance in existing menus	130	0.4	0.2
8	Personal loans screens	65	0.3	0.2
9	Customer Acquisition dev.	110	0.5	0.4
10	Expense infrastructure dev.	130	0.6	0.3
11	Tucana read/understood section dev.	50	0.2	0.3
12	Approval rules of Aquila operation menus	60	0.2	0.3
13	M/G calls	125	0.1	0.3
14	Notonus customer processes	120	0.5	0.2
15	Self-service processes expansion	90	0.3	0.6
16	Rounding up on reimbursements dev.	75	0.5	0.5
17	Debit card cancellation screen	100	0.4	0.3
18	Debit/credit card password screens	110	0.3	0.2
19	SA and RA monitoring screens	80	0.2	0.1

Table. 5.13. Stories with Story Points, Priorities and Risks of New Project #7

Story#	Story	Story Point	Priority D.	Risk D.
1	Remote access channels dev.	150	0.5	0.7
2	Aquila and Tucana functions dev.	125	0.3	0.4
3	Mobile terminal dev.	70	0.7	0.7
4	Account book printing	55	0.2	0.2
5	Hand vessel trace authentication integration	130	0.5	0.2
6	Process session relation	95	0.7	0.2
7	Improving customer experience, quality and performance in existing menus	130	0.4	0.2
8	Personal loans screens	65	0.3	0.2
9	Customer Acquisition dev.	80	0.5	0.4
10	Expense infrastructure dev.	90	0.6	0.3
11	Tucana read/understood section dev.	50	0.2	0.3
12	Approval rules of Aquila operation menus	60	0.2	0.3
13	M/G calls	125	0.1	0.3
14	Notonus customer processes	120	0.5	0.2
15	Self-service processes expansion	110	0.3	0.6
16	Rounding up on reimbursements dev.	130	0.5	0.5
17	Debit card cancellation screen	120	0.4	0.3
18	Debit/credit card password screens	110	0.3	0.2
19	SA and RA monitoring screens	80	0.2	0.1

Table. 5.14. Stories with Story Points, Priorities and Risks of New Project #8

Story#	Story	Story Point	Priority D.	Risk D.
1	Remote access channels dev.	160	0.6	0.6
2	Aquila and Tucana functions dev.	150	0.3	0.1
3	Mobile terminal dev.	120	0.5	0.5
4	Account book printing	90	0.4	0.2
5	Hand vessel trace authentication integration	130	0.2	0.7
6	Process session relation	95	0.7	0.2
7	Improving customer experience, quality and performance in existing menus	130	0.5	0.2
8	Personal loans screens	65	0.1	0.2
9	Customer Acquisition dev.	80	0.5	0.4
10	Expense infrastructure dev.	90	0.6	0.3
11	Tucana read/understood section dev.	50	0.2	0.3
12	Approval rules of Aquila operation menus	60	0.2	0.3
13	M/G calls	125	0.1	0.3
14	Notonus customer processes	120	0.5	0.2
15	Self-service processes expansion	90	0.3	0.6
16	Rounding up on reimbursements dev.	75	0.5	0.5
17	Debit card cancellation screen	100	0.4	0.3
18	Debit/credit card password screens	110	0.3	0.2
19	SA and RA monitoring screens	80	0.2	0.1

Table. 5.15. Stories with Story Points, Priorities and Risks of New Project #9

Story#	Story	Story Point	Priority D.	Risk D.
1	Remote access channels dev.	125	0.5	0.7
2	Aquila and Tucana functions dev.	150	0.3	0.4
3	Mobile terminal dev.	70	0.5	0.6
4	Account book printing	55	0.4	0.2
5	Hand vessel trace authentication integration	130	0.2	0.7
6	Process session relation	95	0.7	0.2
7	Improving customer experience, quality and performance in existing menus	130	0.4	0.2
8	Personal loans screens	65	0.3	0.2
9	Customer Acquisition dev.	80	0.5	0.4
10	Expense infrastructure dev.	90	0.6	0.3
11	Tucana read/understood section dev.	50	0.2	0.3
12	Approval rules of Aquila operation menus	60	0.2	0.3
13	M/G calls	125	0.1	0.3
14	Notonus customer processes	120	0.5	0.2
15	Self-service processes expansion	90	0.3	0.6
16	Rounding up on reimbursements dev.	110	0.5	0.5
17	Debit card cancellation screen	130	0.5	0.3
18	Debit/credit card password screens	150	0.7	0.2

Table. 5.16. Stories with Story Points, Priorities and Risks of New Project #10

Story#	Story	Story Point	Priority D.	Risk D.
1	Remote access channels dev.	125	0.5	0.7
2	Aquila and Tucana functions dev.	150	0.3	0.4
3	Mobile terminal dev.	70	0.5	0.6
4	Account book printing	55	0.4	0.2
5	Hand vessel trace authentication integration	130	0.2	0.7
6	Process session relation	95	0.7	0.2
7	Improving customer experience, quality and performance in existing menus	130	0.4	0.2
8	Personal loans screens	65	0.3	0.2
9	Customer Acquisition dev.	80	0.5	0.4
10	Expense infrastructure dev.	90	0.6	0.3
11	Tucana read/understood section dev.	50	0.2	0.3
12	Approval rules of Aquila operation menus	60	0.2	0.3
13	M/G calls	155	0.1	0.3
14	Notonus customer processes	140	0.5	0.2
15	Self-service processes expansion	130	0.3	0.6
16	Rounding up on reimbursements dev.	75	0.5	0.5
17	Debit card cancellation screen	100	0.5	0.3
18	Debit/credit card password screens	110	0.3	0.2

After the new projects are created, they are all solved in order. Three new model created with the best 3 epsilon values for all projects. These three models are solved and the best model is determined by the proposed cumulative objective function. The new project #1's objective function values has shown in Figure 5.13 to Figure 5.15 consecutively and calculated cumulative objective function values has shown in Table 5.17.

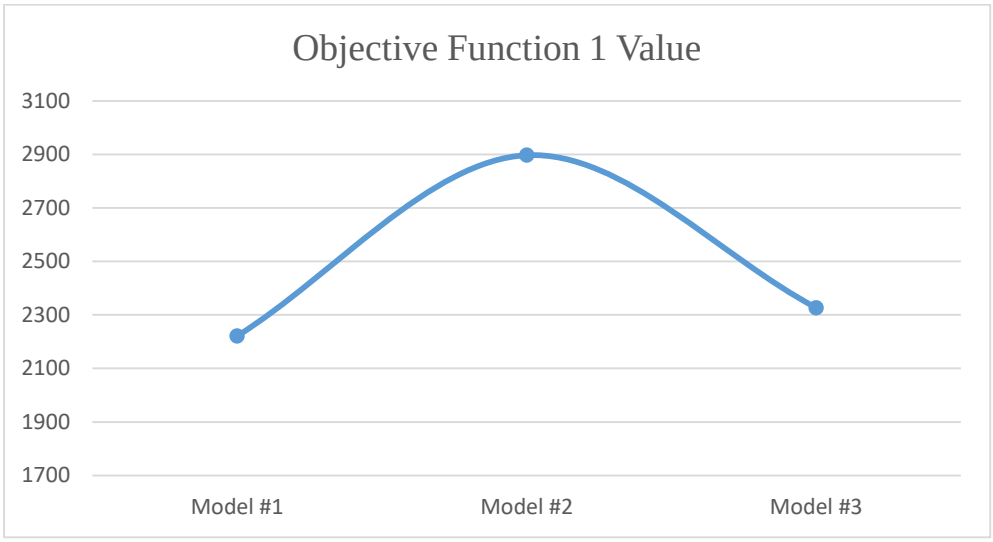

Figure 5.13. Objective Function 1 Values of the New Project #1

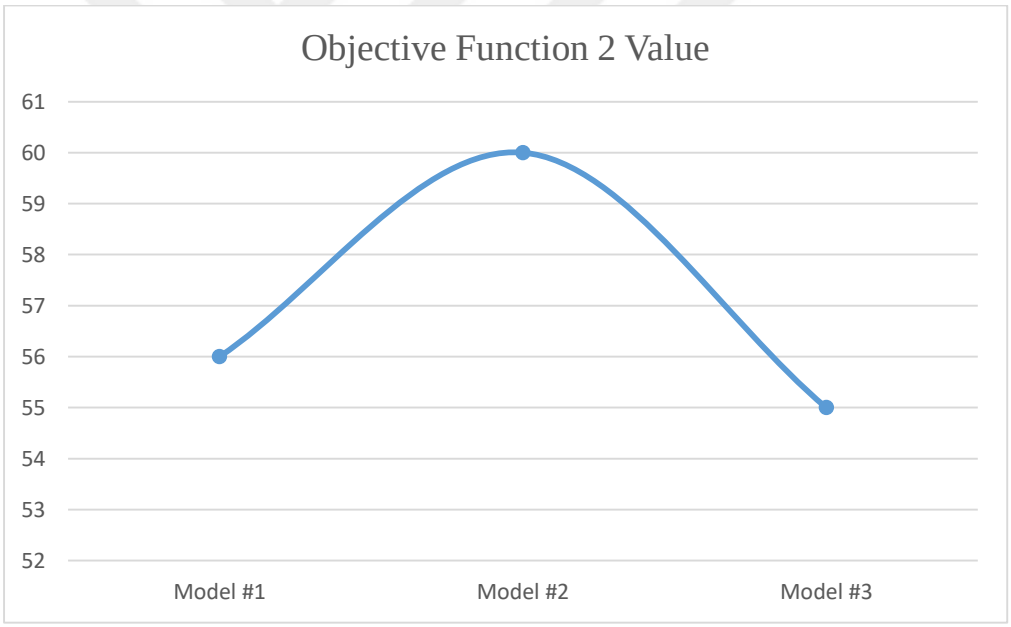

Figure 5.14. Objective Function 2 Values of the New Project #1

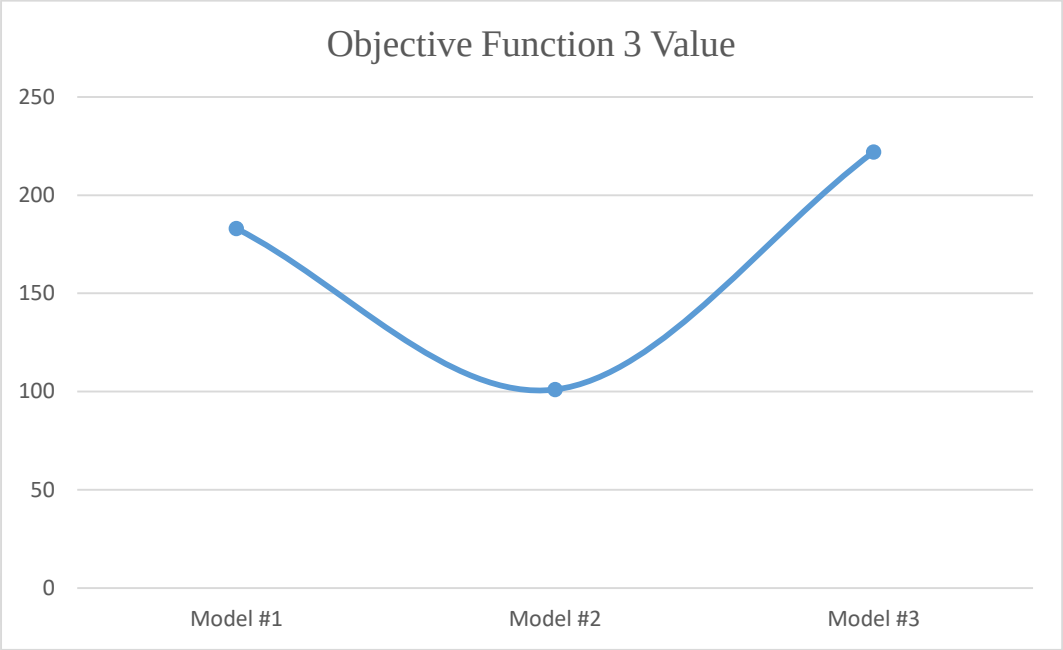

Figure 5.15. Objective Function 3 Values of the New Project #1

Table. 5.17. Calculated Cumulative Objective Function Values of New Project #1

	Calculated Cumulative Objective Function Values
Model #1	4.70
Model #2	3.37
Model #3	4.78

As it is seen in the Table 5.17, the maximum valued model is the model #3. After the first project completed, the same operations were carried out for the second project. The new project #2's objective function values has shown in Figure 5.16 to Figure 5.18 consecutively and calculated cumulative objective function values has shown in Table 5.18.

