# RISK IDENTIFICATION AND ANALYSIS OF PRIVATE HOSPITAL CONSTRUCTIONS IN TURKEY

by

Esra Gülen YILMAZ

B.S., Civil Engineering, Istanbul Technical University, 2007

Submitted to the Institute for Graduate Studies in
Science and Engineering in partial fulfillment of
the requirements for the degree of
Master of Science

Graduate Program in Civil Engineering

Boğaziçi University

2010

## ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my co-advisor Dr. Mehmet Sait Cülfik for his invaluable guidance and help during the preparation of this dissertation. I would like to mention his patience, giving me inspiration and hope when I was stuck at dead-ends. I want to express my gratitude to my supervisor Prof. Turan Özturan, who widened my visions and made me think about what I would do in this study. I want to thank him with all my sincerity for his trust on me.

I wish to express my sincere thanks to Mr. Sedat Artukoğlu for sharing his invaluable experiences about hospital management and providing important data for my research. I want to thank him for all his generosity.

A special thank is for Ms. İlke Bozkurt, who oriented me to the project that is analyzed as a case study in this thesis.

Dear Mr. Bora Atay; I wish you to know your support during my work was very precious for me. You gave me long hours listening to me about everything; thank you.

Another bunch of special thanks is for Onur Kayaturan. Thank you for your great help.

Dear Mr. Kerem Ergüven; your new profession has lightened my world, thank you for your coaching.

Dear Mr. Cenk Ertutkun; thank you for being in my life, your ideas, interest and sharing’s.

Dear mom, dad and my sister thank you for all the things you provided to me. Everything you do is very valuable for me. Thank You.

# ABSTRACT


## RISK IDENTIFICATION AND RISK ANALYSIS OF PRIVATE HOSPITAL CONSTRUCTIONS IN TURKEY

Investments of Private hospital projects in Turkey are subject to substantial risks, which may not only emerge from project activities such as design and construction, but also from global issues beyond the control of project parties, such as legal and political risks. Therefore, investors must manage risks effectively and efficiently, in hospital projects, in order to ensure a successful delivery. The aim of this study is to identify the potential risks of private hospital investments in Turkey and, as a case study, in order to examine the impacts of risks in private hospital investments causing schedule slippages and cost overruns with a probabilistic plan.

The first part of this study includes identifying potential risks for private health sector investment projects. An investment project is evaluated under 2 main processes, namely project development and project implementation processes, which are further detailed and developed into 5 phases as investment planning, design, resource supplying, construction and commissioning. A risk breakdown structure is developed for classifying the identified risks considering these phases. As a result of broad literature reviews and interviews arranged with project managers, construction supervisors, consultants, investors, hospital directors and with many project engineers that have been associated with hospital projects a risk checklist is established, which contains 110 potential risks for hospital projects in Turkey.

Subsequently, a case study is performed on a real hospital project in Turkey, in which risks impacting schedule and cost targets of the project are examined. First deterministic cost and schedule plans are developed. Risk identification, qualitative and quantitative risk analysis steps of risk management processes have been illustrated on this project. The project cost and duration is simulated by Monte Carlo simulation technique. Distribution analysis and sensitivity analysis are performed. Domain risk factors that affect

the schedule and cost of the hospital construction project are determined. Finally the probabilistic results are compared with the results of deterministic plans, which show the obvious need for risk management in hospital projects in order to see the potential deviations in schedule and cost performances of the projects and to successfully manage the projects.

The results of this research will enable private hospital investors not only to be aware of potential risks, which will allow them to focus more attention on the activities which are more critical in terms project targets , but also to show the need to implement risk analysis process through the use of qualitative and quantitative analysis .

# ÖZET

## TÜRKİYE’DE ÖZEL HASTANE İNŞAATLARINDA RISKLERİN BELİRLENMESİ VE ANALİZİ

Türkiye'de özel hastane projeleri, proje tasarım ve inşaat faaliyetlerinden kaynaklanan risklerin yanı sıra yasal ve politik riskleri de içermektedir. Bu nedenle, hastane projelerinde yatırımcıların projeyi başarı ile tamamlayabilmeleri için riskleri etkin bir şekilde yönetmeleri gerekir. Bu çalışmanın amacı, Türkiye'de özel hastane projelerinde karşılaşılabilecek potansiyel riskleri belirlemek ve örnek bir hastane projesinde süre ve maliyet aşımına neden olan risklerin etkilerini olasılıklı plan üzerinde inceleyerek risk yönetiminin gerekliliğini ortaya koymaktır.

Araştırmanın ilk bölümünde Türkiye’de özel sağlık sektörü inşaat projelerinde genel olarak karşılaşılabilecek riskleri belirlemektir. Projeler, proje geliştirme ve proje uygulama adı altında 2 ana fazla incelenmiş, daha sonra yatırım planlama, tasarım, ürün temini, inşaat ve işletmeye alma olmak üzere 5 alt safhada incelenmiştir. Riskleri belirlemek için bir risk ayrışım yapısı oluşturulmuş ve tüm riskler bu yapıya gör gruplandırılmıştır. Bunun için literatür taramaları yapılmış, proje yöneticileri, şantiye şefleri, danışmanlar, yatırımcılar, hastane direktörleri, dizayn ekipleri ve bir çok proje mühendisi ile görüşmeler yapılmıştır. Bu çalışmalar sonucunda Türkiye’de özel hastane yatırımlarında karşılaşılan 110 riski kapsayan bir risk kontrol listesi elde edilmiştir.

Daha sonra Türkiye’deki gerçek bir hastane projesi üzerinde, projelenin süre ve maliyet hedeflerine etki eden riskler incelenmiştir. Deterministik iş programı ve maliyet tahmini yapılmıştır. Risk yönetimi adımlarından risk belirleme, nitel risk ve nicel risk analizi çalışılmıştır. Risklerin süreye ve maliyete etkilerinin Monte Carlo simülasyon tekniği ile simulasyonu yapılmış ve tüm projeye olan etkileri ortaya konulmuştur. Risk analizinin sonunda dağılım ve duyarlılık analizleri yapılarak maliyeti ve süreyi en çok etkileyen aktivitelerin belirlenmesi ve hangi aktivitelerin daha iyi yönetilmesi gerektiği

saptanmıştır. Deterministik iş programı ve bütçe tahmini ile risk analizi sonucu elde edilen planlar karşılaştırılarak Türkiye'de sağlık yatırımları ile ilgili inşaat projelerinde maliyet ve süredeki olası sapmaları görmek için risk yönetiminin gerekliliği ortaya koyulmaya çalışılmıştır.

Bu çalışmanın sonucunda, yatırımcıların potansiyel risklere karşı farkındalığı arttırılmış, risk analizi ile projede bazı aktivitelerin proje hedefleri açısından daha kritik olabilecekleri ve bunların daha iyi yönetilmesi gerektiği saptanmış, nicel ve nitel risk analizi uygulamalarının gerekliliği ortaya konulmuştur.

# TABLE OF CONTENT

# LIST OF FIGURES

# LIST OF TABLES

# LIST OF ABBREVIATIONS

| | |
|---|---|
| CPM | Critical Path Method |
| H | High |
| IVF | In Vitro Fertilization |
| L | Low |
| L.R. | Literature Review |
| M | Medium |
| N | Negligible |
| RBS | Risk Breakdown Structure |
| SSI | Schedule Sensitivity Index |
| VH | Very High |
| VL | Very Low |
| WBS | Work Breakdown Structure |

# 1. INTRODUCTION

## 1.1. Introduction

The construction business, like any other business, is considered to be risky, as construction projects are comprehended to have more inherent risks due to the involvement of many contracting parties, such as owners, designers, contractors, subcontractors, suppliers, etc. In other words, every construction project is subject to risk [1]. Risk is a potential problem that has not yet occurred, but if it does occur, then it could prevent or limit the attainment of the objectives defined at the beginning of the project [2]. Project risk is a combination of the probability of occurrence of a defined hazard, an uncertain event or a condition, and the consequences of the event should it occur [2]. In the construction industry, risk is the possibility that an event will cause loss, injury, disadvantage, destruction, or have a negative effect on at least one project objective, such as time, cost, scope or quality [3].

Risk management is not a technique, but rather a framework, within which potential courses of action may be reviewed, judged and evaluated in terms of risks and opportunities. Risk management describes how risks can be identified, assessed, mitigated, monitored and controlled to ensure they are fully understood and that they fall within the tolerance limit of the clients and stakeholders. Rosenau [4] describes risk management as "…a systematic process of managing an organization's risk exposures to achieve its objectives in a manner consistent with public interest, human safety, environmental factors, and the law. Therefore, risk management is a systematic approach to minimizing risk occurrences that may affect the achievement of key objectives of a project".

Effective risk management begins with risk identification, which is a critical activity for any meaningful risk management exercise [5]. During risk identification, potential risks that may affect the achievement of a project's goals are identified, as are appropriate courses of action that can be taken to manage them. Several techniques have been established for risk identification in the construction industry, including brainstorming, checklists and the Delphi technique. Risks can be analyzed both qualitatively and quantitatively [6]. Qualitative risk analysis involves identifying the anticipated probability of occurrence of risks; whereas quantitative risk analysis usually involves the use of computer-based programs to determine the impact of risks on a particular project should they occur. Risks should be mitigated once they are identified and analyzed, usually by project teams that are best able to manage them. Risk monitoring and control are conducted with the intent of assessing the progress of each mitigated risk during project implementation.

The first objective of this study is to help potential Private Hospital Investors to be aware of potential risks in hospital investments including country, location site, legal, client, and contractor related risks. In order to identify the risks associated with the whole Hospital project life-time, risks that might be faced through each phase of projects, which effect the schedule and cost performance of projects, are investigated through interviews arranged with Project Managers, Construction Supervisors, Technical Office Chiefs/Managers, Planning Engineers, Cost Engineers, Architects, Electrical, Mechanical Engineers who are involved in different Hospital Projects.

Secondly this study focuses on the negative effects of the lack of risk identification and risk analysis in hospital construction projects executed in Turkey, through a case study on a Private Hospital project, which was selected due to being a recent project in Turkey. This research examines deterministic Schedule and cost plans and the stochastic values obtained after qualitative and quantitative risk analysis, which require estimating the probability of occurrence and impacts of the risks in terms of two project success criteria: cost and time.

The significance of this study is that it will provide insight on how effectively risks should be managed by Investors in achieving successful projects in private healthcare sector. Findings from this case study can be used as a milestone to increase the awareness of private hospital investors of the possible consequences to such projects if risk identification and analysis processes are not conducted in an effective and efficient manner.

## 1.2. Problem Statement

Due to various uncertainties and risks budget overruns and schedule slippages are usually encountered in major private hospital construction projects. Risks have significant effect on completion cost and time of construction. Private hospital construction projects in Turkey generally, suffer problems of budget overruns, and schedule slippages.

There is a variety of research on risk analysis in several construction types such as transportation, bridge construction. Since the characteristics of construction sectors differ from one type to other, there is also need for studies in hospital constructions about risk factors in healthcare construction industry. This study aims to investigate the encountered risks and the benefits of risks analysis during private hospital construction projects in Turkey.

## 1.3. Aim and Objective of the Study

This research was aimed at identifying the major risks that cause delays, cost overruns and to evaluate the results of risk analysis in private hospital construction project in Turkey. To perform these aims the following objectives have been defined;

- Evaluate the risk factors contributing to delays and cost overruns in healthcare sector constructions in Turkey
- Help potential private hospital investors to be aware of potential risks in hospital construction projects in Turkey through a risk checklist
- Implement risk analysis on a real hospital project
- Develop a schedule and cost risk analysis model
- Show the necessity and significance of risk identification and risk analysis in Private Hospital project in Turkey through a case study

## 1.4. Scope of the Study

The scope of the research was mainly focus on establishing a checklist by literature review and interviews and a case study.

In this research, 110 risks have been explored categorized by country, legal, lack of project management, direct client, design team, technology, financial, procurement/production, contractor, contract, site location related factors under 5 main phases of a project life time which are; investment planning phase, design & material selection phase, resource supplying phase, construction phase and finish up commissioning phase.

A case study is performed to implement risk identification, qualitative and quantitative risk analysis steps of risk management process for evaluating the impacts of risk on project objectives in terms of time and cost.

In this case study, a work breakdown structure is developed to define the scope of work and provide a base for deterministic schedule and cost estimation. A deterministic schedule is developed including 33 activities by using Primavera software program which is based on critical path method. Further, cost estimation is performed to obtain a deterministic total cost. After developing the deterministic schedule and cost plans, risk identification and analysis are performed by Oracle Primavera Risk Analysis software program. Checklist and brainstorming methods are used to conduct the risk identification process for the case study. 21 potential risks are foreseen for this specific project among 110 risks described in check list. A qualitative risk analysis is performed to weight each risk element identified for this project by assessing and combining their probability of occurrence and impact. A quantitative risk analysis is performed by using Monte Carlo simulation method. Finally, for the results of the analysis, distribution analysis, sensitivity analysis and scatter plot analysis are conducted.

## 1.5. Research Methodology

First of all, for evaluating the risk factors contributing to delays and cost overruns in healthcare sector constructions in Turkey the term risk and risk management process in the literature are reviewed and presented.

Secondly, with the aim of helping potential private hospital investors to be aware of potential risks in hospital construction projects in Turkey a risk checklist is established for hospital projects in Turkey by interviews with 102 people involving investors, hospital directors, project engineers and project managers that have been associated with hospital projects, and literature reviews.

Further, a case study is implemented on a real hospital project in Turkey. Deterministic schedule and cost estimation results are found to further compare the results of stochastic plans. Critical path method is used to evaluate a master schedule for the deterministic study. A risk analysis model is developed and stochastic plans are established by using Monte Carlo simulation technique. Qualitative and quantitative risk analyses are implemented for the case study. The results of analysis are shown by using distribution graphs, sensitivity graphs and scatter plots to show the necessity and significance of risk identification and risk analysis.

Finally, the conclusions are explained which focus on the comparison of the results of qualitative risk analysis processes with the deterministic plans conducted on the case study.

# 2. LITERATURE REVIEW ON RISK AND RISK MANAGEMENT

## 2.1. Risk

### 2.1.1. Definition and nature of risk

Risk is a pervasive part of all actions. Neither man nor the organizations created can survive without taking risks. It is simply not possible to avoid risks. In every human decision or action, the question is never one of whether or not to take a risk but rather which risk to choose [7].

Similarly, projects have many risks in their nature.

Risk can be defined differently depending on specific applications. In day-to day language, risk is usually referred to as something adverse or undesirable.

In finance industry, risk can be defined as the possibility of loss or the uncertainty of future returns while risk can be defined as the possibility of loss of trading capital in commerce/trading. These definitions of risk neither address the probability of occurrence of a risky event nor provide an indication of a measure of the impact of the outcome. In the field of engineering, the definition of risk combines the probability of occurrence as well as the consequence of a specified risky event and this is often simply expressed as the product of the probability of occurrence of the risk and the impact of the risk [8]. In the construction industry, risk is the possibility that an event will cause loss, injury, disadvantage, destruction, or have a negative effect on at least one project objective, such as time, cost, scope or quality [3].

### 2.1.2. Risk and uncertainty

A risk is defined as "an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives" [3]. It must be emphasized that a risk is characterized by having both an impact and a probability. An uncertainty is defined as "the difference between the amount of information required to perform the task and the amount of information already possessed by the organization" [9]. Therefore, a risk is categorized as having an impact, while an uncertainty may or may not have a known impact on the projects goals.

An uncertainty is therefore the most comprehensive term. Both terms do here include both positive and negative possibilities.

Chapman and Ward explain that uncertainty which matters are critical to all projects and that this uncertainty relates to more than just time and cost objectives of a project. An uncertainty includes for example problems like which parties ought to be involved, their motives and alignment of project objectives with corporate strategy. According to the authors, managing these uncertainties efficiently is a best practice in project risk management [10].

### 2.1.3. Risk components

Risk has two components: outcome and likelihood.

In order to discuss the existence of risk; "First, there must always be at least two possible outcomes and second, at least one of the possible outcomes must be undesirable. For instance, if it is known that a loss will occur definitely, there cannot be any risk [11].

The main definition of the verb "risk" in the Oxford English Dictionary is "to expose to the chance of injury or loss". It is worthwhile to reflect on the implications of various aspects of the definition. First, it is necessary that there must be a potential *loss* of some amount. Second, there must be a chance of loss. A sure loss is not a risk. Third, the notion "to expose" means that the decision maker can take actions that can increase (or decrease) the magnitude or chance of loss. Therefore "to risk" implies the availability of a choice [12].

### 2.1.4. Sources of risks

Risk source can be explained as the events that can cause variation from what is planned or expected. According to Flanagan and Norman [13] the sources of risk and the effects of risk , which must be clearly distinguished and the sequence is as follows;


Figure 2.1. Sequence of risk

Flanagan and Norman [13] presented some examples of sources and effects of risks as follows;

The sources of risk can be:

- Inflation rising above the allowance in the estimate
- Unforeseen adverse ground conditions
- Exceptionally inclement weather
- Late delivery of crucial materials, for instance after a fire at a supplier’s works
- Incorrect design details , such as the wrong size of the beams being shown on the architectures drawings
- Insolvency of the main contactor
- No coordination , for instance between the mechanical services, contractors drawings and the suspended ceilings specialists drawing

The most serious effects of risk are:

- Failure to keep within the cost estimate
- Failure to achieve the required completion date
- Failure to achieve the required quality
- Damage to the property as a result of fire or flood
- Injury to a worker due to an inadequate system of working

### 2.1.5. Construction Risks

There are three main types of risks that could be generally identified in a construction project.

The first type of risk is related to cost and can simply be described in terms of a project exceeding its budget. According to Abdou [14] budget overrun is not always a result of poor construction supervision. He attributes budget overrun to poor planning and wishful pricing or the lack of coordination/communication between design professionals and construction trades. Rydeen [15] also mentions overlooked budget items, poor management, unforeseen site conditions and inaccurate cost estimates as some of the factors that contribute to budget overruns for construction projects.

The second type of risk deals with time; that is, the inability to complete the construction of a facility within a specified duration. For projects in which the time to market is critical, delays could mean failure to reach the market ahead of competitors. In addition, delays in the completion of certain construction projects could mean lost revenue because every day that the completion of a facility extends beyond the planned completion date represents a day that the facility cannot be used. Mulholland and Christian [16] in their study on risk assessment in construction schedules mentioned excessive change orders, poor communication between disciplines, poor planning, incompetent management and poor management controls as some of the causes of schedule overrun. It can be concluded from the causes of cost and schedule overrun listed above that some of the causes of budget overruns can also cause schedule overruns. Thus cost and schedule risks can be interrelated and this is unsuspectingly expressed in the popular phrase “Time is money”.

The third risk is design related, that is, risk related to the technical characteristics of the constructed facility. This type of risk could simply be described as a constructed facility failing to meet performance requirements. Quality control and safety should be the priority of all construction managers because defects or failures in constructed facilities can result in very large costs of re-construction and even severe injuries and deaths in the worst case.