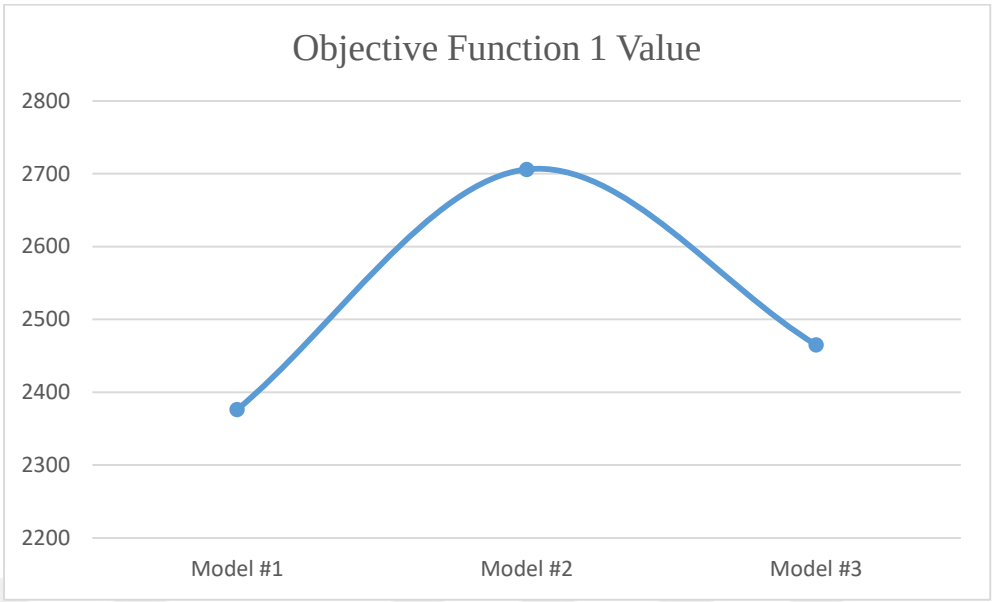

Figure 5.16. Objective Function 1 Values of the New Project #2

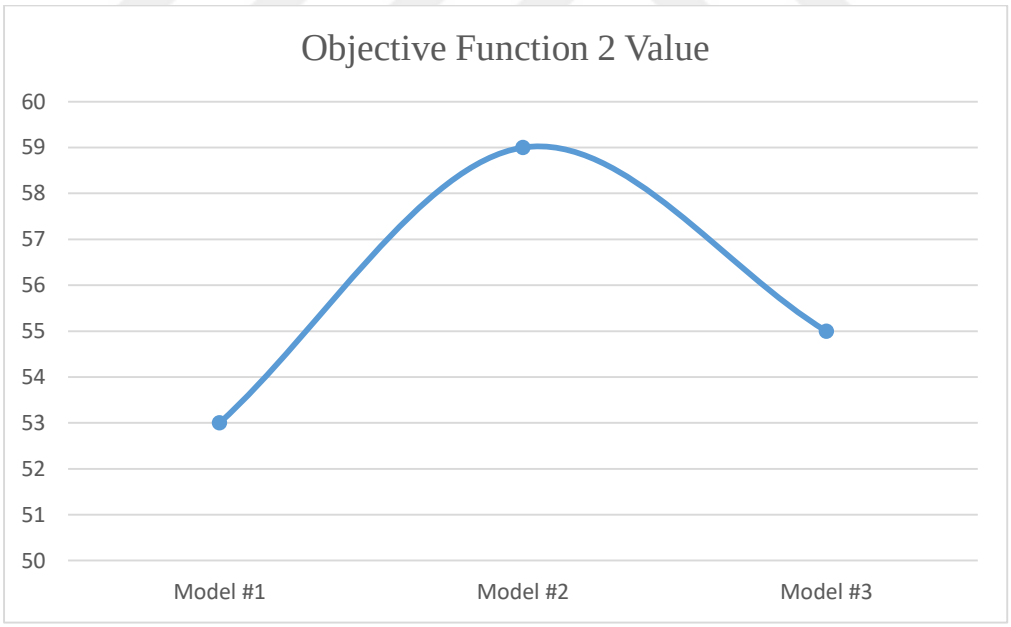

Figure 5.17. Objective Function 2 Values of the New Project #2

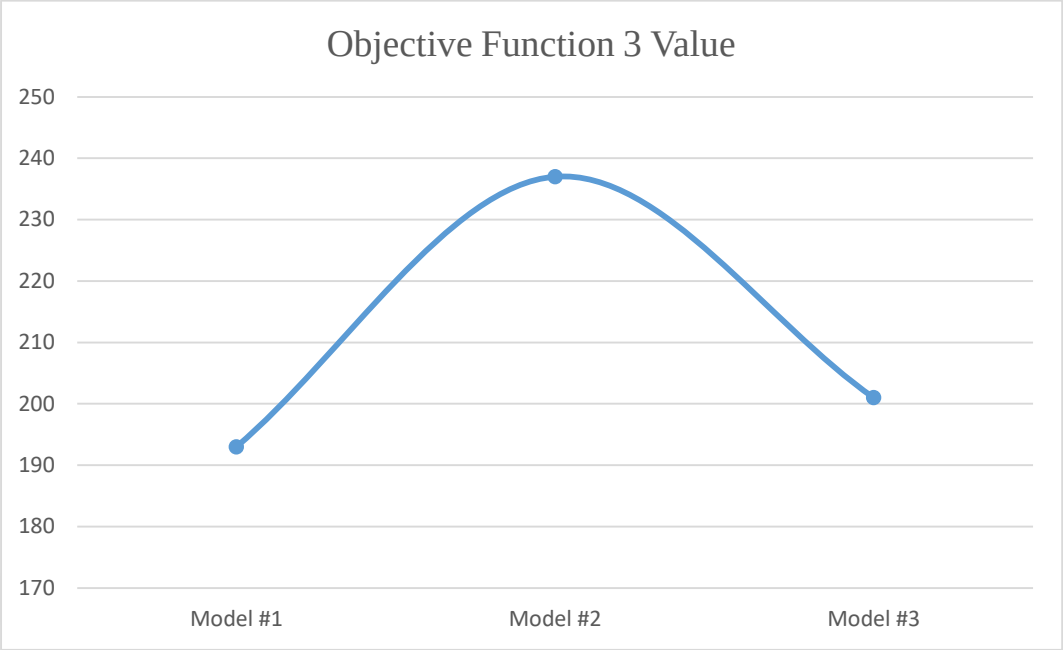

Figure 5.18. Objective Function 3 Values of the New Project #2

Table. 5.18. Calculated Cumulative Objective Function Values of New Project #2

	Calculated Cumulative Objective Function Values
Model #1	5.30
Model #2	4.74
Model #3	5.10

As it is seen in the Table 5.18, the maximum valued model is the model #1. After the second project completed, the same operations were carried out for the third project. The new project #3's objective function values has shown in Figure 5.19 to Figure 5.21 consecutively and calculated cumulative objective function values has shown in Table 5.19.

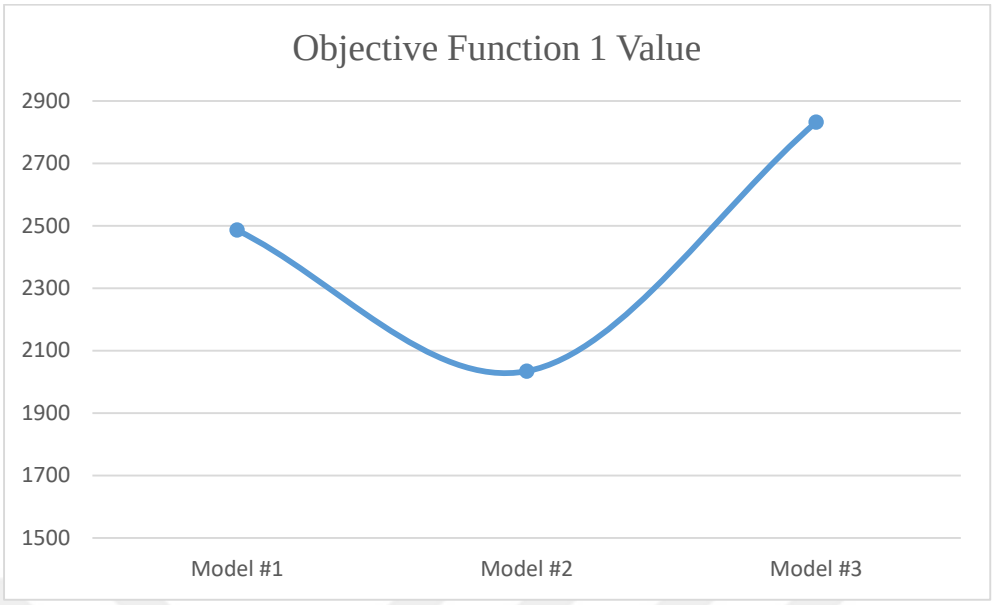

Figure 5.19. Objective Function 1 Values of the New Project #3

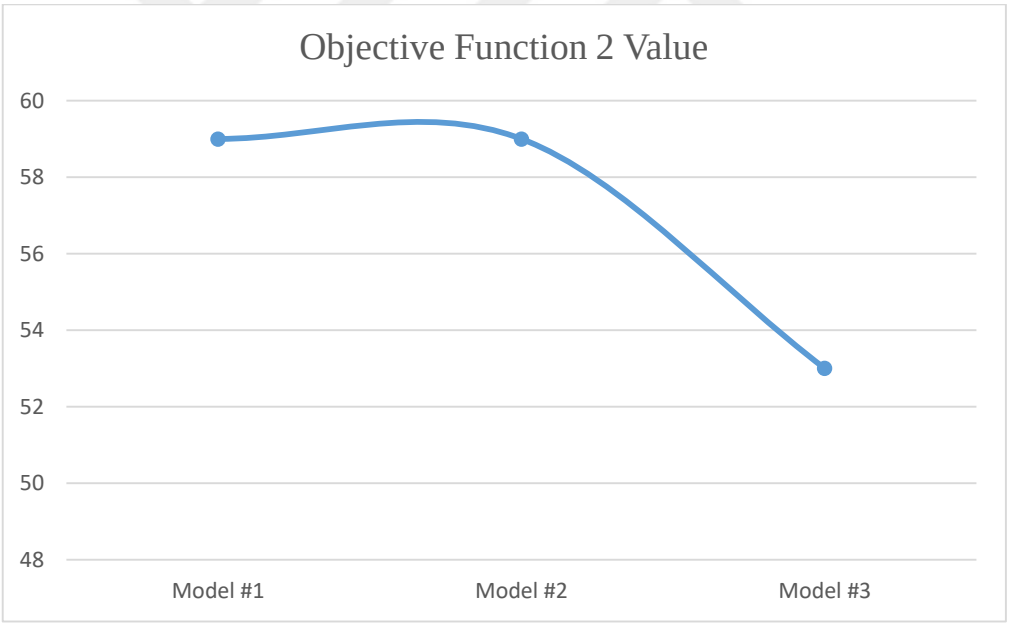

Figure 5.20. Objective Function 2 Values of the New Project #3

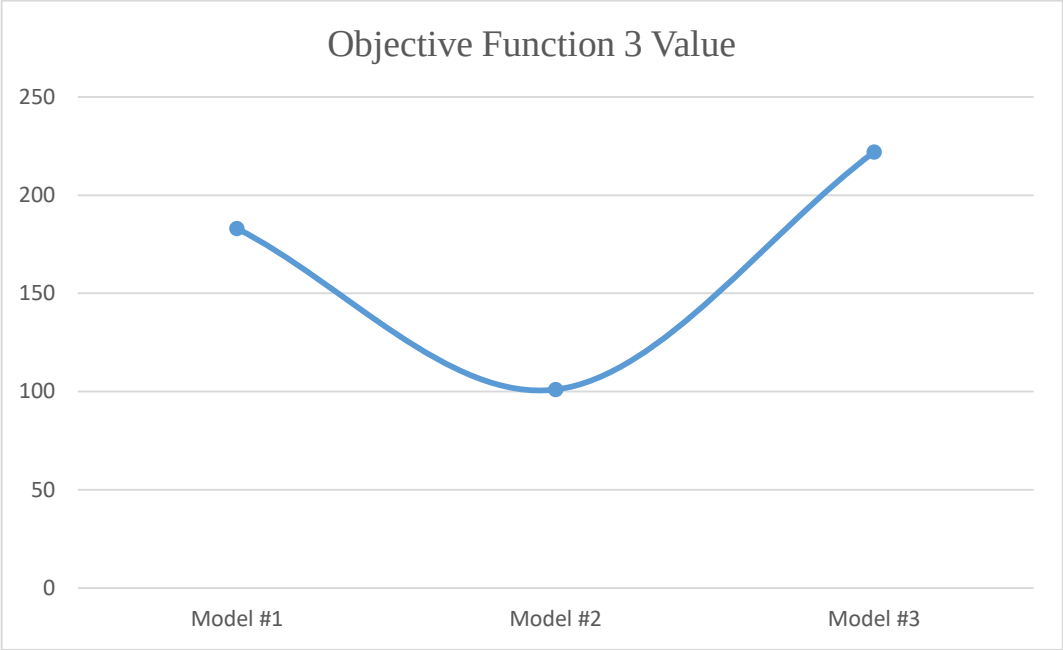

Figure 5.21. Objective Function 3 Values of the New Project #3

Table. 5.19. Calculated Cumulative Objective Function Values of New Project #3

	Calculated Cumulative Objective Function Values
Model #1	5.13
Model #2	5.35
Model #3	4.96

As it is seen in the Table 5.19, the maximum valued model is the model #2. After the third project completed, the same operations were carried out for the fourth project. The new project #4's objective function values has shown in Figure 5.22 to Figure 5.24 consecutively and calculated cumulative objective function values has shown in Table 5.20.

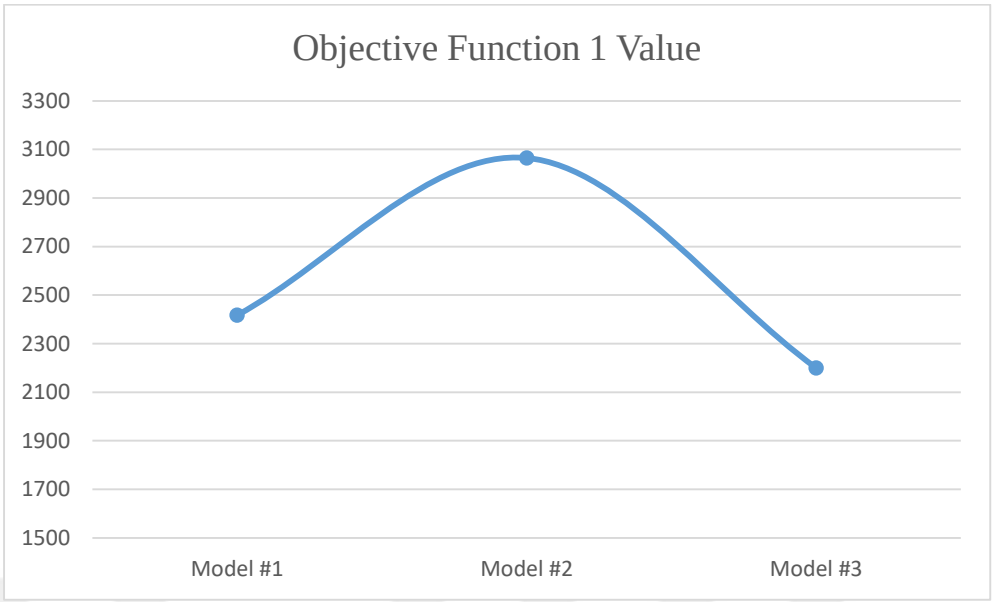

Figure 5.22. Objective Function 1 Values of the New Project #4

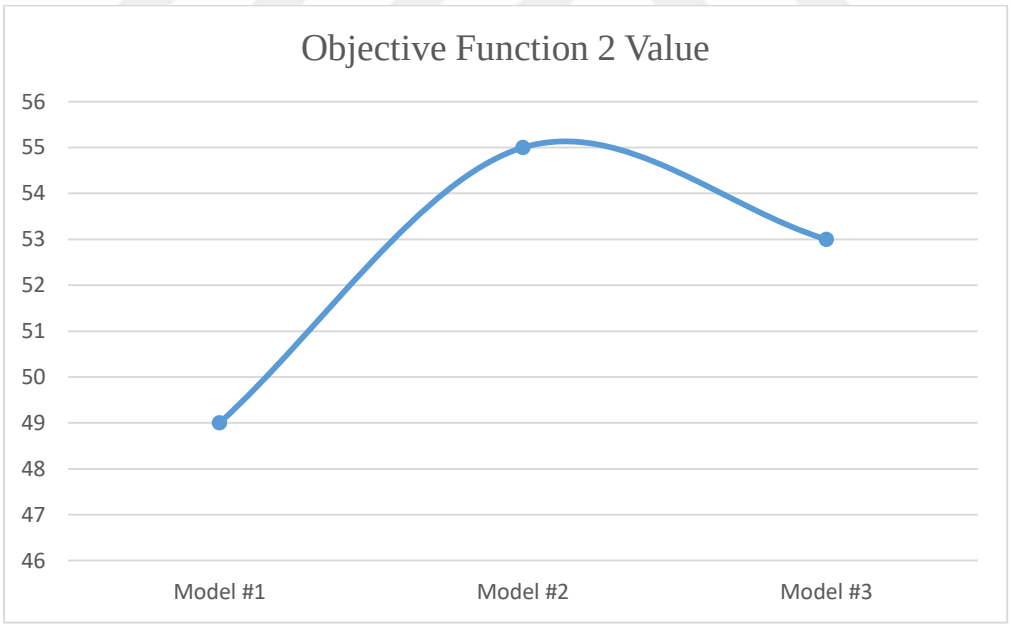

Figure 5.23. Objective Function 2 Values of the New Project #4

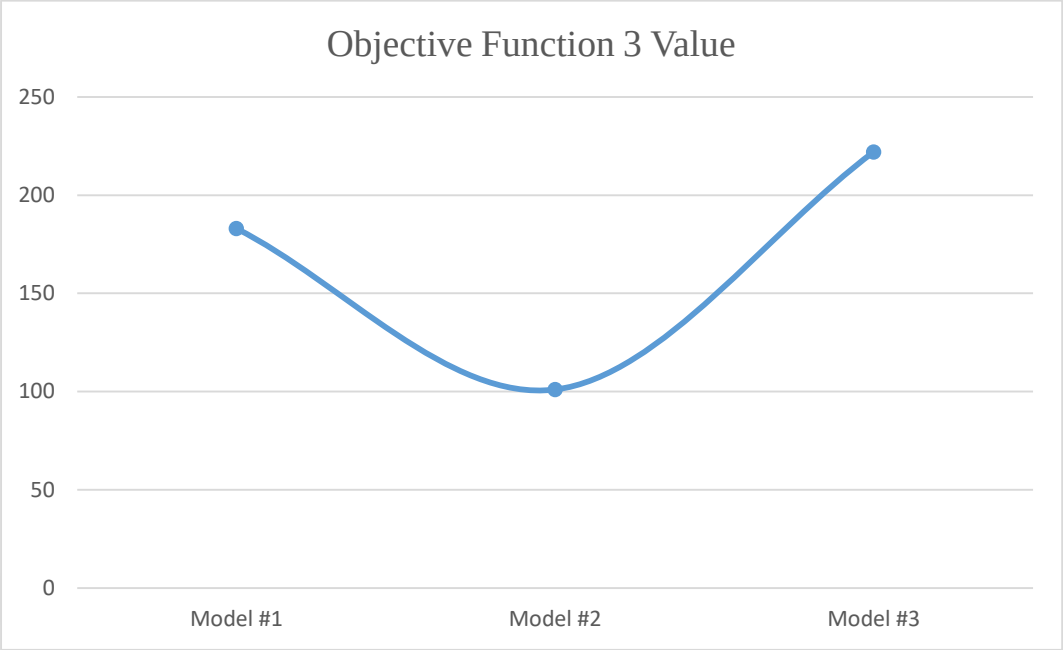

Figure 5.24. Objective Function 3 Values of the New Project #4

Table. 5.20. Calculated Cumulative Objective Function Values of New Project #4

	Calculated Cumulative Objective Function Values
Model #1	5.88
Model #2	3.74
Model #3	5.24

As it is seen in the Table 5.20, the maximum valued model is the model #1. After the fourth project completed, the same operations were carried out for the fifth project. The new project #5's objective function values has shown in Figure 5.25 to Figure 5.27 consecutively and calculated cumulative objective function values has shown in Table 5.21.