It should be noted that the order in which the different types of construction risks are mentioned above does not necessarily depict order of importance even though for some projects one type of risk may be more critical than the others. Each construction project has its own technical characteristics and these differ from project to project. The technical characteristics of any construction project will depend on the construction type, execution time as well as the construction environment [17]. This leads to a different risk management atmosphere for each project. Risk management can be described in this context as a systematic procedure of controlling all risks that are predicted to be faced on a project rather than as a kind of insurance system. The development of construction projects involves considerable risk due to the uniqueness of different projects, the uncertainties introduced by project stakeholders and intrinsic and extrinsic constraints [18]. Risks can adversely impact the achievement of key project objectives of time, cost and quality. The failure to reach pre-defined project objectives could mean extra costs over the planned costs and less returns on investment to the owner. To the engineers and/or architects, it could mean loss of the confidence their clients have in them. To the contractors, it could mean loss of profit through penalties for non-completion and declined client satisfaction that could affect their chances of future jobs [18]. There is therefore the necessity to determine which risks are likely to affect all projects and document the characteristics of each in order to devise means of addressing these risks.

## 2.2. Systematic Risk Management and Analysis

Companies work on several stages of many industries, recognized increasing importance of managing risks. Risk management can be defined as monitoring risks in a systematic structure that helps minimizing the affects of possible adverse events. Risk management is a stepwise phenomenon as like every systematic method. The necessity to implement risk management in construction projects has increased day by day due to the rising complexity, size, competition, client–consumer relation, politic–economic–social structure of country, and environmental and physical conditions in such projects. Since, the management of risk has become a critical activity for the completion of projects within time schedule and budget. Risk management application provides doing more realistic estimations and preparing more accurate programs.

### 2.2.1. Goals and Benefits of Risk Management System

Risk management is a systematic process of identifying, analyzing and responding to project risks. The overall goal of the risk management process is to maximize the opportunities and minimize the consequences of a risk event. Benefits of risk management can be defined as:

- Obtaining more realistic planning and budgeting
- Accessing the project goals (Cost , time and quality)
- Selecting the appropriate type of contract
- Determining the contingency
- Gathering statistical information for future projects
- Awareness against the project risks

Project risk management does not remove the uncertainties; however, it shows the possible results between a completely determined or a completely uncertain situation in an uncertain atmosphere. Main Goals of risk management system can be defined as :

- Managing the risks after identifying and analyzing them.
- Preventing a problem before it occurs,
- Achieving the Project goals : project performance, cost and Schedule
- Defining the source of effective risks and taking action against them

### 2.2.2. Systematic Risk Management Framework

There are several suggestions to improve the project risk management processes in the literature. All of these processes basically have the same phases; only the level of detail in describing processes varies. All of them are meant to be iterative processes where risk management phases are kept ongoing during the whole project life-cycle [19].

The risk management system suggested in PMBOK Guide [3] with 6 phases is given in Table 2.1.

Table 2.1. Project risk management overview

| ***STAGES*** | ***DEFINITION*** |
| --- | --- |
| Risk Management Planning | Deciding how to approach ,plan and execute the risk management activities for a project |
| Risk Identification | Determining which risk might affect the Project and documenting their characteristics |
| Qualitative Risk Analysis | Prioritizing risks for subsequent further analysis or action by assessing and combining their probability of occurrence and impact |
| Quantitative Risk Analysis | Numerically analyzing the effect on overall Project objectives of identified risks |
| Risk Response Planning | Developing options and actions to enhance opportunities , and to reduce threats to Project objectives |
| Risk Monitoring and Control | Tracking identified risks , monitoring residual risks, identifying new risks, executing risk response plans, and evaluating their effectiveness throughout the Project life cycle. |

2.2.2.1. Risk Management Planning: Risk Management Planning is the process of deciding how to approach and conduct the risk management activities for a project. Planning of risk management process is important to ensure that the level, type and visibility of risk management are commensurate with both the risk and importance of the project to the organization, to provide sufficient resources and time for risk management activities, and to establish an agreed-upon basis for evaluating risks [3].

The result of Risk Management Planning is a Risk Management Plan. The risk management plan identifies and establishes the activities of risk management for the project in the project plan.

The tools and techniques for planning is arranging planning meetings and analysis within project teams.

2.2.2.2. Risk Identification: Risk identification determines what might happen that could affect the objectives of the project and how those things happen.

The Institution of Civil Engineers et al. [20] produced a guide for managing risk in projects. They highlight the importance of identifying risk because those which are not identified cannot be managed [20].

Risk identification determines which risks might affect the project and document their characteristics. Participants in risk identification activities can include the following, where appropriate: the project manager, project team members, risk management team, subject matter experts from outside the project team, customers, end users, other project managers, stake holders and risk management experts. While these personnel are often key participants for risk identification, PMBOK [3] suggests that all project personnel should be encouraged to identify risks. The efficiency of risk identification belongs to the information obtained by the decision maker. The information is the main resource in risk identification phase.

There are a number of tools and techniques for identifying the project risks. These are documentation reviews, brainstorming, expert opinion, interviewing, root cause identification, SWOT analysis, checklist analysis, assumption analysis and diagramming techniques. Empirical studies of risk management practice show that checklist and brainstorming are the most usable techniques.

One approach for risk identification is preparing a Risk Breakdown Structure (RBS). PMBOK [3] defines the RBS as a structure that ensures a comprehensive process of systematically identifying risk to a consistent level of detail and contributes to the effectiveness and Quality of risk identification.

PMBOK [3] represented an example of a RBS in the following Figure 2.2. where also denoted the different RBSs will be appropriate for different types of projects.

According to PMBOK [3] different RBS s will be appropriate for different types of projects and the benefit of this approach is to remind participants in a risk identification exercise of the many sources from which project risk may arise.

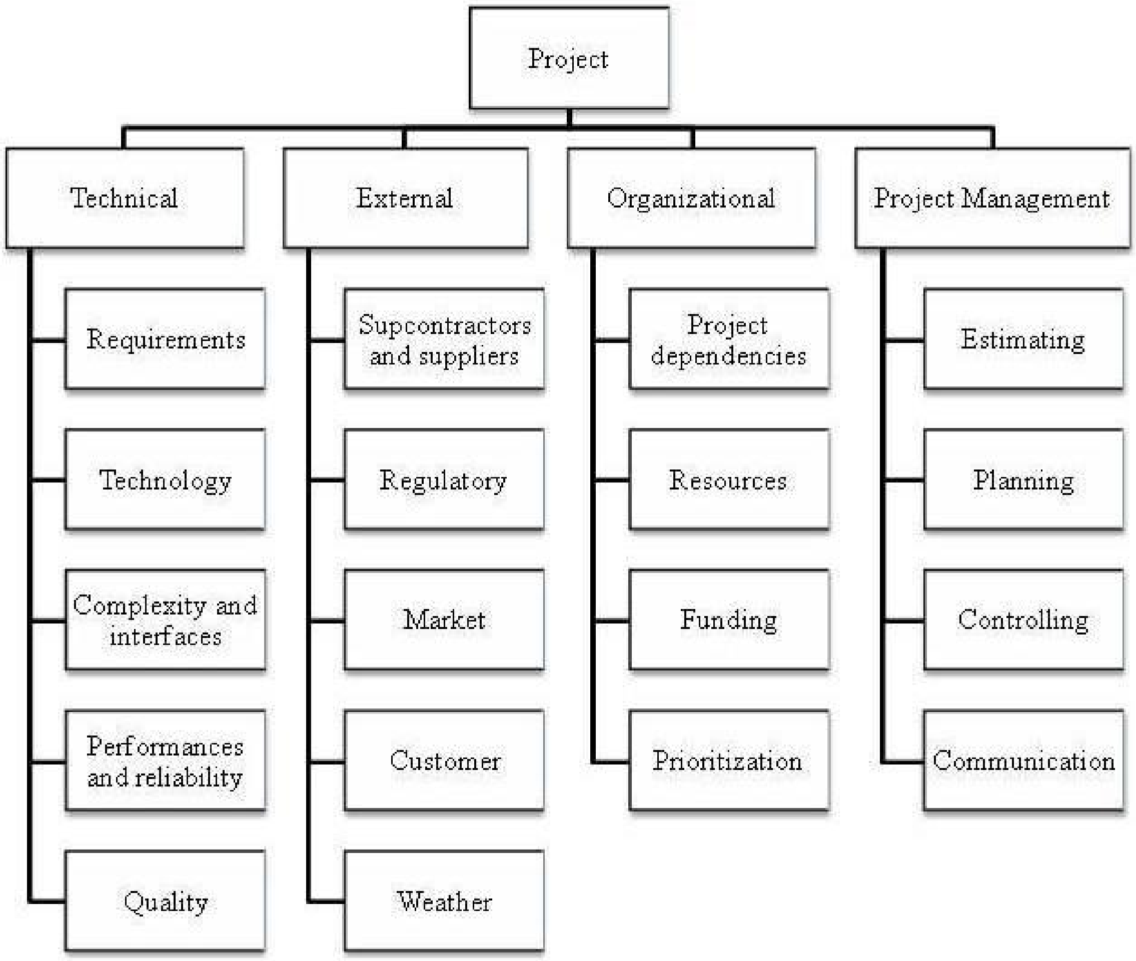



Figure 2.2. Example of a risk breakdown structure (RBS) [3]

2.2.2.3. Qualitative Risk Analysis: Qualitative risk analysis includes methods for prioritizing the identified risks for further actions, such as quantitative risk analysis or risk response planning. Organizations can improve the projects performance effectively by focusing on high-priority risks. Qualitative risk analysis assesses the priority of identified risks using their probability of occurring, the corresponding impact on project objectives if the risks do occur, as well as other factors such as the time frame and risk tolerance of the project constraints of cost, schedule, scope and quality [3].

Probability and impact matrix is the most common used technique of qualitative risk analysis.

The probability and impact matrix illustrates a risk rating assignment for identified risks. Each risk is rated on its probability of occurrence and impact upon objective. From a spotlight analysis reds are in the high risk zone, yellows are medium risk, and greens are low rated risks which should just be added to the watch list.