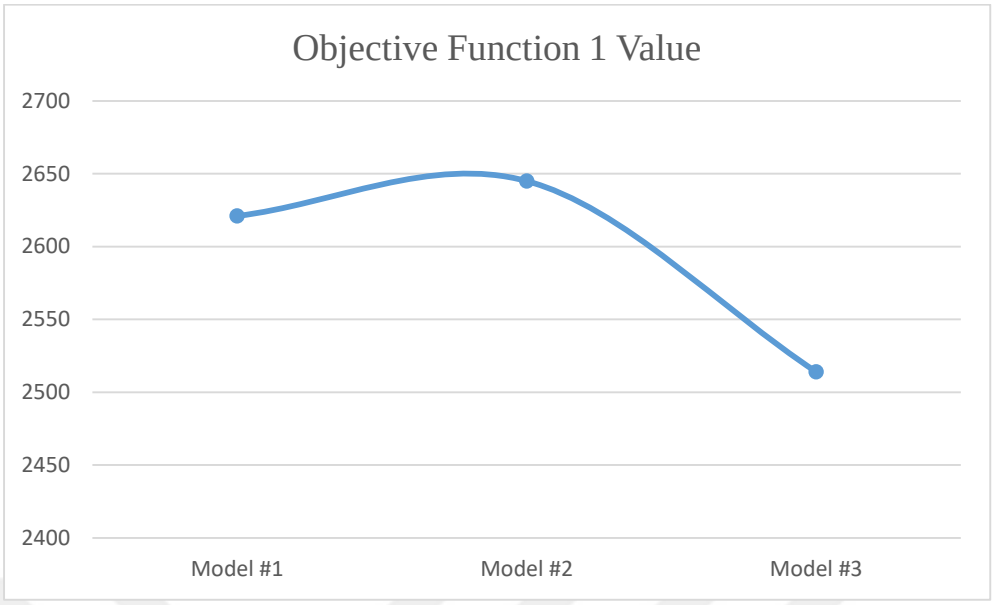

Figure 5.25. Objective Function 1 Values of the New Project #5

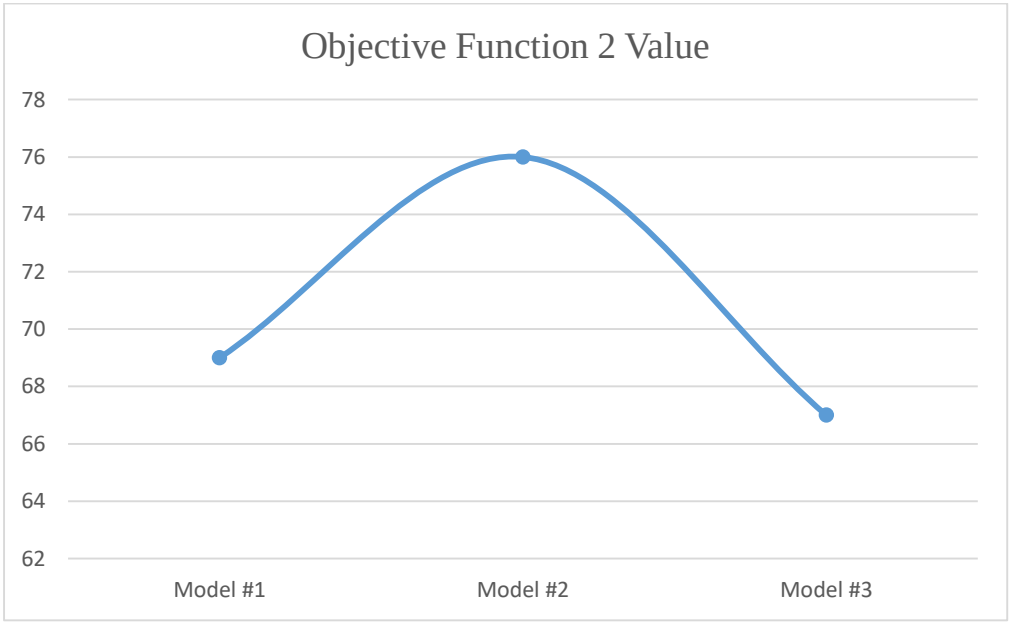

Figure 5.26. Objective Function 2 Values of the New Project #5

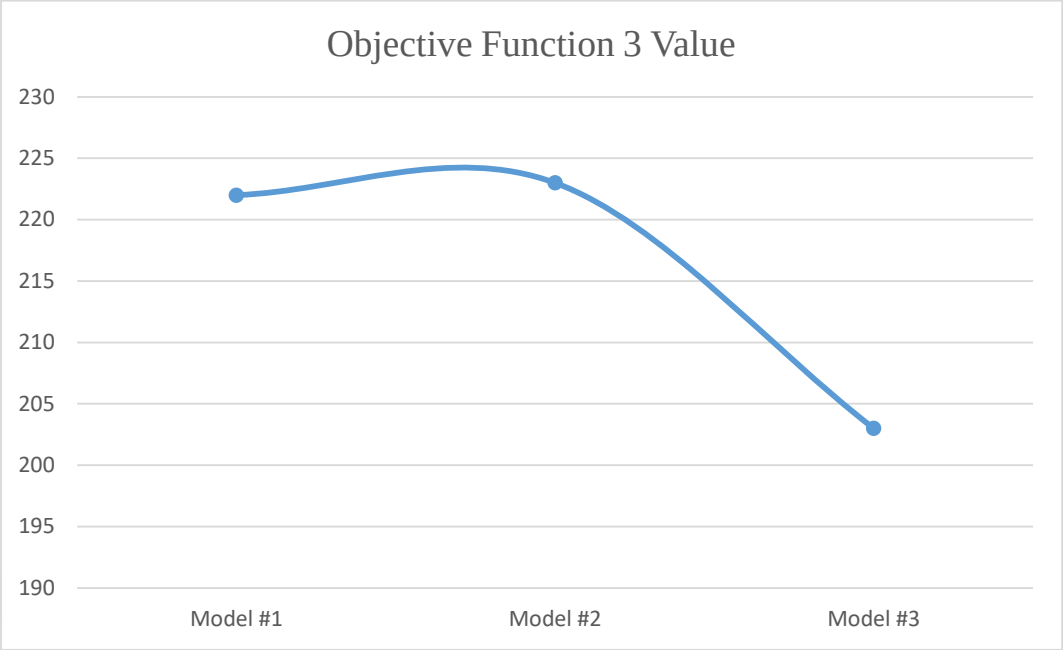

Figure 5.27. Objective Function 3 Values of the New Project #5

Table. 5.21. Calculated Cumulative Objective Function Values of New Project #5

	Calculated Cumulative Objective Function Values
Model #1	4.50
Model #2	4.24
Model #3	4.64

As it is seen in the Table 5.21, the maximum valued model is the model #3. After the fifth project completed, the same operations were carried out for the sixth project. The new project #6's objective function values has shown in Figure 5.28 to Figure 5.30 consecutively and calculated cumulative objective function values has shown in Table 5.22.

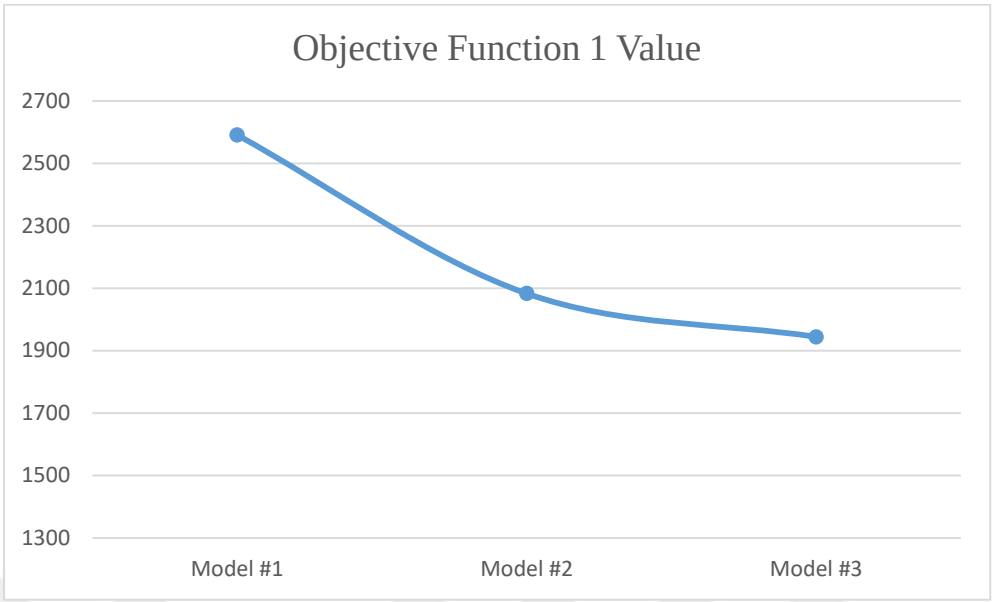

Figure 5.28. Objective Function 1 Values of the New Project #6

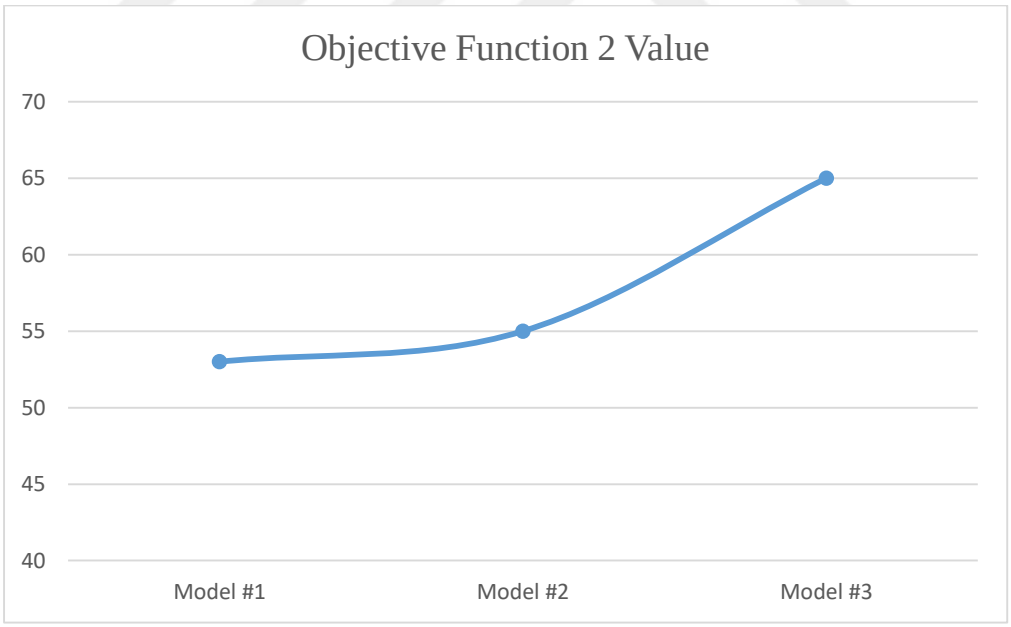

Figure 5.29. Objective Function 2 Values of the New Project #6

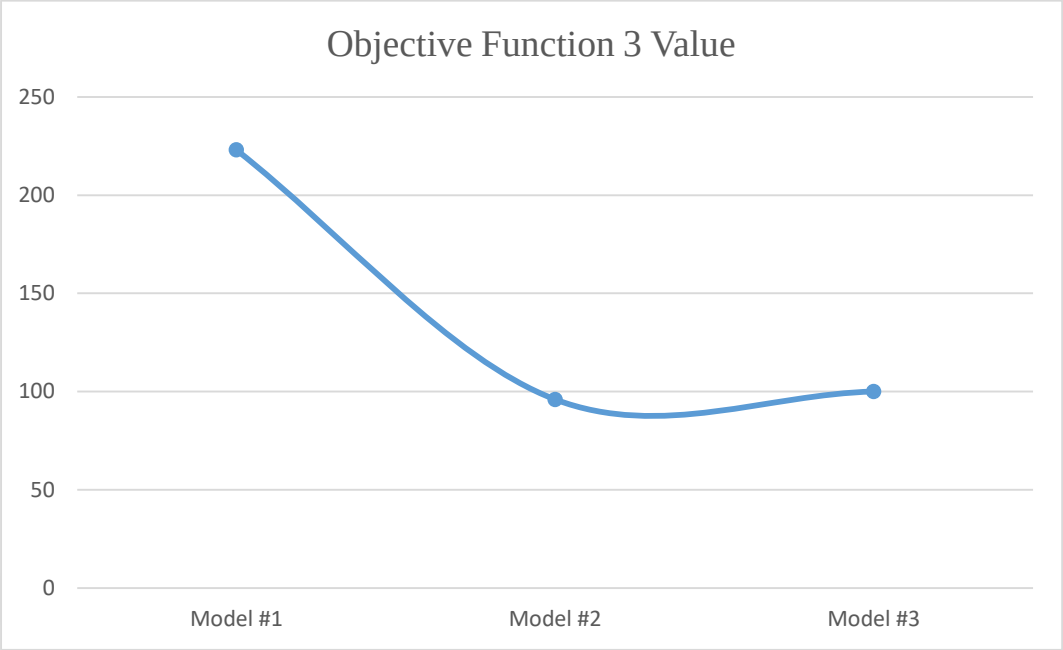

Figure 5.30. Objective Function 3 Values of the New Project #6

Table. 5.22. Calculated Cumulative Objective Function Values of New Project #6

	Calculated Cumulative Objective Function Values
Model #1	5.06
Model #2	5.00
Model #3	5.09

As it is seen in the Table 5.22, the maximum valued model is the model #3. After the sixth project completed, the same operations were carried out for the seventh project. The new project #7's objective function values has shown in Figure 5.31 to Figure 5.33 consecutively and calculated cumulative objective function values has shown in Table 5.23.

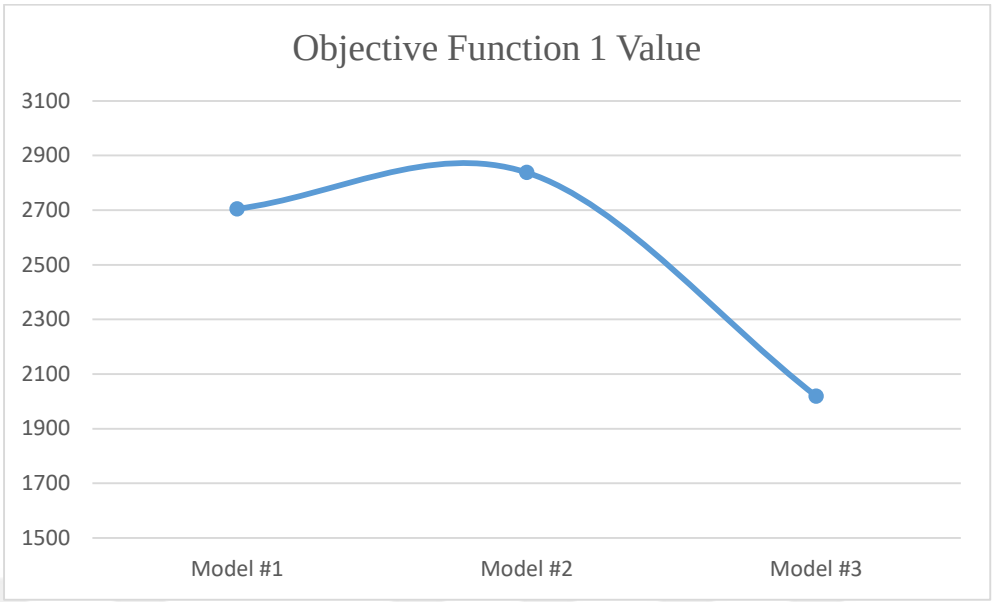

Figure 5.31. Objective Function 1 Values of the New Project #7

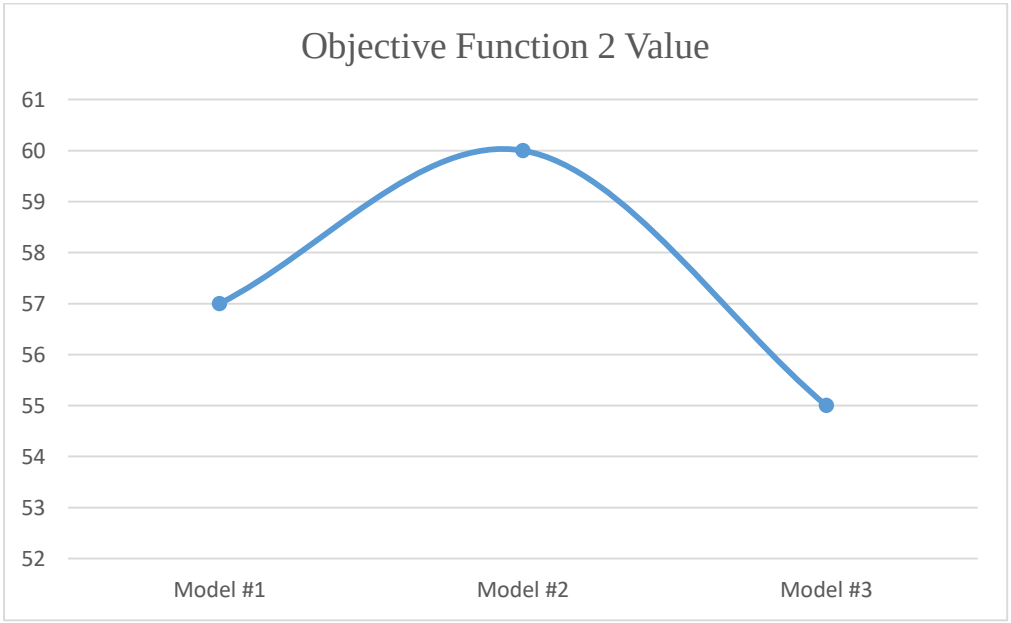

Figure 5.32. Objective Function 2 Values of the New Project #7

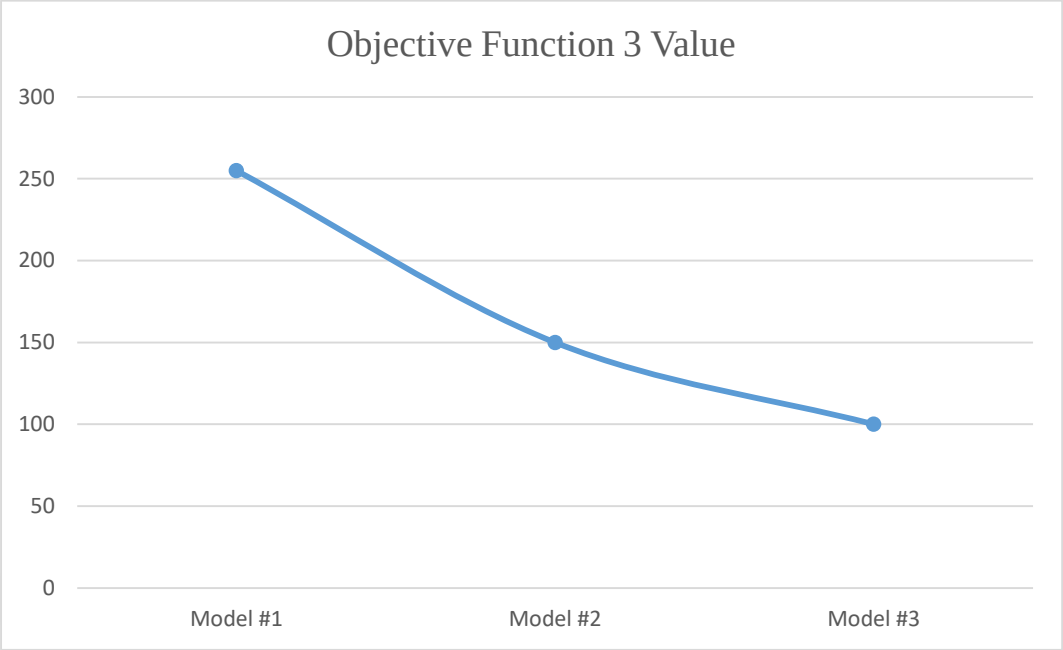

Figure 5.33. Objective Function 3 Values of the New Project #7

Table. 5.23. Calculated Cumulative Objective Function Values of New Project #7

	Calculated Cumulative Objective Function Values
Model #1	4.98
Model #2	3.51
Model #3	5.20

As it is seen in the Table 5.23, the maximum valued model is the model #3. After the seventh project completed, the same operations were carried out for the eighth project. The new project #8's objective function values has shown in Figure 5.34 to Figure 5.36 consecutively and calculated cumulative objective function values has shown in Table 5.24.

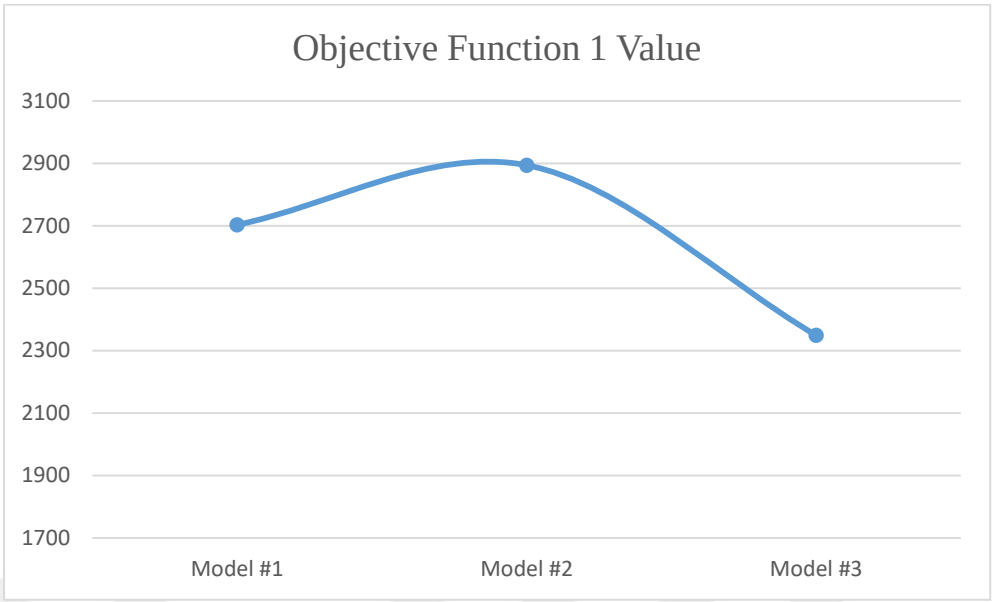

Figure 5.34. Objective Function 1 Values of the New Project #8

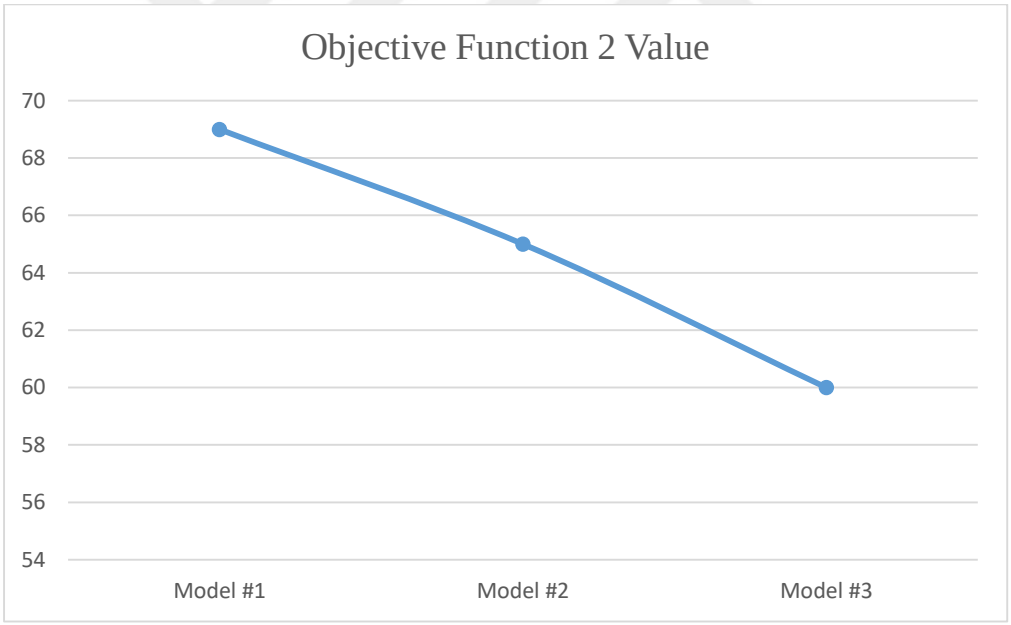

Figure 5.35. Objective Function 2 Values of the New Project #8

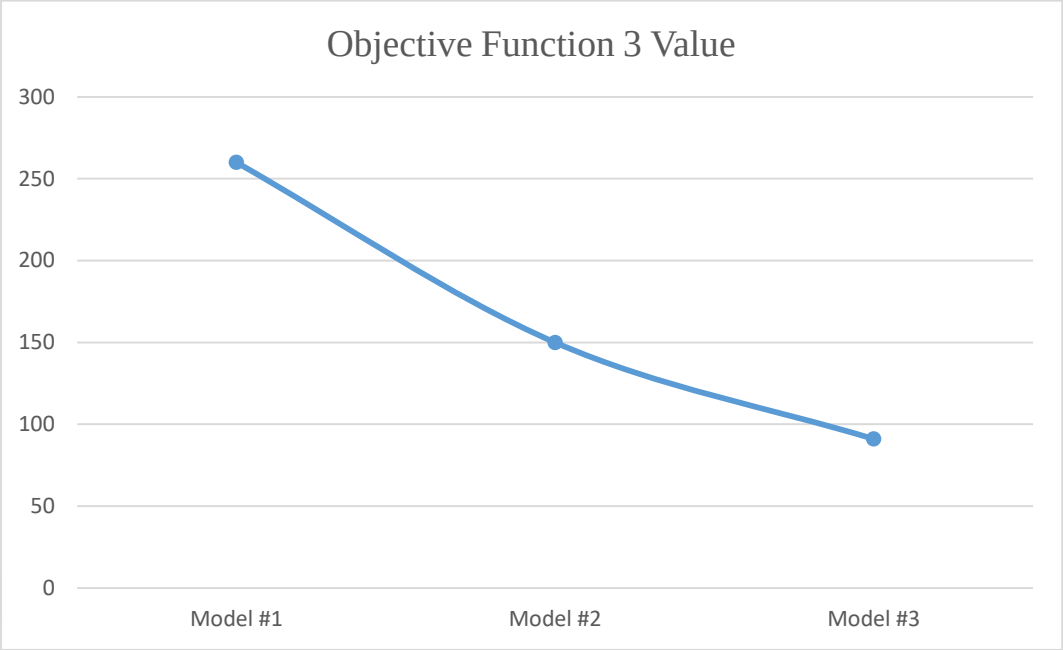

Figure 5.36. Objective Function 3 Values of the New Project #8

Table. 5.24. Calculated Cumulative Objective Function Values of New Project #8

	Calculated Cumulative Objective Function Values
Model #1	4.67
Model #2	3.22
Model #3	4.14

As it is seen in the Table 5.24, the maximum valued model is the model #1. After the eighth project completed, the same operations were carried out for the nineth project. The new project #9's objective function values has shown in Figure 5.37 to Figure 5.39 consecutively and calculated cumulative objective function values has shown in Table 5.25.

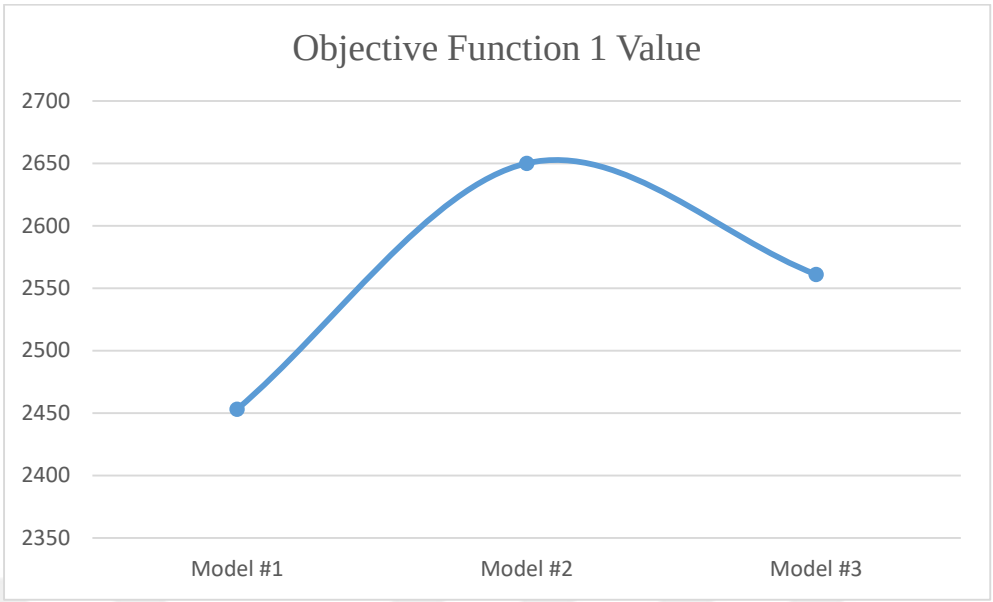

Figure 5.37. Objective Function 1 Values of the New Project #9

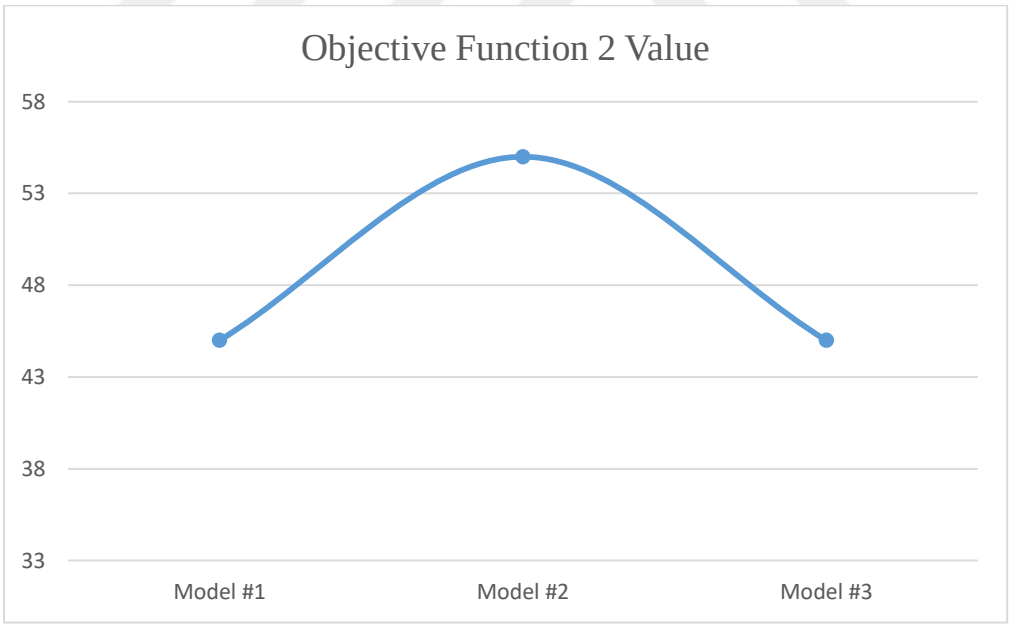

Figure 5.38. Objective Function 2 Values of the New Project #9

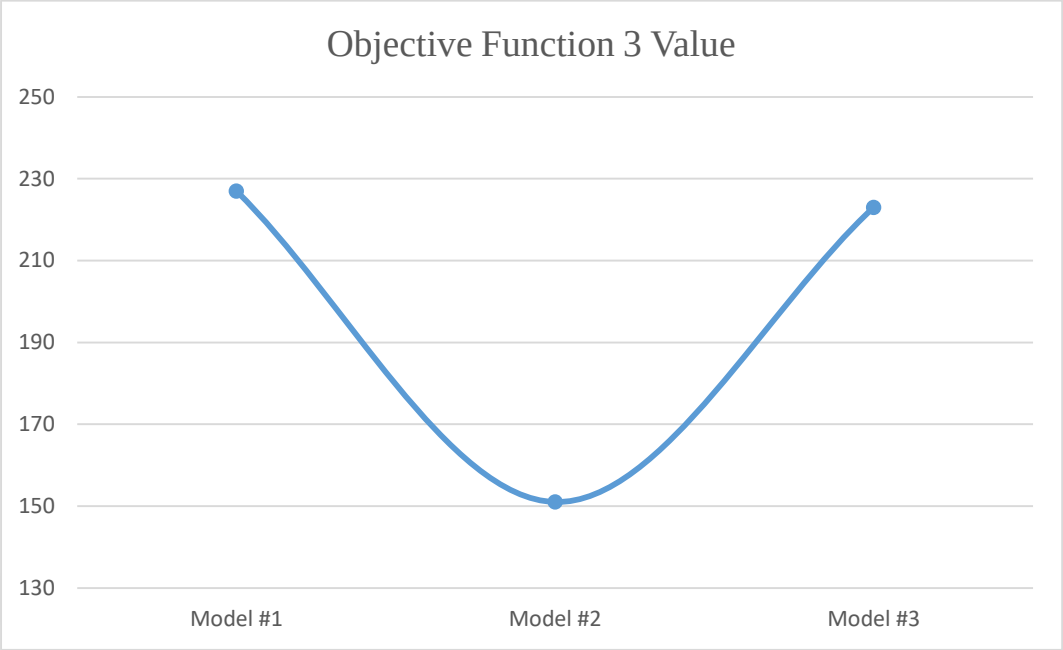

Figure 5.39. Objective Function 3 Values of the New Project #9

Table. 5.25. Calculated Cumulative Objective Function Values of New Project #9

	Calculated Cumulative Objective Function Values
Model #1	5.69
Model #2	4.14
Model #3	5.38

As it is seen in the Table 5.25, the maximum valued model is the model #1. After the nineth project completed, the same operations were carried out for the tenth project. The new project #10's objective function values has shown in Figure 5.40 to Figure 5.42 consecutively and calculated cumulative objective function values has shown in Table 5.26.