Figure 2.3. illustrates an example of Probability and Impact Matrix given in PMBOK [3] with the score scales.

| | **Impact** | | | | |
|---|---|---|---|---|---|
| **Probability** | **Very Low** | **Low** | **Medium** | **High** | **Very High** |
| **Very High** | 5 | 9 | 18 | 36 | 72 |
| **High** | 4 | 7 | 14 | 28 | 56 |
| **Medium** | 3 | 5 | 10 | 20 | 40 |
| **Low** | 2 | 3 | 6 | 12 | 24 |
| **Very Low** | 1 | 1 | 2 | 4 | 8 |

| **Scale** | | |
|---|---|---|
| Up to 5 | 5 to 23 | 23 or higher |

Figure 2.3. Probability and impact matrix [3]

Specifically in Figure 2.3. the red area with the largest numbers represents high risk; the green area with the smallest numbers represents low risks; and the yellow area with in-between numbers represents moderate risks.

The default Probability and Impact Scoring values are calculated using probability factors from VL to VH as 1,3,5,7 and 9, and impact factors from VL to VH as 0.5,1,2,4 and 8 with the factors rounded up to the nearest whole number. These are based on PMBOK [3] scores.

The score is calculated as (Probability factor* Impact factor)

Impact Factor is calculated as (Cost Impact Factor + Schedule Impact factor) /2

2.2.2.4. Quantitative Risk Analysis: A project risk analysis should indicate how things could vary from the project goals, which gives an opportunity to make changes or manage the project in a way that will improve the chance of meeting those goals.

The quantitative risk analysis process analysis the effect of risk events and assigns a numerical rating to those risks. Quantitative risk analysis is a way of numerically estimating the probability that a project will meet its cost and time objectives. Quantitative analysis is based on a simultaneous evaluation of the impact of all identified and quantified risks. The result is a probability distribution of the project's completion date based on the identified risks in the project.

There are several techniques for quantitative risk analysis. PMBOK [3] suggests Monte Carlo simulation as a powerful tool. Monte Carlo is known to be more powerful than the other methods existing in the risk management [3]. Nevertheless, the power of Monte Carlo simulation lies behind the effectiveness of the modeling. Constructing models that best reflect real world situations is extremely important in order to reach realistic schedule and cost estimates.

The Monte Carlo process creates a series of probability distributions for potential risk items and randomly samples the distributions and the numbers into useful information that reflects the quantification of a project's potential risks [8].This process can be used to assess a project by using either project cost or schedule as the parameter to analyze project success or both.

Unlike the deterministic duration and cost values employed in standard Project Scheduling and Cost Estimation Methods, the durations and costs are assigned in a stochastic manner. The probability distributions of the activities are provided by expert judgment of the responsible managers of the proposed project and/or from historical data, if it is possible and available. Monte Carlo simulation is a form of stochastic simulation, which involves the random sampling of each probability distribution within the model to produce hundreds or even thousands of scenarios [21].

Once the distributions are assigned, the Monte Carlo simulation is conducted on the computer with an acceptable trial (run) time. The number of runs (N) is a factor that can influence the estimates. It is preferred to have N large enough to obtain a smoother histogram and cumulative frequency chart. : In terms of quantitative risk analysis, the optimum number of iterations was found to be 1000, and iterations beyond this number have produced results where the outcomes do not change significantly [22].

During each iteration, the random number generators select random values within the assigned probability distribution. The total duration is determined by the addition of outcome durations of each activity involved in the analysis. The result of the simulation can be analyzed by the distribution of the trial outcomes.

2.2.2.5. Risk Response Planning: Risk response planning is the process of developing options, and determining actions to enhance opportunities and reduce treats to the project's objectives.

There are mainly four response types to cope with the negative risks:

- Avoid: Risk avoidance deals with the risks by changing the project management plan or finding methods to eliminate risks such as: reducing the scope, extending the schedule etc.
- Transfer: Risk transferring requires transferring the risk to another party by contracts or insurance.

- Mitigate: Risk mitigation implies a reduction in the probability and /or impact of an adverse risk event to an acceptable threshold.
- Accept: This strategy indicates that the project team has decided not to change the project management plan to deal with a risk. This means that the project involves that risk. Project team can develop a contingency plan or wait until the risk is triggered.

2.2.2.6. Risk Monitoring and Control: Risk Monitoring and control involves track of the identified risks. It also monitors the execution of planned strategies on the identified risks and evaluates their effectiveness. Risk monitoring and control continues for the life of the project. The list of project risk changes as the project matures, new risks develop, or anticipated risks disappear [23]. Figure 2.4. below shows the Risk Management Process Flow Diagram which starts with Risk Management Planning and continues with other steps.


Figure 2.4. Risk management process flow diagram

### 2.3. Evaluation of Hospital Project Main Phases

Flanagan and Norman [13] emphasize two aspects of any construction project: the process and the organization. From the process perspective, any construction project comprises a number of sequential phases. The simplest approach identifies two main phases –project development and project implementation. These two can be further detailed and developed into a large number of phases, e.g. feasibility, design, procurement, construction, commissioning, and operation.

Figure2.5. shows the sequence of the main phases developed for this research and case study and below they are explained shortly. The first three phases are named as Project development phase and the final two phases are named as Project implementation phase.

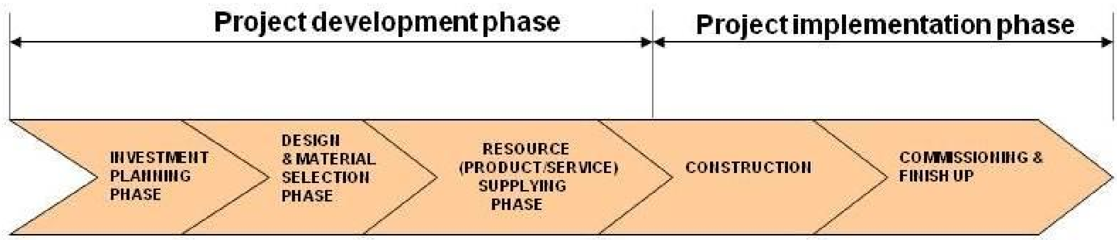



Figure 2.5. Hospital project main phases

(i) Investment Planning Phase: In the investment planning phase location selection, needs assessment, selection of administrative and medical staff, feasibility studies, site survey, scoping, preliminary budgeting and scheduling works are performed.

(ii) Design Phase: Design phase includes conceptual design, preliminary design and functional design for hospital, medical equipment planning, final application project drawings with material and equipment selections for interior design.

(iii) Resource (Product/ Service) Supplying Phase: Resource supplying phase includes the labor, materials and special equipments procurements and deliveries.

(iv) Construction Phase: Construction phase includes structural, architectural, electrical, mechanical works, landscaping and medical equipment installation.

(v) Commissioning Phase: Review of construction by considering the general and technical specifications, deficiencies determinations and corrections are done in this phase. At the end of this phase, commissioning is performed.

Figure 2.6. below shows the major activities through these main phases in the Gantt Chart form, which also shows the dependencies between the activities and the critical ones in red color.

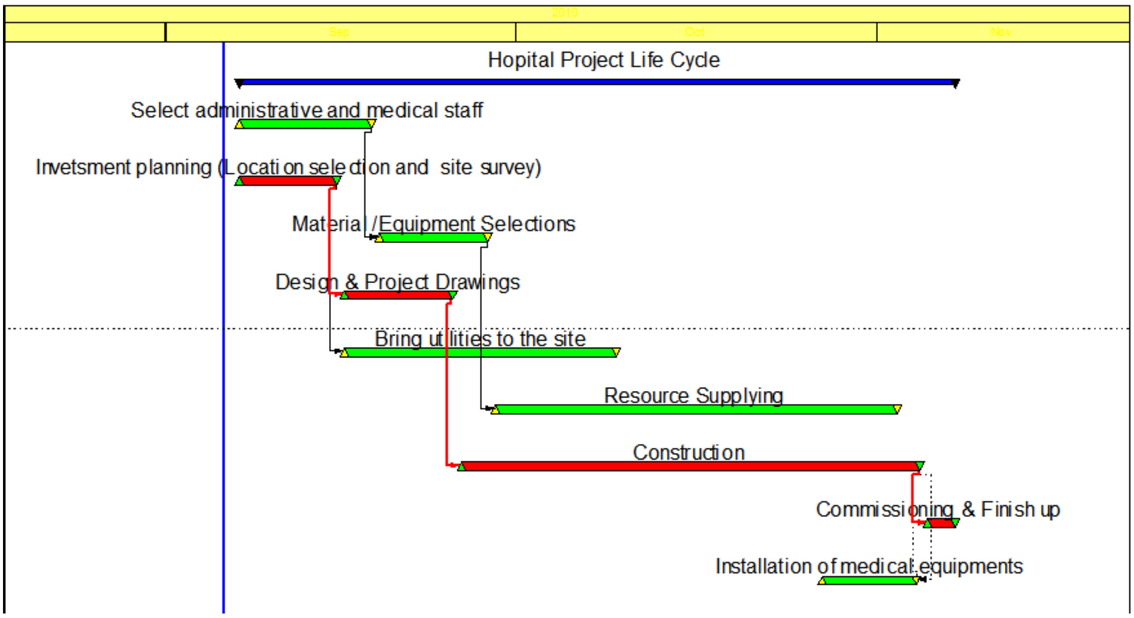



Figure 2.6 Hospital project Gantt Chart

A hospital investment starts with location selection and feasibility studies. The phase where the ideas of investor take shape on paper is the design phase including preliminary design, design development and detailed design works. After obtaining preliminary design permits material selections and equipment selections start and continue with resource supplying. Right after completing of design phase, construction phase starts and the project finishes with installation of medical equipments and performance of commissioning.