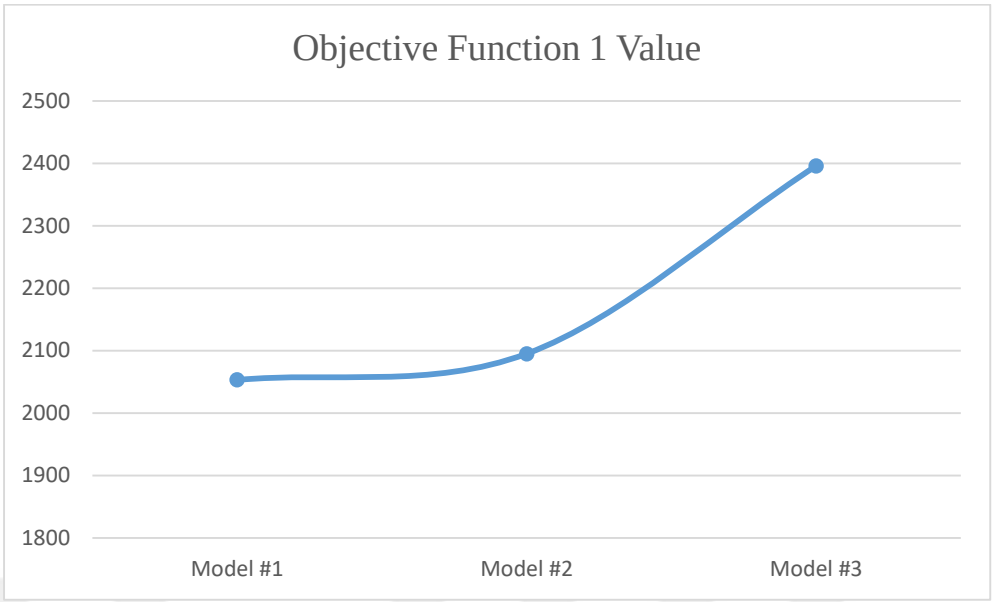

Figure 5.40. Objective Function 1 Values of the New Project #10

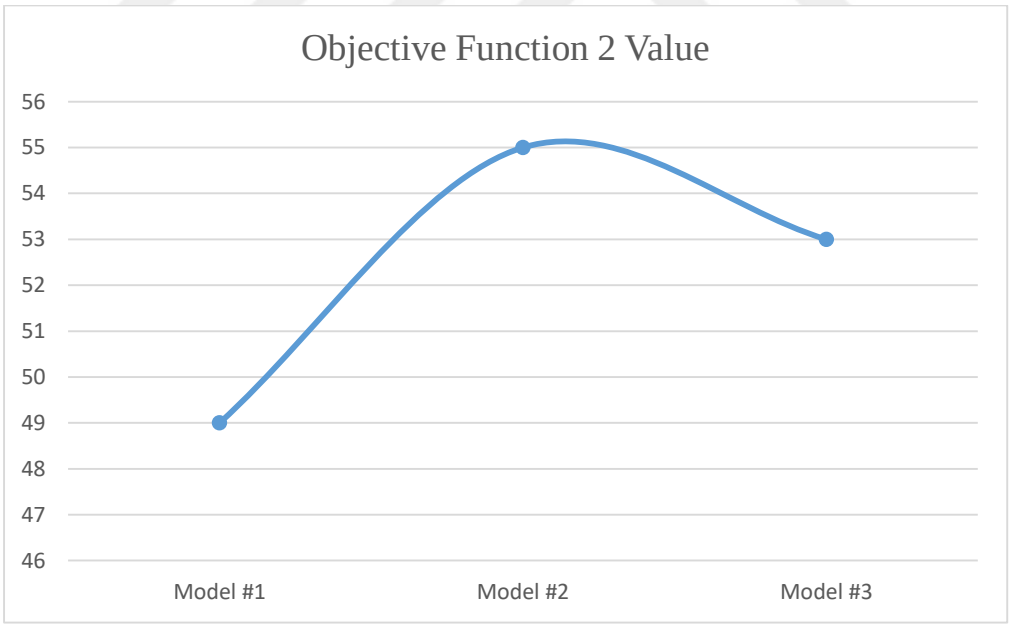

Figure 5.41. Objective Function 2 Values of the New Project #10

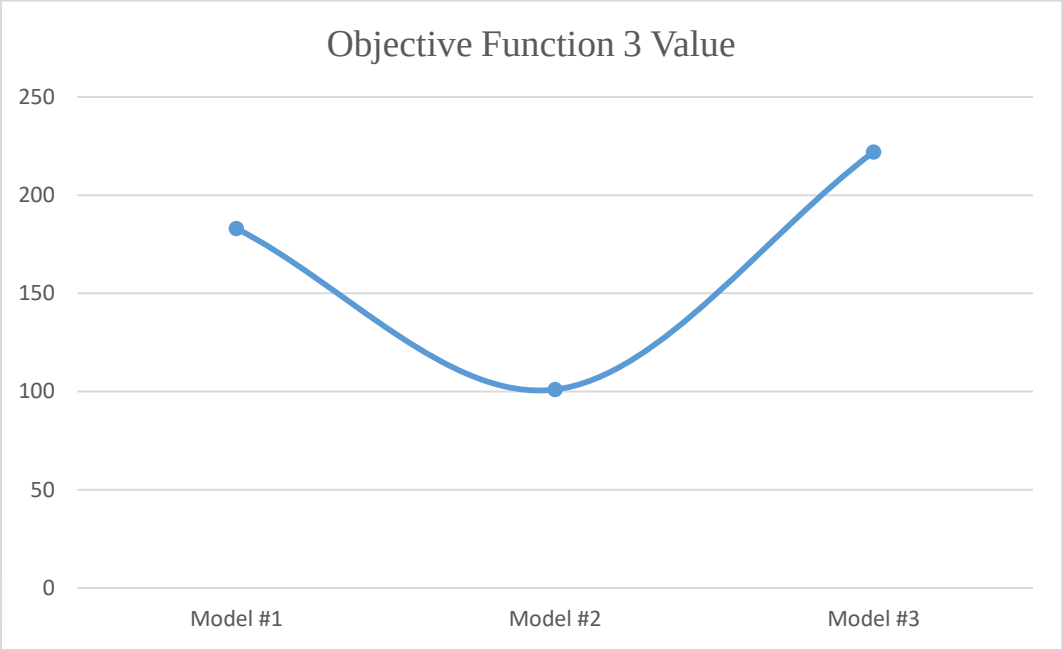

Figure 5.42. Objective Function 3 Values of the New Project #10

Table. 5.26. Calculated Cumulative Objective Function Values of New Project #10

	Calculated Cumulative Objective Function Values
Model #1	6.13
Model #2	5.02
Model #3	5.54

As it is seen in the Table 5.26, the maximum valued model is the model #1. After the tenth project completed, the whole solving process was completed. Thus, we have proved effectiveness of our model in other projects.

6. CONCLUSION

One of the essential business fields in today's world is Software Engineering. From Social Media to Education, from military to economics, almost all sectors are using Software Engineering products. The fact that it is used in almost all business fields increases the need for software products. The complexity of software development processes is another important reality. Therefore, the project management methodology used in software development is vital.

Project management approaches play a vital role in the success of projects. Old methodologies like waterfall approach have some problems in meeting customer needs, managing changes in project scope, delivery time and cost effectively. Due to the problems related to the old project management methodologies, agile project management in software engineering projects has become popular in the last years especially scrum and kanban.

Increasing customer experience is one of the fundamental aspects of kanban as all the other agile methodologies; it is even more important than contract negotiations, as stated in the previous sections. In almost all of the agile methodologies, a project is split into functionalities, labelled as user stories. Putting these stories in an order secures the completion of the project successfully. Various factors have effects on the excellence of a story plan, such as business value, complexity and affinity of the stories which are processed together.

Story planning has a significant impact on increasing the customer experience. Additionally, it secures the completion of the project successfully. Various factors have effects on the perfection of a story plan, such as business value, complexity and affinity of the stories which are processed together. Team members perform story planning based on their experience by default. We proposed a multi-objective integer linear programming model to find a story plan considering business value, complexity and user experience. We used the ε-constraint method for dealing with the multi-objective problem effectively. We solved the problem by using a general-purpose MIP solver. The process took approximately 2 hours. Although this time is much, the

process can be consent since it runs only one at the beginning of the project. Then, to proving effectiveness of our model in other projects, we changed story number, priority, risk and affinity values of our project, and created 10 new projects. We solved all new problem by using a general-purpose MIP solver. The whole process took approximately 2 days for creating ten new projects plans. Heuristics or meta-heuristics approaches can be considered for reducing solving process's elapsed time in future studies.

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APPENDIX A: GAMS CODES OF PROPOSED MODEL

```
Set
   i 'stories' / 1*21 /
   t 'time intervals'          / 1*100 /
   g 'affinity groups'         / 1*3 /;
 Alias (t, tt) ;
 Alias (t, k) ;
 Alias (i, ii) ;
 Alias (i, iii) ;
Parameters
      Z(i)  required work for story i
       /      1       125
              2       150
              3       70
              4       55
              5       130
              6       80
              7       95
              8       130
              9       65
              10      80
              11      90
              12      50
              13      60
              14      125
              15      95
              16      120
              17      75
              18      100
```

19 110

20 80

21 75 /

r(i) risk of story i

/ 1 0.6

2 0.4

3 0.5

4 0.2

5 0.6

6 0.1

7 0.2

8 0.2

9 0.2

10 0.4

11 0.3

12 0.3

13 0.3

14 0.3

15 0.2

16 0.6

17 0.5

18 0.3

19 0.2

20 0.1

21 0.2 /

p(i) priority degree of story i

/ 1 0.5

2 0.3

3 0.5

4 0.4

5 0.2

```
        6       0.4
        7       0.7
        8       0.3
        9       0.4
        10      0.5
        11      0.6
        12      0.2
        13      0.2
        14      0.1
        15      0.3
        16      0.5
        17      0.5
        18      0.4
        19      0.3
        20      0.2
        21      0.4   /
    a(g)  affinity of group g
    /   1    5
        2    4
        3    6   /
    cg(g)  count table  of affinity
    /   1    3
        2    2
        3    3  /
    www(t)  reduced work list;
```

Table ag(i,g) affinity group table

	1	2	3
1	0	0	0
2	1	0	0
3	0	0	0

4	0	0	0
5	0	0	0
6	0	0	1
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	1	0	0
13	0	0	0
14	0	0	0
15	1	0	0
16	0	0	0
17	0	0	0
18	0	1	0
19	0	1	0
20	0	0	1
21	0	0	1;

Table prr(i,i) prereq table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

6 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0
0 0 0 0 0
7 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0
0 0 0 0 0
8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
13 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
14 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
16 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
17 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 1 0 0
21 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0;

```
Scalar c  cap of each time interval  /24/
     rmax  risk limit  /2/
     M  buyuk sayi  /10000/
     w  wip limit  /3/  ;

Free Variable s1;
Free Variable zti;
Free Variable s2;
Free Variable s3;
Free Variable sr;
Free Variable wi;
Positive variable xplus(i,t), xneg(i,t);
Free Variable rdwrk;
Free Variable rsk;
integer Variable x;
integer Variable bas(i);
integer Variable s;
x.up(i,t)   =  1  ;
x.lo(i,t)   =  0  ;
s.lo(i,t)   =  0  ;
bas.lo(i)   =  0 ;
Equations
    obj1       define objective function
    obj2       define objective function
    obj3       affinity objective function
    obj_real   define objective function
    obj_real2  define objective function
    obj_real3  define objective function
    cons_rlt(i,t)   absolute constraint
    cons_rlt2(i,t)  absolute constraint
    zit(i,t)   remaining work for all stories on all time intervals
```

```
    prereq(i,t)     prereq cons
    cons_abs(i,t)    absolute constraint
    fin(i)      all stories must be finish
    wlim(t)      all stories must be finish
    wip(t)    work in progrss limit of all time intervals  ;
obj1 ..       s1  =e=  sum((t,i), (p(i) + r(i)) * t.val * x(i,t)) ;
obj2 ..       s2  =e=  sum((t,i), (p(i)  * (xplus(i,t+1) + xneg(i,t)))) ;
obj3 ..       s3  =e=  sum((t,g), (sum(ii$(ag(ii,g) eq 1),x(ii,t)) * a(g) / cg(g) )) ;
obj_real ..    sr  =e=   s1 ;
obj_real2 ..    s2  =l=   57 ;
obj_real3 ..    s3  =g=   75 ;
cons_rlt(i,t) ..   M * x(i,t) =g= s(i,t) ;
cons_rlt2(i,t) ..   M * s(i,t) =g= x(i,t) ;
zit(i,t) ..     zti(i,t) =e=  Z(i) - sum(tt$(ord(tt) le t.val-1), s(i,tt));
prereq(i,t)..  M * (1 - x(i,t)) =g= sum(iii$(prr(i,iii) eq 1),zti(iii,t))  ;
cons_abs(i,t)..  x(i,t+1) - x(i,t) =e=  xplus(i,t+1) - xneg(i,t);
fin(i) ..   sum(t, s(i,t) )  =e=  Z(i) ;
wlim(t) ..  sum(i, s(i,t) )  =l=  c ;
wip(t) ..   sum(i, x(i,t)) =l= w;
Model transport /all/ ;
Options reslim=360000;
Options MIP = XPRESS;
transport.OptFile = 1;
Solve transport using MIP minimizing sr ;
```

APPENDIX B: OUTPUTS OF EXECUTION OF REAL PROJECT

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE transport Using MIP From line 189

S O L V E S U M M A R Y

MODEL transport OBJECTIVE sr

TYPE MIP DIRECTION MINIMIZE

SOLVER XPRESS FROM LINE 189

**** SOLVER STATUS 1 Normal Completion

**** MODEL STATUS 8 Integer Solution

**** OBJECTIVE VALUE 1433.9000

RESOURCE USAGE, LIMIT 466.508 360000.000

ITERATION COUNT, LIMIT 863713 2000000000

FICO-Xpress Aug 18, 2010 23.5.2 WEX 19143.19383 WEI x86_64/MS Windows

Xpress Optimizer 20.00

Xpress-MP licensed by Fair Isaac Corporation to GAMS Development Corp. for GAMS

Type of presolve applied: MIP presolve.

LP relaxation solved: objective = 1247.69

calling chgbnds (4200,idx,type,bnds)

fixing discrete vars and re-solving as an LP.

?140 Warning: Basis lost - recovering

fixed LP solved successfully, objective = 1433.9.

Integer solution satisfies relative optimality tolerance of 0.1.