At different stages of project development, there are different types of potential risks. At the investment planning stages, for example the client might not have decided exactly on the car parking area that is required, or an amount of additional units in a hospital project may be in abeyance. Such matters will represent an uncertainty from the estimator’s point of view.

The need for piling for foundation is another example of uncertainty. Some of the uncertainties will be eliminated or clarified as the planning of the project develops toward detailed design stage when, for example, the client has decided additional units required. Some uncertainties will be carried forward to construction stage.

Risk management process should take place in both the project development and implementation phases.

# 3. ESTABLISHING RISK CHECK LIST FOR HOSPITAL PROJECTS

The aim of this chapter is to identify the risks and establish a risk check list for Private Hospital Investments through investment planning phase to commissioning phase and to help potential health industry investors to be aware potential risks in private hospital projects in Turkey. This is achieved through a broad literature review and interviews with 102 people involving investors, hospital directors, project engineers and project managers that have been associated with hospital projects. A Risk Breakdown structure is developed for the identification of risks under the identified main phases of a hospital project. Finally, a risk checklist for Private Hospital projects is established including country, location site, legal, client, and contractor related risks.

## 3.1. Developing a Risk breakdown Structure

In this section the most significant risk categories causing delays and cost overruns of a hospital construction project is analyzed by risk break down structure method. The objective is to define the risk factors that can be faced during a hospital project main phases that are explained above in section 2.3. For this reason, risks are defined under 11 Risk Classification sub-categories.

The subcategories of risks reflect all types of risk source for hospital projects. It would provide a systematic and objective approach to the risk identification process and ensure that no major risk element is overlooked. With various project delivery methods, the provisions addressed in the terms and conditions of construction contracts, and various project resources and characteristics, risks should be identified specifically upon needs for a specified project.

Table 3.1. Risk classification sub-categories

| **Risk Classification sub-categories** |
|---|
| 1-Country related |
| 2-Legal |
| 3-Lack of Project Management |
| 4-Direct Client |
| 5-Design Team |
| 6-Technology |
| 7-Financial |
| 8-Procurement/Production |
| 9-Contractor |
| 10-Contract |
| 11-Site Location |

A source oriented risk break down structure (RBS) is developed, which consist of the main phases of hospital projects, namely investment planning, design, resource supplying, construction, commissioning, Figure 3.1. shows the RBS structure developed for this study.

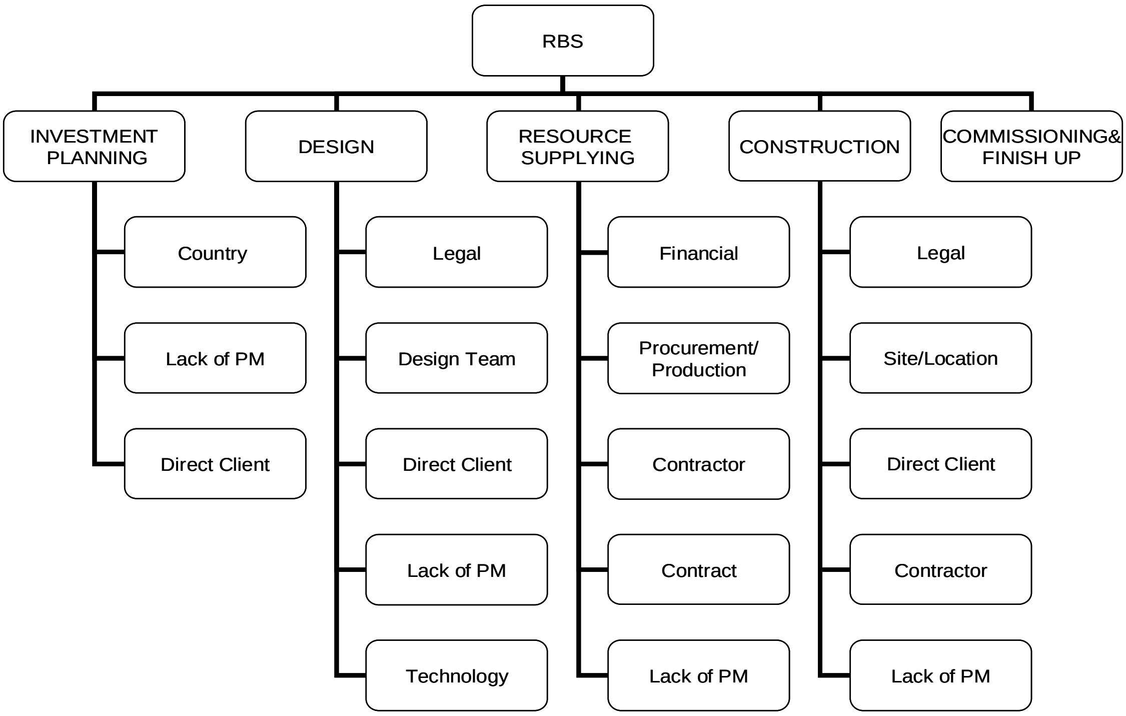



Figure 3.1 Risk breakdown structure for hospital projects

### 3.2. Risk Checklist

The risk listing would be beneficial for risk identification and qualitative analysis of risk analysis process. It serves as a guideline of potential risks for hospital projects. The list would be helpful for breaking down all risks into manageable components as well.

In order to identify the risks associated with the whole Hospital project life-time, risks that might be faced through each phase of projects, which effects the schedule and cost performance of projects, are investigated through interviews arranged with 102 people involving Project Managers, Construction Supervisors, Technical Office Chiefs/Managers, Planning Engineers, Cost Engineers, Architects, Electrical, Mechanical Engineers who have experience on Hospital Projects.

In addition, brainstorming sessions and discussions performed with Investors and Hospital Directors during these interviews to identify the potential risks investment planning phase of Hospitals.

The demographic characteristics of the participants who are involved in these interviews are given in Table 3.2. with their occupational levels supported by a pie chart graph on Figure 3.2. to show the distribution of occupational levels of participants.

Table 3.3. shows the 110 risks that have been explored through examining the project’s documents, contract clauses, and conversations arranged with investors, design teams, consultants and construction teams of 5 different companies acting in private hospital projects in Turkey. There are 87 risks are selected from the literature review that may have effect on hospital construction projects and 23 risks are added through the interviews.

Table 3.2. Demographic characteristics of participants with their occupational levels

| **Fields of specializations** | **Number of participants** | **Percent** |
|---|---|---|
| Owner/Investor | 5 | 4.90 |
| General Manager | 1 | 0.98 |
| Project Coordinator | 1 | 0.98 |
| Project Manager | 8 | 7.84 |
| Hospital Director | 7 | 6.86 |
| Technical Office Chief/Manager | 15 | 14.71 |
| Mechanical Engineer | 9 | 8.82 |
| Electrical Engineer | 8 | 7.84 |
| Architect | 22 | 21.57 |
| Planning Engineer | 5 | 4.90 |
| Cost Engineer | 3 | 2.94 |
| Construction Supervisor | 9 | 8.82 |
| Business Development Specialist | 1 | 0.98 |
| Biomedical Engineer | 4 | 3.92 |
| Product Engineer | 1 | 0.98 |
| Consultants | 3 | 2.94 |
| **Occupational level** | **Number of participants** | **Percent** |
| Top Level Manager | 62 | 60.79 |
| Senior Manager | 28 | 27.45 |
| 1-5 years experienced | 12 | 11.76 |
| **Total** | **102** | **%100.00** |

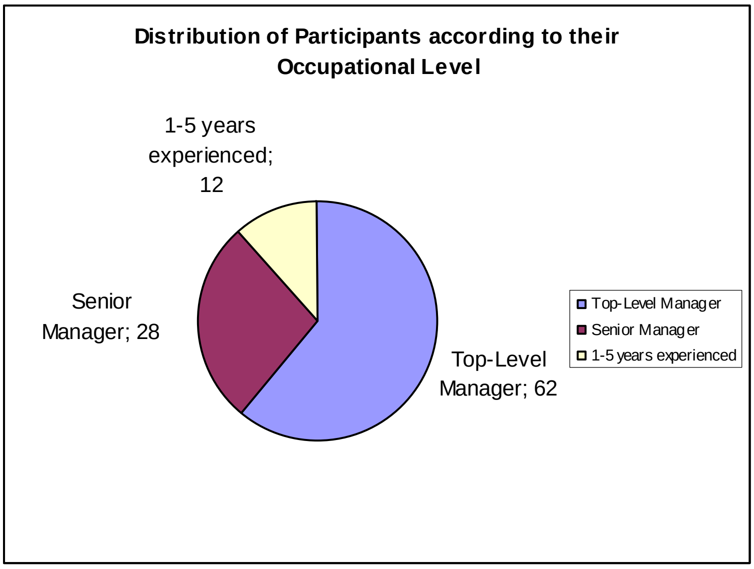



Figure 3.2. Distribution of participants according to their occupational level

Table 3.3. Risk checklist for hospital projects in Turkey

| **RISK CHECKLIST FOR PRIVATE HOSPITAL PROJECTS IN TURKEY** | |
|---|---|
| **1- INVESTMENT PLANNING PHASE** | **From** |
| • **Country Risks** | |
| I-01. Political instability or support changes | L.R. |
| I-02. Changing Social structure | L.R. |
| I-03. Economical instability | L.R. |
| I-04. Income Rate | L.R. |
| I-05. Customs and tariff agreements change | L.R. |
| I-06. Bureaucracy change | L.R. |
| I-07. Bureaucratic Delays | L.R. |
| I-08. Changes in conditions affecting viability of completed project | Interviews |
| I-09. Land owner problems | L.R. |
| • **Lack of Project Management** | |
| I-010. Inadequate feasibility studies | L.R. |
| I-011. Inadequate use of previous project experiences | Interviews |
| I-012. Incomplete surveys | L.R. |
| I-013. Inaccurate assumptions on technical issues in planning stage | L.R. |
| I-014. Inadequacy of schedule requirements (Activity durations, wrong critical path) | L.R. |
| I-015. Inadequate technical information | L.R. |
| I-016. Omitting the activities defined in the scope | L.R. |
| I-017. Inadequate estimation of quantities / costs | L.R. |
| I-018. Inadequate needs estimation of resources (material /equipment or contractors) | L.R. |
| • **Direct Client** | |
| I-019. Incomplete project scope definition and needs | L.R. |
| I-020. Unclear scope definition | L.R. |
| I-021. Appointing inadequate person/project team for organization scheme | L.R. |
| I-022. Unspecified administrative and medical staff | Interviews |

Table 3.3. Risk checklist for hospital projects in Turkey (con't)

| **2- DESIGN & MATERIAL SELECTION PHASE** | **From** |
|---|---|
| • **Legal** | |
| D-01. Change in municipal plans | Interviews |
| D-02. Changes in regulations of Private Hospital Act | Interviews |
| D-03. Need for new permits or additional information | Interviews |
| D-04. Delay in obtaining General Project Approvals | L.R. |
| D-05. Delay in obtaining Construction Permit for Hospital | Interviews |
| D-06. Delay in obtaining Pre-Approval for Ministry of Health | Interviews |
| D-07. Delay in obtaining Building Usage Permit | Interviews |
| D-08. Inability to get Construction Permit for Hospital | Interviews |
| D-09. Inability to get Pre -approval | Interviews |
| D-010. Inability to get General Project permit approvals (Chambers of architects and engineers, Municipality approvals, fire department approvals, elevator use permit….etc.) | Interviews |
| • **Design Team** | |
| D-011. Inadequate functional planning (Medical Design) | Interviews |
| D-012. Inadequate design for meeting Private Hospital Act's requirements | Interviews |
| D-013. Failure to meet due dates | L.R. |
| D-014. Revised works due to design mistakes | L.R. |
| D-015. Design inappropriate to budget | L.R. |
| D-016. Incomplete design | L.R. |
| D-017. Unresolved constructability items | L.R. |
| D-018. Incomplete quantity estimates | L.R. |
| • **Direct Client** | |
| D-019. Delay in design and plan approvals | L.R. |
| D-020. Delays in selection of interior design materials | Interviews |
| D-021. Change in quantity/scope of work | L.R. |
| D-022. Change in quality of materials defined in the preliminary design | L.R. |
| • **Lack of Project Management** | |
| D-023. Design changes due to doctors' demands | Interviews |
| D-024. Inadequate coordination between medical consultant and design team | Interviews |
| D-025. Conflicts between design and construction site | L.R. |
| D-026. Lack of communication and/or information with operator of a brunch | Interviews |
| D-027. Lack of consultancy for local norms & regulations | L.R. |
| D-028. Lack of tracking for necessary permits and approvals | Interviews |
| • **Technology** | |
| D-029. Technological change | L.R. |
| D-030. New medical equipment /device cost | Interviews |
| D-031. System performance requirements or guarantees | L.R. |

Table 3.3. Risk checklist for hospital projects in Turkey (con’t)

| **3- RESOURCE SUPPLYING PHASE** | **From** |
|---|---|
| • **Financial** | |
| R-01. Exchange rate fluctuation/devaluation | L.R. |
| R-02. Change in market prices and inflation | L.R. |
| R-03. Cash flow and credit problems | L.R. |
| R-04. Interest rate changes of financial credits | L.R. |
| R-05. Cost changes of labor, material, equipment | L.R. |
| • **Procurement & Production** | |
| R-06. Delays in procurement of materials | L.R. |
| R-07. Procurement durations longer than expected | L.R. |
| R-08. Production durations longer than expected | L.R. |
| R-09. Damage to material /equipment | L.R. |
| R-010. Material Storages or damage to stored materials | L.R. |
| R-011. Medical Equipment transfer risk (MR, CT, Tomography, X-ray etc.) | Interviews |
| • **Contractor** | |
| R-012. Wrong contractor selection (non-qualified labor) | L.R. |
| R-013. Supplier –contractor’s additional requests | L.R. |
| R-014. High quality obligations | L.R. |
| R-015. High technical specification terms | L.R. |
| R-016. Contractor's reliability | L.R. |
| R-017. Contractor’s financial position | L.R. |
| R-018. Lack of previous experience | L.R. |
| R-019. Unavailability of sufficient amount of skilled labor | L.R. |
| • **Contract** | |
| R-020. Wrong Supplier Selection | L.R. |
| R-021. Performance guarantee | L.R. |
| R-022. Indefinite work scope | L.R. |
| R-023. Unarranged issues during contract | L.R. |
| R-024. Conflicts between contractual clauses | L.R. |
| R-025. Obligations for using local materials | L.R. |
| R-026. Warranties / Guarantee period | L.R. |
| R-027. Inadequate level of work scope definition in the contract | L.R. |
| • **Lack of Project Management** | |
| R-028. Late Procurement of Equipment/ Material | L.R. |
| R-029. Improper definitions for material specs. or production methods | L.R. |
| R-030. Improper or inefficient construction means and methods | L.R. |
| R-031. Inadequacy of pre-quality control | L.R. |
| R-032. Procurement plan delays | L.R. |
| R-033. Production plan delays | L.R. |
| R-034. Managerial /supervisory inadequacy or inefficiency | L.R. |

Table 3.3. Risk checklist for hospital projects in Turkey (con't)

| **4- CONSTRUCTION PHASE** | | **From** |
|---|---|---|
| • **Legal** | | |
| C-01. | General legislative change | L.R. |
| C-02. | Health specific legislative change | L.R. |
| C-03. | Strike | L.R. |
| • **Site-Location** | | |
| C-04. | Unforeseen ground conditions | L.R. |
| C-05. | Exceptionally inclement weather | L.R. |
| C-06. | Necessity of working time changes due to construction noise impacting adjacent businesses or residents | L.R. |
| C-07. | Natural Disasters | L.R. |
| • **Direct Client** | | |
| C-08. | Change in Financial Condition of Client | L.R. |
| C-09. | Change in payment /cash flow program of Client | L.R. |
| • **Contractor** | | |
| C-010. | Contractor's inadequacy of materials, labors and/or equipments | L.R. |
| C-011. | Contractor's efficiency under standards | L.R. |
| C-012. | Inadequate quality of work and need for correction | L.R. |
| C-013. | Inadequacy of implementing specification terms | L.R. |
| • **Lack of Project Management** | | |
| C-014. | Inadequate coordination | L.R. |
| C-015. | Construction methodology mistakes | L.R. |
| C-016. | Electro-mechanical works methodology mistakes | L.R. |
| C-017. | Inadequate quality management procedures | L.R. |
| C-018. | Inadequate internal financial controls | L.R. |
| C-019. | Doing business without proper license | L.R. |

Table 3.3. Risk checklist for hospital projects in Turkey (con't)

| **5- COMMISSIONING & FINISH UP PHASE** | | **From** |
|---|---|---|
| F-01. | Guarantee period | L.R. |
| F-02. | Inability to get Building Usage Permit for Hospital | Interviews |
| F-03. | Overly burdensome inspection and testing requirements | L.R. |
| F-04. | Medical equipment test & commissioning cost/ duration | Interviews |

# 4. CASE STUDY

## 4.1. Introduction

This Case Study shows the effects of potential risks impacting design and construction phases of hospital projects in Turkey. This is achieved by performing both qualitative and quantitative risk analysis and tracking the impacts of risks on cost and schedule of the entire project. Also, the study compares the deterministic plan with the stochastic plan obtained after risk analysis.

The methodology of the case study mainly conducted in two parts.

In the first part, deterministic plans are developed. A work breakdown structure (WBS) is build up to divide the project into identifiable parts that will define the work to be performed. The WBS is used as base for deterministic project scheduling and cost estimation. Then a deterministic project schedule is established using Critical Path Method with Primavera Project Planning software. A cost estimation work is conducted in order to determine the total cost of developing the facility.

In the second part, risk identification and analysis is performed. Checklist and brainstorming techniques are used to conduct the risk identification process for the case study. Both the qualitative and quantitative risk analysis are conducted to prioritize the risks and to observe the effects of risks in a quantitative way.

Before discussing the risk analysis in this case study, it should be emphasized that this study is performed in a hospital project of a Company that is specialized in hospital construction project in Turkey. Obviously there are advantages of working on this specific building project and with this specific Company while identifying and analyzing the risks of Private Hospital Construction Projects in Turkey. These advantages can be summarized as: the company is the only and the biggest company specialized for hospital project management, construction and design in Turkey. Also, the Company belongs to the biggest Private Hospital Group in Turkey and has many experiences in hospital constructions. There are many completed Health-care facility projects that design, construction and project management's services have been conducted. Also a broad document and database including schedules and budgets are available. The experience and database of the company concerning hospital constructions have increased the reliability of the research.

#### 4.1.1. Company Description

The Company is carrying out Design, Project Management, Construction Management and Medical Equipment Procurement Services for healthcare facilities with its own team of experts and its local and international solution partners within a concept to successfully meeting the goals of the project in respect to quality, time and cost.

The scope of the design service includes medical planning, architectural design, electrical design, mechanical design and interior design. The design process starts with determination of design criteria and architectural requirements and covers functions of organizing design teams and specialist consultants, functional planning and preliminary design, selection of materials, design development.

The Project Management service range from preparing schedule, the tender and contracts to testing and commissioning management. Project management is served during project development and implementation phases covering pre-tender and tender processes, work schedule, cash flow plan, labor plan, quality and conformity with the design, contract management, conclusions of works.

The company completed 42 projects including different types of health-care facilities in 9 cities in Turkey since 2005, which means a wide range of recent Private Hospital Constructions in Turkey have been completed by the Company. Also the company worked with 9 different Clients in Turkey since 2005.