MIP solution : 1433.900000

Best possible : 1307.043189

Absolute gap : 126.856811 optca : 0.000000

Relative gap : 0.097056 optcr : 0.100000

LOWER LEVEL UPPER MARGINAL

---- EQU obj1 . . . 1.000

---- EQU obj2 . . . EPS

---- EQU obj3 . . . EPS

---- EQU obj_real . . . 1.000

---- EQU obj_real2 -INF 2300.000 2300.000 EPS

---- EQU obj_real3 400.000 523.333 +INF .

obj1 define objective function

obj2 define objective function

obj3 affinity objective function

obj_real define objective function

obj_real2 define objective function

obj_real3 define objective function

---- VAR s

LOWER LEVEL UPPER MARGINAL

1 .1 . 10.000 +INF EPS

1 .2 . . +INF EPS

1 .3 . 20.000 +INF EPS

1 .4 . 10.000 +INF EPS

1 .5 . . +INF EPS

1 .6 . 25.000 +INF EPS

1 .7 . . +INF 7.7000E-4

1 .8 . 30.000 +INF EPS

1 .9 . . +INF EPS

1 .10 . . +INF EPS

1 .11 . . +INF EPS

1 .12 . 30.000 +INF EPS

1 .13 . . +INF 0.001

1 .14 . . +INF 0.002

1 .15 . . +INF EPS

1 .16 . . +INF EPS

1 .17 . . +INF EPS

1 .18 . . +INF EPS

1 .19 . . +INF EPS

1 .20 . . +INF 0.002

1 .21 . . +INF 0.002

1 .22 . . +INF EPS

1 .23 . . +INF 0.003

1 .24 . . +INF 0.003

1 .25 . . +INF 0.003

1 .26 . . +INF EPS

1 .27 . . +INF EPS

1 .28 . . +INF EPS

1 .29 . . +INF EPS

1 .30 . . +INF EPS

1 .31 . . +INF EPS

1 .32 . . +INF EPS

1 .33 . . +INF EPS

1 .34 . . +INF EPS

1 .35 . . +INF EPS

1 .36 . . +INF EPS

1 .37 . . +INF EPS

1 .38 . . +INF EPS

1 .39 . . +INF EPS

1 .40 . . +INF EPS

1 .41 . . +INF EPS

1 .42 . . +INF EPS

1 .43 . . +INF EPS

1 .44 . . +INF EPS

1 .45 . . +INF EPS

1 .46 . . +INF EPS

1 .47 . . +INF EPS

1 .48 . . +INF EPS

1 .49 . . +INF EPS

1 .50 . . +INF EPS

1 .51 . . +INF EPS

1 .52 . . +INF EPS

1 .53 . . +INF EPS

1 .54 . . +INF EPS

1 .55 . . +INF EPS

1 .56 . . +INF EPS

1 .57 . . +INF EPS

1 .58 . . +INF EPS

1 .59 . . +INF EPS

1 .60 . . +INF EPS

1 .61 . . +INF EPS

1 .62 . . +INF EPS

1 .63 . . +INF EPS

1 .64 . . +INF EPS

1 .65 . . +INF EPS

1 .66 . . +INF EPS

1 .67 . . +INF EPS

1 .68 . . +INF EPS

1 .69 . . +INF EPS

1 .70 . . +INF EPS

1 .71 . . +INF EPS

1 .72 . . +INF EPS

1 .73 . . +INF EPS

1 .74 . . +INF EPS

1 .75 . . +INF EPS

1 .76 . . +INF EPS

1 .77 . . +INF EPS

1 .78 . . +INF EPS

1 .79 . . +INF EPS

1 .80 . . +INF EPS

1 .81 . . +INF EPS

1 .82 . . +INF EPS

1 .83 . . +INF EPS

1 .84 . . +INF EPS

1 .85 . . +INF EPS

1 .86 . . +INF EPS

1 .87 . . +INF EPS

1 .88 . . +INF EPS

1 .89 . . +INF EPS

1 .90 . . +INF EPS

1 .91 . . +INF EPS

1 .92 . . +INF EPS

1 .93 . . +INF EPS

1 .94 . . +INF EPS

1 .95 . . +INF EPS

1 .96 . . +INF EPS

1 .97 . . +INF EPS

1 .98 . . +INF EPS

1 .99 . . +INF EPS

1 .100 . . +INF EPS

2 .1 . . +INF EPS

2 .2 . . +INF EPS

2 .3 . . +INF 2.1000E-4

2 .4 . . +INF EPS

2 .5 . . +INF EPS

2 .6 . . +INF EPS

2 .7 . . +INF EPS

2 .8 . . +INF 5.6000E-4

2 .9 . 30.000 +INF EPS

2 .10 . . +INF EPS

2 .11 . 30.000 +INF EPS

2 .12 . . +INF 8.4000E-4

2 .13 . 30.000 +INF EPS

2 .14 . . +INF 9.8000E-4

2 .15 . . +INF EPS

2 .16 . . +INF EPS

2 .17 . . +INF 0.001

2 .18 . . +INF 0.001

2 .19 . . +INF EPS

2 .20 . . +INF 0.001

2 .21 . . +INF EPS

2 .22 . . +INF 0.002

2 .23 . . +INF 0.002

2 .24 . 30.000 +INF EPS

2 .25 . . +INF 0.002

2 .26 . 30.000 +INF EPS

2 .27 . . +INF 0.002

2 .28 . . +INF 0.002

2 .29 . . +INF 0.002

2 .30 . . +INF 0.002

2 .31 . . +INF EPS

2 .32 . . +INF EPS

2 .33	.	.	+INF	0.002
2 .34	.	.	+INF	0.002
2 .35	.	.	+INF	EPS
2 .36	.	.	+INF	EPS
2 .37	.	.	+INF	EPS
2 .38	.	.	+INF	0.003
2 .39	.	.	+INF	0.003
2 .40	.	.	+INF	EPS
2 .41	.	.	+INF	EPS
2 .42	.	.	+INF	EPS
2 .43	.	.	+INF	EPS
2 .44	.	.	+INF	EPS
2 .45	.	.	+INF	EPS
2 .46	.	.	+INF	EPS
2 .47	.	.	+INF	EPS
2 .48	.	.	+INF	EPS
2 .49	.	.	+INF	EPS
2 .50	.	.	+INF	EPS
2 .51	.	.	+INF	EPS
2 .52	.	.	+INF	EPS
2 .53	.	.	+INF	EPS
2 .54	.	.	+INF	EPS
2 .55	.	.	+INF	EPS
2 .56	.	.	+INF	EPS
2 .57	.	.	+INF	EPS
2 .58	.	.	+INF	EPS
2 .59	.	.	+INF	EPS
2 .60	.	.	+INF	EPS
2 .61	.	.	+INF	EPS
2 .62	.	.	+INF	EPS
2 .63	.	.	+INF	EPS
2 .64	.	.	+INF	EPS

2 .65 . . +INF EPS

2 .66 . . +INF EPS

2 .67 . . +INF EPS

2 .68 . . +INF EPS

2 .69 . . +INF EPS

2 .70 . . +INF EPS

2 .71 . . +INF EPS

2 .72 . . +INF EPS

2 .73 . . +INF EPS

2 .74 . . +INF EPS

2 .75 . . +INF EPS

2 .76 . . +INF EPS

2 .77 . . +INF EPS

2 .78 . . +INF EPS

2 .79 . . +INF EPS

2 .80 . . +INF EPS

2 .81 . . +INF EPS

2 .82 . . +INF EPS

2 .83 . . +INF EPS

2 .84 . . +INF EPS

2 .85 . . +INF EPS

2 .86 . . +INF EPS

2 .87 . . +INF EPS

2 .88 . . +INF EPS

2 .89 . . +INF EPS

2 .90 . . +INF EPS

2 .91 . . +INF EPS

2 .92 . . +INF EPS

2 .93 . . +INF EPS

2 .94 . . +INF EPS

2 .95 . . +INF EPS

2 .96 . . +INF EPS

2 .97 . . +INF EPS

2 .98 . . +INF EPS

2 .99 . . +INF EPS

2 .100 . . +INF EPS

3 .1 . 1.000 +INF EPS

3 .2 . 9.000 +INF EPS

3 .3 . . +INF EPS

3 .4 . . +INF EPS

3 .5 . . +INF EPS

3 .6 . . +INF EPS

3 .7 . . +INF EPS

3 .8 . . +INF EPS

3 .9 . . +INF EPS

3 .10 . . +INF 0.001

3 .11 . . +INF EPS

3 .12 . . +INF 0.001

3 .13 . . +INF EPS

3 .14 . 30.000 +INF EPS

3 .15 . . +INF 0.001

3 .16 . . +INF 0.002

3 .17 . . +INF 0.002

3 .18 . . +INF 0.002

3 .19 . 30.000 +INF EPS

3 .20 . . +INF EPS

3 .21 . . +INF 0.002

3 .22 . . +INF EPS

3 .23 . . +INF EPS

3 .24 . . +INF EPS

3 .25 . . +INF 0.002

3 .26 . . +INF 0.003

3 .27 . . +INF EPS

3 .28 . . +INF 0.003

3 .29 . . +INF EPS

3 .30 . . +INF EPS

3 .31 . . +INF EPS

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4 .34 . . +INF EPS

4 .35 . . +INF EPS

4 .36 . . +INF 0.002

4 .37 . . +INF EPS

4 .38 . 25.000 +INF EPS

4 .39 . . +INF 0.002

4 .40 . . +INF 0.002

4 .41 . . +INF EPS

4 .42 . . +INF 0.003

4 .43 . . +INF 0.003

4 .44 . . +INF EPS

4 .45 . . +INF EPS

4 .46 . . +INF 0.003

4 .47 . 30.000 +INF EPS

4 .48 . . +INF EPS

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4 .100 . . +INF EPS

5 .1 . . +INF EPS

5 .2 . . +INF EPS

5 .3 . 10.000 +INF EPS

5 .4 . . +INF EPS

5 .5 . . +INF EPS

5 .6 . . +INF EPS

5 .7 . . +INF EPS

5 .8 . . +INF 6.4000E-4

5 .9 . . +INF 7.2000E-4

5 .10 . . +INF EPS

5 .11 . . +INF EPS

5 .12 . . +INF EPS

5 .13 . . +INF 0.001

5 .14 . . +INF EPS

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5 .19 . . +INF EPS

5 .20 . . +INF EPS

5 .21 . . +INF 0.002

5 .22 . . +INF EPS

5 .23 . 30.000 +INF EPS

5 .24 . . +INF EPS

5 .25 . . +INF 0.002

5 .26 . . +INF 0.002

5 .27 . . +INF 0.002

5 .28 . . +INF 0.002

5 .29 . . +INF 0.002

5 .30 . . +INF 0.002

5 .31 . 30.000 +INF EPS

5 .32 . . +INF 0.003

5 .33 . . +INF 0.003

5 .34 . 30.000 +INF EPS

5 .35 . . +INF 0.003

5 .36 . . +INF 0.003

5 .37 . 30.000 +INF EPS

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5 .57	.	.	+INF	EPS
5 .58	.	.	+INF	EPS
5 .59	.	.	+INF	EPS
5 .60	.	.	+INF	EPS
5 .61	.	.	+INF	EPS
5 .62	.	.	+INF	EPS
5 .63	.	.	+INF	EPS
5 .64	.	.	+INF	EPS
5 .65	.	.	+INF	EPS
5 .66	.	.	+INF	EPS
5 .67	.	.	+INF	EPS
5 .68	.	.	+INF	EPS
5 .69	.	.	+INF	EPS
5 .70	.	.	+INF	EPS
5 .71	.	.	+INF	EPS
5 .72	.	.	+INF	EPS
5 .73	.	.	+INF	EPS
5 .74	.	.	+INF	EPS
5 .75	.	.	+INF	EPS
5 .76	.	.	+INF	EPS
5 .77	.	.	+INF	EPS
5 .78	.	.	+INF	EPS
5 .79	.	.	+INF	EPS
5 .80	.	.	+INF	EPS
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6 .18	.	.	+INF	EPS
6 .19	.	.	+INF	EPS
6 .20	.	.	+INF	EPS
6 .21	.	.	+INF	EPS
6 .22	.	.	+INF	EPS
6 .23	.	.	+INF	EPS
6 .24	.	.	+INF	EPS
6 .25	.	.	+INF	EPS
6 .26	.	.	+INF	EPS
6 .27	.	.	+INF	EPS
6 .28	.	.	+INF	EPS
6 .29	.	.	+INF	EPS
6 .30	.	.	+INF	EPS
6 .31	.	.	+INF	EPS
6 .32	.	.	+INF	EPS
6 .33	.	.	+INF	EPS
6 .34	.	.	+INF	EPS
6 .35	.	.	+INF	EPS
6 .36	.	.	+INF	EPS
6 .37	.	.	+INF	EPS
6 .38	.	.	+INF	EPS
6 .39	.	.	+INF	0.002
6 .40	.	.	+INF	EPS
6 .41	.	.	+INF	0.002
6 .42	.	.	+INF	0.002
6 .43	.	.	+INF	EPS
6 .44	.	.	+INF	EPS
6 .45	.	.	+INF	EPS
6 .46	.	.	+INF	0.002
6 .47	.	.	+INF	0.002
6 .48	.	.	+INF	EPS

6 .49	.	.	+INF	0.002
6 .50	.	.	+INF	0.002
6 .51	.	.	+INF	EPS
6 .52	.	.	+INF	0.003
6 .53	.	.	+INF	EPS
6 .54	.	.	+INF	EPS
6 .55	.	30.000	+INF	EPS
6 .56	.	30.000	+INF	EPS
6 .57	.	20.000	+INF	EPS
6 .58	.	.	+INF	EPS
6 .59	.	.	+INF	EPS
6 .60	.	.	+INF	EPS
6 .61	.	.	+INF	EPS
6 .62	.	.	+INF	EPS
6 .63	.	.	+INF	EPS
6 .64	.	.	+INF	EPS
6 .65	.	.	+INF	EPS
6 .66	.	.	+INF	EPS
6 .67	.	.	+INF	EPS
6 .68	.	.	+INF	EPS
6 .69	.	.	+INF	EPS
6 .70	.	.	+INF	EPS
6 .71	.	.	+INF	EPS
6 .72	.	.	+INF	EPS
6 .73	.	.	+INF	EPS
6 .74	.	.	+INF	EPS
6 .75	.	.	+INF	EPS
6 .76	.	.	+INF	EPS
6 .77	.	.	+INF	EPS
6 .78	.	.	+INF	EPS
6 .79	.	.	+INF	EPS
6 .80	.	.	+INF	EPS

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6 .97 . . +INF EPS

6 .98 . . +INF EPS

6 .99 . . +INF EPS

6 .100 . . +INF EPS

7 .1 . . +INF EPS

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7 .4 . . +INF EPS

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7 .8 . . +INF EPS

7 .9 . . +INF EPS

7 .10 . . +INF EPS

7 .11 . . +INF EPS

7 .12 . . +INF EPS

7 .13	.	.	+INF	EPS
7 .14	.	.	+INF	EPS
7 .15	.	.	+INF	EPS
7 .16	.	.	+INF	EPS
7 .17	.	.	+INF	EPS
7 .18	.	.	+INF	EPS
7 .19	.	.	+INF	EPS
7 .20	.	.	+INF	EPS
7 .21	.	.	+INF	EPS
7 .22	.	.	+INF	0.002
7 .23	.	.	+INF	EPS
7 .24	.	.	+INF	0.002
7 .25	.	.	+INF	EPS
7 .26	.	.	+INF	0.002
7 .27	.	.	+INF	EPS
7 .28	.	.	+INF	EPS
7 .29	.	.	+INF	0.003
7 .30	.	30.000	+INF	EPS
7 .31	.	.	+INF	EPS
7 .32	.	5.000	+INF	EPS
7 .33	.	30.000	+INF	EPS
7 .34	.	.	+INF	EPS
7 .35	.	.	+INF	EPS
7 .36	.	.	+INF	0.003
7 .37	.	.	+INF	EPS
7 .38	.	.	+INF	EPS
7 .39	.	30.000	+INF	EPS
7 .40	.	.	+INF	EPS
7 .41	.	.	+INF	EPS
7 .42	.	.	+INF	EPS
7 .43	.	.	+INF	EPS
7 .44	.	.	+INF	EPS

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8 .9	.	.	+INF	EPS
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8 .18	.	.	+INF	EPS
8 .19	.	.	+INF	EPS
8 .20	.	.	+INF	EPS
8 .21	.	.	+INF	EPS
8 .22	.	.	+INF	EPS
8 .23	.	.	+INF	EPS
8 .24	.	.	+INF	EPS
8 .25	.	30.000	+INF	EPS
8 .26	.	.	+INF	0.001
8 .27	.	.	+INF	0.001
8 .28	.	.	+INF	EPS
8 .29	.	.	+INF	EPS
8 .30	.	.	+INF	EPS
8 .31	.	.	+INF	EPS
8 .32	.	.	+INF	0.002
8 .33	.	.	+INF	0.002
8 .34	.	.	+INF	EPS
8 .35	.	.	+INF	EPS
8 .36	.	.	+INF	EPS
8 .37	.	.	+INF	EPS
8 .38	.	.	+INF	EPS
8 .39	.	.	+INF	EPS
8 .40	.	.	+INF	0.002