#### 4.1.2. Project Description

In this case study a Hospital is chosen which is located in close proximity of residential and business areas in Istanbul. With its architectural concept, high technology, physical interiors, internal equipment and range of medical services, the hospital bears the distinction of initiating many “firsts and differentiating factors”.

As one of the largest private hospitals in Istanbul, the Hospital stretches over an enclosed area of approximately 40.000 m² and has a capacity of 191 beds. The hospital is noteworthy for its multidisciplinary (disciplines complementing and supporting one another) and specialized approach. Special units set up within this framework consist of a Cancer and Radiotherapy Centre, Breast Clinic, Thyroid Clinic, Liver, Pancreas and Bile Duct Surgery Centre, Gastrointestinal Surgery Centre, Orthopaedics Clinic, an Ophthalmology Centre, Obstetrics and Gynaecology Clinic, IVF (Test Tube Baby) Centre, Interventional Cardiology, Electrophysiology and Interventional Radiology Laboratories and Third Level Neo-natal Intensive Care Unit.

Aiming to become the Oncology Base of Turkey, the Hospital boasts the most significant technological investment in the field of cancer in private healthcare sector.

The Hospital has been equipped with the “smart building” technology which runs different systems simultaneously by integrating them with one another through a central system. The electronic recording system allows the digital hospital to present all medical information to the physician and the patient in the safest possible manner and puts the hospital well on its way to becoming a paperless office with no files. The short term plans of the hospital include the institution of a system which will allow all treatment-related procedures performed on the patient to be entered in the digital environment, thus no longer necessitating the wet signature of the patient.

The specialized and multidisciplinary approach pioneered by the Hospital in the private healthcare sector aims to perform all disease-related tests and treatments fully under its own roof and with the latest medical technology available in the world.

The complex consists of 7 blocks and 8 stories (4 base floors, 1 ground floor and 3 normal floors). The site plan and floor plans of the project can be seen in Appendix A.

Including design works, structural works, electrical, mechanical, architectural and civil works, there are 73 sub-contractors that are planned to be included in the project.

There are approximately 50 white-collar project members appointed for this specific project. The organization scheme of the project can be seen in Figure 4.1.

The company started to carry out the design processes of the project on 01.06.2005. Preliminary deterministic estimation of the total duration of the project estimated was 989 days which gives a completion date of 24.02.2008 with a deterministic budget of $74.774.697.

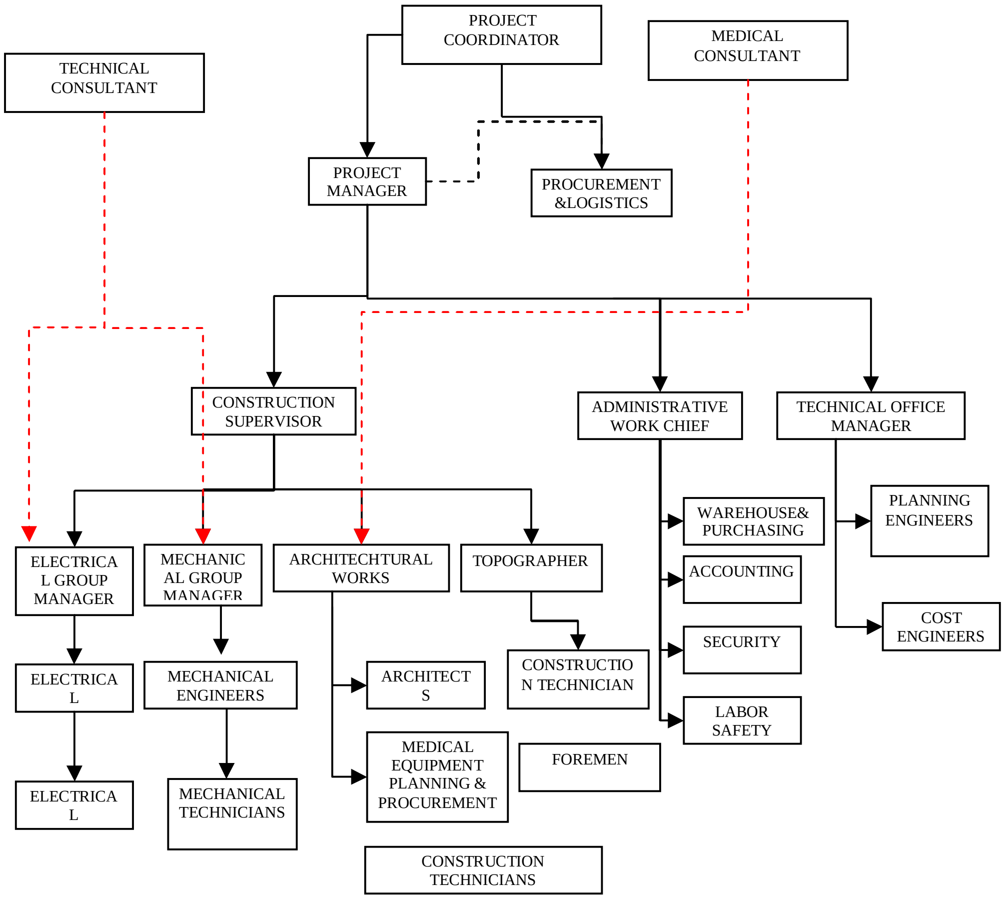



Figure 4.1. Organization scheme of the project

#### 4.1.3. Definitions of terms

Deterministic: A deterministic value is one that is not calculated from running a risk analysis. The word deterministic is used to distinguish between risk values and non-risk values.

The deterministic finish is the finish date as defined by the project and is a single value (e.g. 14th March 2008). The risk finish date is not a single value and is described using a distribution of finish dates.

The deterministic duration is the duration of a task and is a single value (e.g. 20 days). The risk duration is a distribution of durations that is described using one of the risk functions, e.g. Triangle (10, 20, and 35) - the duration varies between 10 and 35 days with 20 being the most likely.

Stochastic: A stochastic process is one whose behavior is non-deterministic, in that a system's subsequent state is determined both by the process's predictable actions and by a random element.

### 4.2. Developing deterministic schedule and cost estimate

#### 4.2.1. Work Breakdown Structure

To effectively manage any project, it is important to divide the project into identifiable parts that will unambiguously define the work to be performed to achieve pre-defined project objectives. It is essential for each identifiable part of a project to be sufficiently defined in order for work to be measured, budgeted, scheduled and managed. The various identifiable parts are referred to as work packages. The summation of work packages in a hierarchical format is called a Work Breakdown Structure (WBS). The U.S. Department of Energy Project Management Practices [24] defines a WBS as the cornerstone of effective project planning, execution, controlling and reporting. The WBS thus establishes a base for project scheduling and control. Figure 4.2. shows the WBS (a graphic representation of the division of work in a multi-level system) developed for this project.