8 .41 . . +INF 0.002

8 .42 . 10.000 +INF EPS

8 .43 . . +INF 0.002

8 .44 . . +INF 0.002

8 .45 . 30.000 +INF EPS

8 .46 . . +INF EPS

8 .47 . . +INF EPS

8 .48 . 30.000 +INF EPS

8 .49 . . +INF EPS

8 .50 . . +INF EPS

8 .51 . . +INF 0.003

8 .52 . . +INF 0.003

8 .53 . 30.000 +INF EPS

8 .54 . . +INF 0.003

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8 .57 . . +INF 0.003

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8 .63 . . +INF 0.003

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8 .96 . . +INF EPS

8 .97 . . +INF EPS

8 .98 . . +INF EPS

8 .99 . . +INF EPS

8 .100 . . +INF EPS

9 .1 . . +INF EPS

9 .2 . 5.000 +INF EPS

9 .3 . . +INF EPS

9 .4 . . +INF EPS

9 .5	.	.	+INF	EPS
9 .6	.	.	+INF	3.6000E-4
9 .7	.	.	+INF	4.2000E-4
9 .8	.	.	+INF	4.8000E-4
9 .9	.	.	+INF	5.4000E-4
9 .10	.	.	+INF	EPS
9 .11	.	.	+INF	EPS
9 .12	.	.	+INF	EPS
9 .13	.	.	+INF	EPS
9 .14	.	.	+INF	EPS
9 .15	.	.	+INF	EPS
9 .16	.	.	+INF	EPS
9 .17	.	.	+INF	0.001
9 .18	.	30.000	+INF	EPS
9 .19	.	.	+INF	0.001
9 .20	.	.	+INF	0.001
9 .21	.	.	+INF	0.001
9 .22	.	.	+INF	EPS
9 .23	.	.	+INF	0.001
9 .24	.	.	+INF	0.001
9 .25	.	.	+INF	0.001
9 .26	.	.	+INF	0.002
9 .27	.	.	+INF	EPS
9 .28	.	30.000	+INF	EPS
9 .29	.	.	+INF	0.002
9 .30	.	.	+INF	0.002
9 .31	.	.	+INF	0.002
9 .32	.	.	+INF	0.002
9 .33	.	.	+INF	0.002
9 .34	.	.	+INF	0.002
9 .35	.	.	+INF	0.002
9 .36	.	.	+INF	0.002

9 .37	.	.	+INF	0.002
9 .38	.	.	+INF	0.002
9 .39	.	.	+INF	0.002
9 .40	.	.	+INF	0.002
9 .41	.	.	+INF	0.002
9 .42	.	.	+INF	0.003
9 .43	.	.	+INF	EPS
9 .44	.	.	+INF	EPS
9 .45	.	.	+INF	EPS
9 .46	.	.	+INF	EPS
9 .47	.	.	+INF	EPS
9 .48	.	.	+INF	EPS
9 .49	.	.	+INF	EPS
9 .50	.	.	+INF	EPS
9 .51	.	.	+INF	EPS
9 .52	.	.	+INF	EPS
9 .53	.	.	+INF	EPS
9 .54	.	.	+INF	EPS
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9 .56	.	.	+INF	EPS
9 .57	.	.	+INF	EPS
9 .58	.	.	+INF	EPS
9 .59	.	.	+INF	EPS
9 .60	.	.	+INF	EPS
9 .61	.	.	+INF	EPS
9 .62	.	.	+INF	EPS
9 .63	.	.	+INF	EPS
9 .64	.	.	+INF	EPS
9 .65	.	.	+INF	EPS
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9 .67	.	.	+INF	EPS
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9 .95 . . +INF EPS

9 .96 . . +INF EPS

9 .97 . . +INF EPS

9 .98 . . +INF EPS

9 .99 . . +INF EPS

9 .100 . . +INF EPS

10.1	.	.	+INF	EPS
10.2	.	.	+INF	EPS
10.3	.	.	+INF	EPS
10.4	.	20.000	+INF	EPS
10.5	.	.	+INF	EPS
10.6	.	.	+INF	EPS
10.7	.	.	+INF	EPS
10.8	.	.	+INF	EPS
10.9	.	.	+INF	8.1000E-4
10.10	.	.	+INF	9.0000E-4
10.11	.	.	+INF	9.9000E-4
10.12	.	.	+INF	0.001
10.13	.	.	+INF	0.001
10.14	.	.	+INF	EPS
10.15	.	.	+INF	0.001
10.16	.	.	+INF	0.001
10.17	.	.	+INF	0.002
10.18	.	.	+INF	0.002
10.19	.	.	+INF	EPS
10.20	.	.	+INF	0.002
10.21	.	.	+INF	0.002
10.22	.	30.000	+INF	EPS
10.23	.	.	+INF	0.002
10.24	.	.	+INF	0.002
10.25	.	.	+INF	0.002
10.26	.	.	+INF	0.002
10.27	.	30.000	+INF	EPS
10.28	.	.	+INF	0.003
10.29	.	.	+INF	0.003
10.30	.	.	+INF	0.003
10.31	.	.	+INF	0.003
10.32	.	.	+INF	0.003

10.33	.	.	+INF	0.003
10.34	.	.	+INF	0.003
10.35	.	.	+INF	EPS
10.36	.	.	+INF	0.003
10.37	.	.	+INF	EPS
10.38	.	.	+INF	0.003
10.39	.	.	+INF	EPS
10.40	.	.	+INF	EPS
10.41	.	.	+INF	0.004
10.42	.	.	+INF	EPS
10.43	.	.	+INF	0.004
10.44	.	.	+INF	EPS
10.45	.	.	+INF	0.004
10.46	.	.	+INF	EPS
10.47	.	.	+INF	EPS
10.48	.	.	+INF	EPS
10.49	.	.	+INF	EPS
10.50	.	.	+INF	EPS
10.51	.	.	+INF	EPS
10.52	.	.	+INF	EPS
10.53	.	.	+INF	EPS
10.54	.	.	+INF	EPS
10.55	.	.	+INF	EPS
10.56	.	.	+INF	EPS
10.57	.	.	+INF	EPS
10.58	.	.	+INF	EPS
10.59	.	.	+INF	EPS
10.60	.	.	+INF	EPS
10.61	.	.	+INF	EPS
10.62	.	.	+INF	EPS
10.63	.	.	+INF	EPS
10.64	.	.	+INF	EPS

10.65	.	.	+INF	EPS
10.66	.	.	+INF	EPS
10.67	.	.	+INF	EPS
10.68	.	.	+INF	EPS
10.69	.	.	+INF	EPS
10.70	.	.	+INF	EPS
10.71	.	.	+INF	EPS
10.72	.	.	+INF	EPS
10.73	.	.	+INF	EPS
10.74	.	.	+INF	EPS
10.75	.	.	+INF	EPS
10.76	.	.	+INF	EPS
10.77	.	.	+INF	EPS
10.78	.	.	+INF	EPS
10.79	.	.	+INF	EPS
10.80	.	.	+INF	EPS
10.81	.	.	+INF	EPS
10.82	.	.	+INF	EPS
10.83	.	.	+INF	EPS
10.84	.	.	+INF	EPS
10.85	.	.	+INF	EPS
10.86	.	.	+INF	EPS
10.87	.	.	+INF	EPS
10.88	.	.	+INF	EPS
10.89	.	.	+INF	EPS
10.90	.	.	+INF	EPS
10.91	.	.	+INF	EPS
10.92	.	.	+INF	EPS
10.93	.	.	+INF	EPS
10.94	.	.	+INF	EPS
10.95	.	.	+INF	EPS
10.96	.	.	+INF	EPS

10.97 . . +INF EPS

10.98 . . +INF EPS

10.99 . . +INF EPS

10.100 . . +INF EPS

11.1 . . +INF EPS

11.2 . . +INF EPS

11.3 . . +INF EPS

11.4 . . +INF EPS

11.5 . . +INF 4.5000E-4

11.6 . . +INF 5.4000E-4

11.7 . . +INF 6.3000E-4

11.8 . . +INF 7.2000E-4

11.9 . . +INF 8.1000E-4

11.10 . . +INF 9.0000E-4

11.11 . . +INF 9.9000E-4

11.12 . . +INF 0.001

11.13 . . +INF 0.001

11.14 . . +INF 0.001

11.15 . . +INF 0.001

11.16 . . +INF 0.001

11.17 . . +INF 0.002

11.18 . . +INF 0.002

11.19 . . +INF 0.002

11.20 . 30.000 +INF EPS

11.21 . 30.000 +INF EPS

11.22 . . +INF 0.002

11.23 . . +INF EPS

11.24 . . +INF 0.002

11.25 . . +INF EPS

11.26 . . +INF 0.002

11.27 . . +INF 0.002

11.28 . . +INF 0.003

11.29	.	30.000	+INF	EPS
11.30	.	.	+INF	0.003
11.31	.	.	+INF	0.003
11.32	.	.	+INF	EPS
11.33	.	.	+INF	0.003
11.34	.	.	+INF	0.003
11.35	.	.	+INF	EPS
11.36	.	.	+INF	0.003
11.37	.	.	+INF	EPS
11.38	.	.	+INF	EPS
11.39	.	.	+INF	EPS
11.40	.	.	+INF	EPS
11.41	.	.	+INF	EPS
11.42	.	.	+INF	EPS
11.43	.	.	+INF	EPS
11.44	.	.	+INF	EPS
11.45	.	.	+INF	EPS
11.46	.	.	+INF	EPS
11.47	.	.	+INF	EPS
11.48	.	.	+INF	EPS
11.49	.	.	+INF	EPS
11.50	.	.	+INF	EPS
11.51	.	.	+INF	EPS
11.52	.	.	+INF	EPS
11.53	.	.	+INF	EPS
11.54	.	.	+INF	EPS
11.55	.	.	+INF	EPS
11.56	.	.	+INF	EPS
11.57	.	.	+INF	EPS
11.58	.	.	+INF	EPS
11.59	.	.	+INF	EPS
11.60	.	.	+INF	EPS

11.61	.	.	+INF	EPS
11.62	.	.	+INF	EPS
11.63	.	.	+INF	EPS
11.64	.	.	+INF	EPS
11.65	.	.	+INF	EPS
11.66	.	.	+INF	EPS
11.67	.	.	+INF	EPS
11.68	.	.	+INF	EPS
11.69	.	.	+INF	EPS
11.70	.	.	+INF	EPS
11.71	.	.	+INF	EPS
11.72	.	.	+INF	EPS
11.73	.	.	+INF	EPS
11.74	.	.	+INF	EPS
11.75	.	.	+INF	EPS
11.76	.	.	+INF	EPS
11.77	.	.	+INF	EPS
11.78	.	.	+INF	EPS
11.79	.	.	+INF	EPS
11.80	.	.	+INF	EPS
11.81	.	.	+INF	EPS
11.82	.	.	+INF	EPS
11.83	.	.	+INF	EPS
11.84	.	.	+INF	EPS
11.85	.	.	+INF	EPS
11.86	.	.	+INF	EPS
11.87	.	.	+INF	EPS
11.88	.	.	+INF	EPS
11.89	.	.	+INF	EPS
11.90	.	.	+INF	EPS
11.91	.	.	+INF	EPS
11.92	.	.	+INF	EPS

11.93 . . +INF EPS

11.94 . . +INF EPS

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11.100 . . +INF EPS

12.1 . . +INF EPS

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12.23 . . +INF EPS

12.24 . . +INF EPS

12.25	.	.	+INF	EPS
12.26	.	.	+INF	EPS
12.27	.	.	+INF	EPS
12.28	.	.	+INF	EPS
12.29	.	.	+INF	EPS
12.30	.	.	+INF	EPS
12.31	.	.	+INF	EPS
12.32	.	.	+INF	EPS
12.33	.	.	+INF	EPS
12.34	.	.	+INF	EPS
12.35	.	.	+INF	0.002
12.36	.	.	+INF	0.002
12.37	.	.	+INF	EPS
12.38	.	.	+INF	0.002
12.39	.	.	+INF	EPS
12.40	.	.	+INF	0.002
12.41	.	.	+INF	0.002
12.42	.	.	+INF	EPS
12.43	.	.	+INF	0.002
12.44	.	.	+INF	EPS
12.45	.	.	+INF	EPS
12.46	.	.	+INF	EPS
12.47	.	.	+INF	EPS
12.48	.	.	+INF	EPS
12.49	.	.	+INF	EPS
12.50	.	.	+INF	EPS
12.51	.	30.000	+INF	EPS
12.52	.	20.000	+INF	EPS
12.53	.	.	+INF	EPS
12.54	.	.	+INF	0.003
12.55	.	.	+INF	0.003
12.56	.	.	+INF	0.003

12.57	.	.	+INF	EPS
12.58	.	.	+INF	0.003
12.59	.	.	+INF	EPS
12.60	.	.	+INF	EPS
12.61	.	.	+INF	EPS
12.62	.	.	+INF	EPS
12.63	.	.	+INF	EPS
12.64	.	.	+INF	EPS
12.65	.	.	+INF	EPS
12.66	.	.	+INF	EPS
12.67	.	.	+INF	EPS
12.68	.	.	+INF	EPS
12.69	.	.	+INF	EPS
12.70	.	.	+INF	EPS
12.71	.	.	+INF	EPS
12.72	.	.	+INF	EPS
12.73	.	.	+INF	EPS
12.74	.	.	+INF	EPS
12.75	.	.	+INF	EPS
12.76	.	.	+INF	EPS
12.77	.	.	+INF	EPS
12.78	.	.	+INF	EPS
12.79	.	.	+INF	EPS
12.80	.	.	+INF	EPS
12.81	.	.	+INF	EPS
12.82	.	.	+INF	EPS
12.83	.	.	+INF	EPS
12.84	.	.	+INF	EPS
12.85	.	.	+INF	EPS
12.86	.	.	+INF	EPS
12.87	.	.	+INF	EPS
12.88	.	.	+INF	EPS

12.89 . . +INF EPS

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13.19 . . +INF EPS

13.20 . . +INF EPS

13.21	.	.	+INF	EPS
13.22	.	.	+INF	EPS
13.23	.	.	+INF	EPS
13.24	.	.	+INF	EPS
13.25	.	.	+INF	EPS
13.26	.	.	+INF	EPS
13.27	.	.	+INF	EPS
13.28	.	.	+INF	EPS
13.29	.	.	+INF	EPS
13.30	.	.	+INF	EPS
13.31	.	.	+INF	EPS
13.32	.	.	+INF	EPS
13.33	.	.	+INF	EPS
13.34	.	.	+INF	EPS
13.35	.	.	+INF	0.002
13.36	.	.	+INF	EPS
13.37	.	.	+INF	EPS
13.38	.	.	+INF	EPS
13.39	.	.	+INF	EPS
13.40	.	30.000	+INF	EPS
13.41	.	.	+INF	EPS
13.42	.	.	+INF	EPS
13.43	.	.	+INF	0.002
13.44	.	.	+INF	EPS
13.45	.	.	+INF	0.002
13.46	.	.	+INF	0.002
13.47	.	.	+INF	EPS
13.48	.	.	+INF	0.002
13.49	.	.	+INF	EPS
13.50	.	.	+INF	0.002
13.51	.	.	+INF	EPS
13.52	.	.	+INF	0.003

13.53 . . +INF EPS

13.54 . . +INF EPS

13.55 . . +INF 0.003

13.56 . . +INF EPS

13.57 . . +INF 0.003

13.58 . . +INF 0.003

13.59 . . +INF 0.003

13.60 . 30.000 +INF EPS

13.61 . . +INF EPS

13.62 . . +INF EPS

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13.66 . . +INF EPS

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14.9 . . +INF EPS

14.10 . 5.000 +INF EPS

14.11 . . +INF EPS

14.12 . . +INF EPS

14.13 . . +INF EPS

14.14 . . +INF EPS

14.15 . . +INF EPS

14.16 . . +INF EPS

14.17	.	.	+INF	EPS
14.18	.	.	+INF	EPS
14.19	.	.	+INF	EPS
14.20	.	.	+INF	EPS
14.21	.	.	+INF	8.4000E-4
14.22	.	.	+INF	EPS
14.23	.	.	+INF	EPS
14.24	.	.	+INF	EPS
14.25	.	.	+INF	EPS
14.26	.	.	+INF	EPS
14.27	.	.	+INF	EPS
14.28	.	.	+INF	EPS
14.29	.	.	+INF	EPS
14.30	.	.	+INF	EPS
14.31	.	.	+INF	EPS
14.32	.	.	+INF	0.001
14.33	.	.	+INF	0.001
14.34	.	.	+INF	0.001
14.35	.	.	+INF	EPS
14.36	.	.	+INF	EPS
14.37	.	.	+INF	0.001
14.38	.	.	+INF	0.002
14.39	.	.	+INF	0.002
14.40	.	.	+INF	0.002
14.41	.	.	+INF	0.002
14.42	.	.	+INF	EPS
14.43	.	.	+INF	EPS
14.44	.	.	+INF	EPS
14.45	.	.	+INF	EPS
14.46	.	.	+INF	0.002
14.47	.	.	+INF	EPS
14.48	.	.	+INF	0.002

14.49	.	.	+INF	0.002
14.50	.	.	+INF	EPS
14.51	.	.	+INF	EPS
14.52	.	.	+INF	0.002
14.53	.	.	+INF	EPS
14.54	.	.	+INF	EPS
14.55	.	.	+INF	EPS
14.56	.	.	+INF	EPS
14.57	.	.	+INF	EPS
14.58	.	30.000	+INF	EPS
14.59	.	.	+INF	EPS
14.60	.	.	+INF	EPS
14.61	.	30.000	+INF	EPS
14.62	.	30.000	+INF	EPS
14.63	.	30.000	+INF	EPS
14.64	.	.	+INF	0.003
14.65	.	.	+INF	EPS
14.66	.	.	+INF	EPS
14.67	.	.	+INF	EPS
14.68	.	.	+INF	EPS
14.69	.	.	+INF	EPS
14.70	.	.	+INF	EPS
14.71	.	.	+INF	EPS
14.72	.	.	+INF	EPS
14.73	.	.	+INF	EPS
14.74	.	.	+INF	EPS
14.75	.	.	+INF	EPS
14.76	.	.	+INF	EPS
14.77	.	.	+INF	EPS
14.78	.	.	+INF	EPS
14.79	.	.	+INF	EPS
14.80	.	.	+INF	EPS

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15.12 . . +INF EPS

15.13	.	.	+INF	EPS
15.14	.	.	+INF	7.0000E-4
15.15	.	.	+INF	EPS
15.16	.	.	+INF	EPS
15.17	.	.	+INF	8.5000E-4
15.18	.	.	+INF	9.0000E-4
15.19	.	.	+INF	9.5000E-4
15.20	.	.	+INF	EPS
15.21	.	.	+INF	0.001
15.22	.	.	+INF	0.001
15.23	.	.	+INF	EPS
15.24	.	.	+INF	EPS
15.25	.	.	+INF	0.001
15.26	.	.	+INF	0.001
15.27	.	.	+INF	0.001
15.28	.	.	+INF	0.001
15.29	.	.	+INF	EPS
15.30	.	.	+INF	EPS
15.31	.	.	+INF	EPS
15.32	.	.	+INF	EPS
15.33	.	.	+INF	EPS
15.34	.	.	+INF	EPS
15.35	.	.	+INF	0.002
15.36	.	.	+INF	0.002
15.37	.	.	+INF	0.002
15.38	.	.	+INF	0.002
15.39	.	.	+INF	0.002
15.40	.	.	+INF	0.002
15.41	.	.	+INF	0.002
15.42	.	.	+INF	0.002
15.43	.	15.000	+INF	EPS
15.44	.	.	+INF	EPS

15.45	.	.	+INF	0.002
15.46	.	.	+INF	EPS
15.47	.	.	+INF	0.002
15.48	.	.	+INF	EPS
15.49	.	30.000	+INF	EPS
15.50	.	.	+INF	EPS
15.51	.	.	+INF	0.003
15.52	.	.	+INF	EPS
15.53	.	.	+INF	EPS
15.54	.	.	+INF	EPS
15.55	.	.	+INF	EPS
15.56	.	.	+INF	EPS
15.57	.	.	+INF	0.003
15.58	.	.	+INF	0.003
15.59	.	20.000	+INF	EPS
15.60	.	.	+INF	EPS
15.61	.	.	+INF	EPS
15.62	.	.	+INF	EPS
15.63	.	.	+INF	EPS
15.64	.	30.000	+INF	EPS
15.65	.	.	+INF	EPS
15.66	.	.	+INF	EPS
15.67	.	.	+INF	EPS
15.68	.	.	+INF	EPS
15.69	.	.	+INF	EPS
15.70	.	.	+INF	EPS
15.71	.	.	+INF	EPS
15.72	.	.	+INF	EPS
15.73	.	.	+INF	EPS
15.74	.	.	+INF	EPS
15.75	.	.	+INF	EPS
15.76	.	.	+INF	EPS

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15.100 . . +INF EPS

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16.6 . 5.000 +INF EPS

16.7 . 30.000 +INF EPS

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16.10 . 25.000 +INF EPS

16.11 . . +INF EPS

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16.13 . . +INF 0.001

16.14 . . +INF 0.002

16.15 . 30.000 +INF EPS

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17.2 . 15.000 +INF EPS

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17.4 . . +INF EPS

17.5	.	.	+INF	EPS
17.6	.	.	+INF	EPS
17.7	.	.	+INF	7.0000E-4
17.8	.	.	+INF	EPS
17.9	.	.	+INF	EPS
17.10	.	.	+INF	EPS
17.11	.	.	+INF	EPS
17.12	.	.	+INF	EPS
17.13	.	.	+INF	EPS
17.14	.	.	+INF	0.001
17.15	.	.	+INF	EPS
17.16	.	30.000	+INF	EPS
17.17	.	30.000	+INF	EPS
17.18	.	.	+INF	0.002
17.19	.	.	+INF	EPS
17.20	.	.	+INF	EPS
17.21	.	.	+INF	0.002
17.22	.	.	+INF	0.002
17.23	.	.	+INF	0.002
17.24	.	.	+INF	0.002
17.25	.	.	+INF	0.002
17.26	.	.	+INF	0.003
17.27	.	.	+INF	EPS
17.28	.	.	+INF	0.003
17.29	.	.	+INF	EPS
17.30	.	.	+INF	0.003
17.31	.	.	+INF	EPS
17.32	.	.	+INF	0.003
17.33	.	.	+INF	EPS
17.34	.	.	+INF	EPS
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18.1	.	19.000	+INF	EPS
18.2	.	.	+INF	EPS
18.3	.	.	+INF	EPS
18.4	.	.	+INF	EPS
18.5	.	.	+INF	EPS
18.6	.	.	+INF	EPS
18.7	.	.	+INF	EPS
18.8	.	.	+INF	EPS
18.9	.	.	+INF	EPS
18.10	.	.	+INF	7.0000E-4
18.11	.	.	+INF	EPS
18.12	.	.	+INF	EPS
18.13	.	.	+INF	9.1000E-4
18.14	.	.	+INF	9.8000E-4
18.15	.	.	+INF	0.001
18.16	.	.	+INF	0.001
18.17	.	.	+INF	0.001
18.18	.	.	+INF	EPS
18.19	.	.	+INF	0.001
18.20	.	.	+INF	0.001
18.21	.	.	+INF	0.001
18.22	.	.	+INF	0.002
18.23	.	.	+INF	0.002
18.24	.	.	+INF	EPS
18.25	.	.	+INF	0.002
18.26	.	.	+INF	0.002
18.27	.	.	+INF	0.002
18.28	.	.	+INF	0.002
18.29	.	.	+INF	EPS
18.30	.	.	+INF	0.002
18.31	.	.	+INF	0.002
18.32	.	25.000	+INF	EPS

18.33 . . +INF 0.002

18.34 . . +INF 0.002

18.35 . 30.000 +INF EPS

18.36 . . +INF 0.003

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18.39 . . +INF 0.003

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19.30	.	.	+INF	EPS
19.31	.	.	+INF	EPS
19.32	.	.	+INF	EPS
19.33	.	.	+INF	EPS
19.34	.	.	+INF	EPS
19.35	.	.	+INF	EPS
19.36	.	.	+INF	EPS
19.37	.	.	+INF	EPS
19.38	.	.	+INF	0.002
19.39	.	.	+INF	0.002
19.40	.	.	+INF	0.002
19.41	.	.	+INF	0.002
19.42	.	20.000	+INF	EPS
19.43	.	.	+INF	0.002
19.44	.	.	+INF	EPS
19.45	.	.	+INF	EPS
19.46	.	30.000	+INF	EPS
19.47	.	.	+INF	0.002
19.48	.	.	+INF	0.002
19.49	.	.	+INF	0.002
19.50	.	30.000	+INF	EPS
19.51	.	.	+INF	0.003
19.52	.	.	+INF	0.003
19.53	.	.	+INF	EPS
19.54	.	30.000	+INF	EPS
19.55	.	.	+INF	0.003
19.56	.	.	+INF	0.003
19.57	.	.	+INF	0.003
19.58	.	.	+INF	0.003
19.59	.	.	+INF	0.003
19.60	.	.	+INF	0.003

19.61	.	.	+INF	EPS
19.62	.	.	+INF	EPS
19.63	.	.	+INF	0.003
19.64	.	.	+INF	EPS
19.65	.	.	+INF	EPS
19.66	.	.	+INF	EPS
19.67	.	.	+INF	EPS
19.68	.	.	+INF	EPS
19.69	.	.	+INF	EPS
19.70	.	.	+INF	EPS
19.71	.	.	+INF	EPS
19.72	.	.	+INF	EPS
19.73	.	.	+INF	EPS
19.74	.	.	+INF	EPS
19.75	.	.	+INF	EPS
19.76	.	.	+INF	EPS
19.77	.	.	+INF	EPS
19.78	.	.	+INF	EPS
19.79	.	.	+INF	EPS
19.80	.	.	+INF	EPS
19.81	.	.	+INF	EPS
19.82	.	.	+INF	EPS
19.83	.	.	+INF	EPS
19.84	.	.	+INF	EPS
19.85	.	.	+INF	EPS
19.86	.	.	+INF	EPS
19.87	.	.	+INF	EPS
19.88	.	.	+INF	EPS
19.89	.	.	+INF	EPS
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20.29	.	.	+INF	EPS
20.30	.	.	+INF	EPS
20.31	.	.	+INF	EPS
20.32	.	.	+INF	EPS
20.33	.	.	+INF	EPS
20.34	.	.	+INF	EPS
20.35	.	.	+INF	EPS
20.36	.	.	+INF	EPS
20.37	.	.	+INF	EPS
20.38	.	.	+INF	EPS
20.39	.	.	+INF	0.001
20.40	.	.	+INF	EPS
20.41	.	.	+INF	EPS
20.42	.	.	+INF	EPS
20.43	.	.	+INF	EPS
20.44	.	.	+INF	EPS
20.45	.	.	+INF	EPS
20.46	.	.	+INF	EPS
20.47	.	.	+INF	0.001
20.48	.	.	+INF	0.001
20.49	.	.	+INF	EPS
20.50	.	.	+INF	EPS
20.51	.	.	+INF	EPS
20.52	.	.	+INF	EPS
20.53	.	.	+INF	0.002
20.54	.	.	+INF	EPS
20.55	.	.	+INF	0.002
20.56	.	.	+INF	EPS

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20.64 . . +INF 0.002

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21.20 . . +INF 0.001

21.21	.	.	+INF	0.001
21.22	.	.	+INF	EPS
21.23	.	.	+INF	EPS
21.24	.	.	+INF	EPS
21.25	.	.	+INF	0.001
21.26	.	.	+INF	0.002
21.27	.	.	+INF	EPS
21.28	.	.	+INF	0.002
21.29	.	.	+INF	0.002
21.30	.	.	+INF	0.002
21.31	.	.	+INF	0.002
21.32	.	.	+INF	0.002
21.33	.	.	+INF	0.002
21.34	.	.	+INF	0.002
21.35	.	.	+INF	EPS
21.36	.	30.000	+INF	EPS
21.37	.	.	+INF	EPS
21.38	.	.	+INF	0.002
21.39	.	.	+INF	0.002
21.40	.	.	+INF	0.002
21.41	.	.	+INF	0.002
21.42	.	.	+INF	0.003
21.43	.	15.000	+INF	EPS
21.44	.	30.000	+INF	EPS
21.45	.	.	+INF	0.003
21.46	.	.	+INF	0.003
21.47	.	.	+INF	0.003
21.48	.	.	+INF	0.003
21.49	.	.	+INF	0.003
21.50	.	.	+INF	0.003
21.51	.	.	+INF	0.003
21.52	.	.	+INF	0.003

21.53	.	.	+INF	0.003
21.54	.	.	+INF	0.003
21.55	.	.	+INF	0.003
21.56	.	.	+INF	0.003
21.57	.	.	+INF	0.003
21.58	.	.	+INF	0.003
21.59	.	.	+INF	0.004
21.60	.	.	+INF	0.004
21.61	.	.	+INF	0.004
21.62	.	.	+INF	0.004
21.63	.	.	+INF	0.004
21.64	.	.	+INF	0.004
21.65	.	.	+INF	EPS
21.66	.	.	+INF	EPS
21.67	.	.	+INF	EPS
21.68	.	.	+INF	EPS
21.69	.	.	+INF	EPS
21.70	.	.	+INF	EPS
21.71	.	.	+INF	EPS
21.72	.	.	+INF	EPS
21.73	.	.	+INF	EPS
21.74	.	.	+INF	EPS
21.75	.	.	+INF	EPS
21.76	.	.	+INF	EPS
21.77	.	.	+INF	EPS
21.78	.	.	+INF	EPS
21.79	.	.	+INF	EPS
21.80	.	.	+INF	EPS
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**** REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

RESUME

Personal Information

- Name-Surname: Hüseyin Ardıç
- Place of Birth: Ermenek
- Date of Birth: 13.11.1988
- Nationality: Turkey
- Marital Status: Single
- Military Obligation: Deferred (12.2018)
- Driving License: B class (2007)
- Cell Phone: +90(532) 177 60 63
- E-Mail: huseynardic@gmail.com

Professional Profile

More than 7 years of Oracle database administration experience with various OS platforms. A self-motivated, responsible and reliable team player with a set of strong technical skills. Strong in solving problems of diverse scope where technical analysis and evaluation is required. Strong communication skills to develop working relationships with customers and partners.

Career Summary

- Vizyoneks Bilgi Teknolojileri / IT Operations (Database Administrator / 01.2016 – …)

Vizyoneks has more than 250 employees and provides software technologies, insurance solutions and field automation solutions and has more than 100 test, production and standby databases from various customers such as Pepsi, Ülker, Neova Insurance…

- Oracle database 10g, 11g, 12c installation, management
- Oracle RAC database 10g to 11g and 11g to 12c upgrade with Disaster Recovery databases
- Oracle RAC database upgrade previous 11.2.0.N version to the latest 11.2.0.N
- Oracle Grid Infrastructure 10g to 11g and 11g to 12c upgrade
- Non-Exadata to Exadata database migration
- Exadata fresh complete installation including OS
- Full Exadata upgrade including OS
- Preparing RMAN backup scripts and managing backup policy
- Sql tuning, detecting problematic sql’s and optimizing
- Cross platform database migration

- Comprehensive reporting Database performances

- Managing 12c and 13c Cloud Control

- Demonstrating through understanding of Bigdata Hadoop eco system such as HDFS, Yarn, Hive, Flume, HBase, Sqoop, Solr, Oozie etc.

- Managing, monitoring and troubleshooting Bigdata Hadoop clusters and environments

- Turkcell / Infrastructure Operations (Database Administrator Consultant / 08.2013 –01.2016)

Turkcell is the biggest telecommunication company in Turkey which has 35 million customers and has more than 300 test and production oracle databases.

- Oracle database 10g, 11g installation, management

- Oracle RAC installation, management

- Oracle ASM installation, management

- Preparing RMAN backup scripts and managing backup policy

- Preparing RMAN restore scripts and making restore tests and scenarios for disaster recovery

- Sql tuning, detecting problematic sql's and optimizing

- Creating Oracle APEX applications

- Oracle database object management
- Cross platform database migration
- Preparing oracle database performance diagnostic scripts

- Turkcell / Infrastructure Operations (Part-Time Database Administrator / 09.2012-08.2013)

  - Oracle database 10g, 11g installation, management
  - Oracle RAC installation, management
  - Oracle ASM installation, management
  - Preparing RMAN backup scripts and managing backup policy
  - Preparing RMAN restore scripts and making restore tests and scenarios for disaster recovery
  - Sql tuning, detecting problematic sql's and optimizing
  - Creating Oracle APEX applications
  - Oracle database object management
  - Cross platform database migration
  - Preparing oracle database performance diagnostic scripts

- Turkcell / Infrastructure Operations (Database Administrator Intern / 07.2012 – 09.2012)

  - Preparing oracle database performance diagnostic scripts

  - Creating Oracle APEX applications

Certifications

- Oracle Database 12c Certified Professional (2016)

Education Information

- İstanbul Technical University Computer Engineering (*Bachelor's Degree*) (2013)

- Konya Meram Science High School (2006)