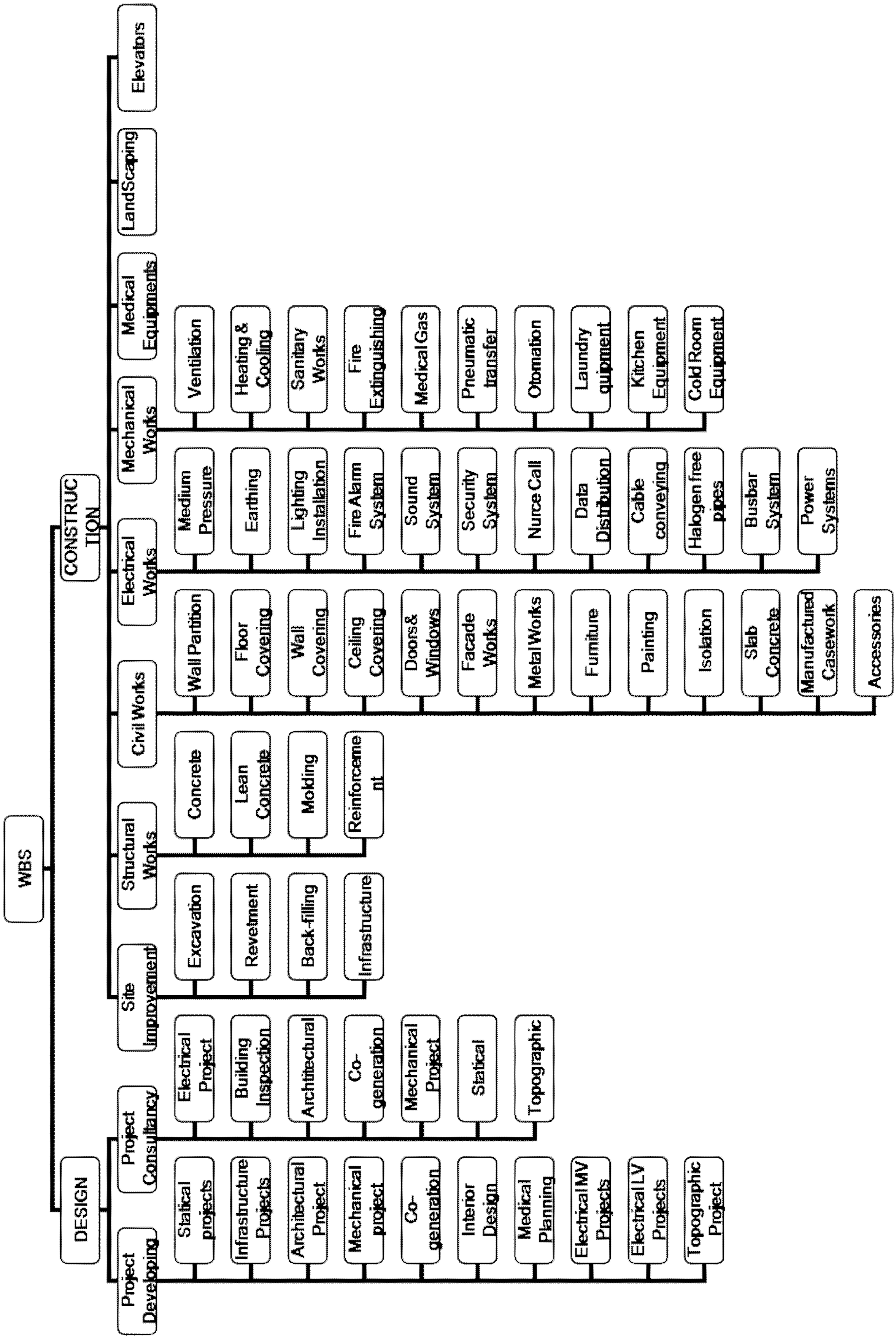
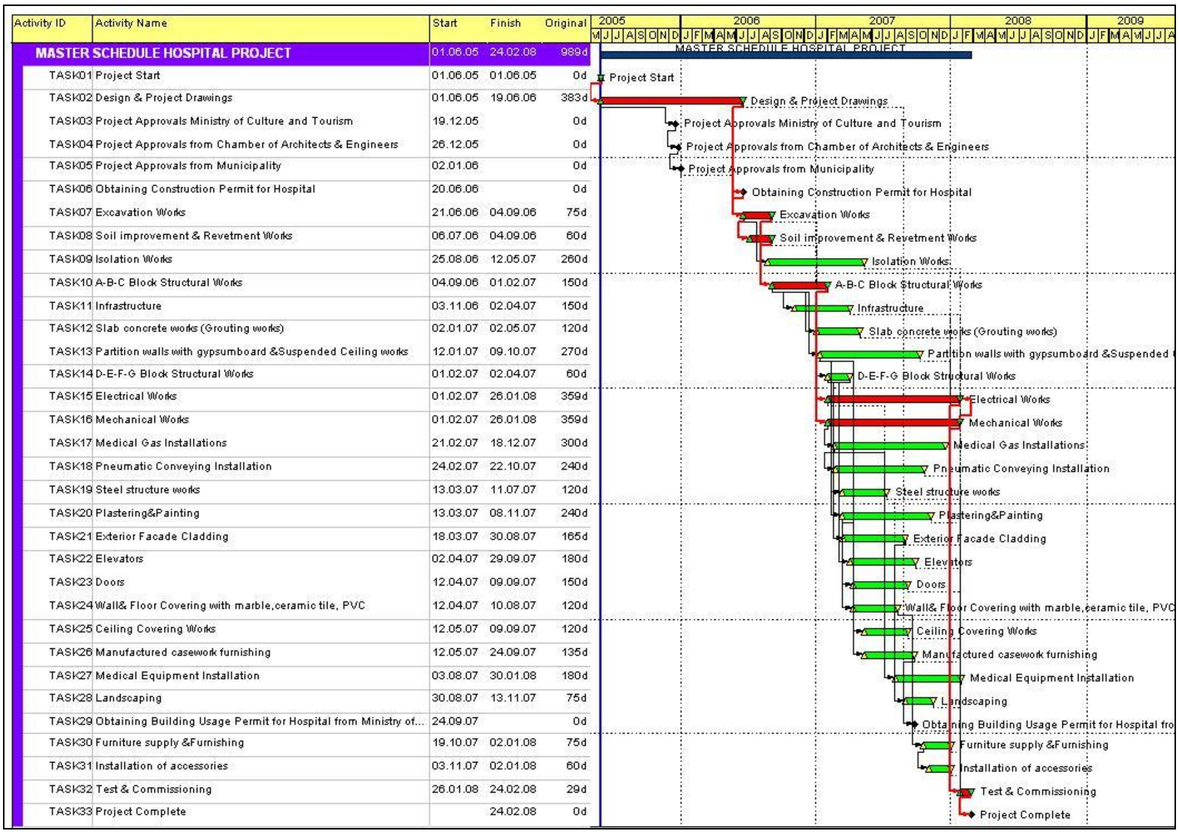



Figure 4.2. Work breakdown structure for the project

### 4.2.2. Deterministic Project Planning and Scheduling

The first step of the study is establishing a deterministic schedule on Primavera P6. Later this schedule is imported into a risk analysis software program to build a risk model by estimating uncertainties and risk events and further compare the deterministic schedule values with stochastic values obtained with the risk analysis.

For this purpose, of all the activities necessary to complete the project is identified at a Master level. This was done by referring to the various work packages on the WBS and determining what activities were to be carried out in order to complete the work. Once the planned activities had been identified, the relationships between activities were determined to obtain the sequence of activities. The duration of each activity was determined from the data base of the company on a detailed schedule which are defined by the design and the project management team (Project Manager, Electrical Engineer, Mechanical Engineer, Design team and others). The Critical Path Method (CPM) was then used to determine the total project duration using the activity durations and their relationships. The activities, activity durations and activity relationships were then entered into the Primavera P6 scheduling software. Figure 4.3. shows the master project schedule generated by Primavera P6 and the detailed schedule can be seen in Appendix B.



| Activity ID | Activity Name | Start | Finish | Original |
|---|---|---|---|---|
| | MASTER SCHEDULE HOSPITAL PROJECT | 01.06.05 | 24.02.08 | 989d |
| TASK01 | Project Start | 01.06.05 | 01.06.05 | 0d |
| TASK02 | Design & Project Drawings | 01.06.05 | 19.06.06 | 383d |
| TASK03 | Project Approvals Ministry of Culture and Tourism | 19.12.05 | | 0d |
| TASK04 | Project Approvals from Chamber of Architects & Engineers | 26.12.05 | | 0d |
| TASK05 | Project Approvals from Municipality | 02.01.06 | | 0d |
| TASK06 | Obtaining Construction Permit for Hospital | 20.06.06 | | 0d |
| TASK07 | Excavation Works | 21.06.06 | 04.09.06 | 75d |
| TASK08 | Soil improvement & Revetment Works | 06.07.06 | 04.09.06 | 60d |
| TASK09 | Isolation Works | 25.08.06 | 12.05.07 | 260d |
| TASK10 | A-B-C Block Structural Works | 04.09.06 | 01.02.07 | 150d |
| TASK11 | Infrastructure | 03.11.06 | 02.04.07 | 150d |
| TASK12 | Slab concrete works (Grouting works) | 02.01.07 | 02.05.07 | 120d |
| TASK13 | Partition walls with gypsumboard &Suspended Ceiling works | 12.01.07 | 09.10.07 | 270d |
| TASK14 | D-E-F-G Block Structural Works | 01.02.07 | 02.04.07 | 60d |
| TASK15 | Electrical Works | 01.02.07 | 26.01.08 | 359d |
| TASK16 | Mechanical Works | 01.02.07 | 26.01.08 | 359d |
| TASK17 | Medical Gas Installations | 21.02.07 | 18.12.07 | 300d |
| TASK18 | Pneumatic Conveying Installation | 24.02.07 | 22.10.07 | 240d |
| TASK19 | Steel structure works | 13.03.07 | 11.07.07 | 120d |
| TASK20 | Plastering&Painting | 13.03.07 | 08.11.07 | 240d |
| TASK21 | Exterior Facade Cladding | 18.03.07 | 30.08.07 | 165d |
| TASK22 | Elevators | 02.04.07 | 29.09.07 | 180d |
| TASK23 | Doors | 12.04.07 | 09.09.07 | 150d |
| TASK24 | Wall& Floor Covering with marble,ceramic tile, PVC | 12.04.07 | 10.08.07 | 120d |
| TASK25 | Ceiling Covering Works | 12.05.07 | 09.09.07 | 120d |
| TASK26 | Manufactured casework furnishing | 12.05.07 | 24.09.07 | 135d |
| TASK27 | Medical Equipment Installation | 03.08.07 | 30.01.08 | 180d |
| TASK28 | Landscaping | 30.08.07 | 13.11.07 | 75d |
| TASK29 | Obtaining Building Usage Permit for Hospital from Ministry of... | 24.09.07 | | 0d |
| TASK30 | Furniture supply &Furnishing | 19.10.07 | 02.01.08 | 75d |
| TASK31 | Installation of accessories | 03.11.07 | 02.01.08 | 60d |
| TASK32 | Test & Commissioning | 26.01.08 | 24.02.08 | 29d |
| TASK33 | Project Complete | | 24.02.08 | 0d |

Figure 4.3. Deterministic work schedule for the project

The deterministic schedule analysis has shown that the project completion date is 24.02.2008 with a start date of design on 01.06.2005 which means that the duration of the project is 989 days.

### 4.2.3. Detailed Cost Estimate

A detailed cost estimate was prepared in order to determine the total cost of developing the facility. This was done by making quantity takeoff, unit price analysis, market search for resource prices and etc. The required materials as well as their quantities were determined from the construction drawings. Appendix C shows detailed cost estimates for the sub-divisions of WBS of the project (i.e. Static projects, architectural projects, excavation, infrastructure, structural works, thermal and moisture isolation, partition walls, plastering& painting, doors and windows). Table 4.1. provides a summary of the estimates. Detailed cost estimate shows that the deterministic budget of the project is $74.774.697.

Table 4.1. Summary of cost estimate for the project

| WBS Activities | Amount |
|---|---|
| **Design** | **$413.930.00** |
| Complete Design | $284.555.00 |
| Consultancy | $129.375.00 |
| **Construction** | **$74.360.767.00** |
| Site Improvement and Excavation Works | $3.615.301.47 |
| Structural Works | $5.887.755.98 |
| Civil Works | $18.042.846.22 |
| Mechanical Works | $8.380.000.00 |
| Electrical Works | $6.476.588.92 |
| Medical Equipment Works | $30.000.000.00 |
| Elevators | $659.531.20 |
| Landscaping | $666.666.67 |
| **Total Cost** | **$74.774.697.00** |

## 4.3. Risk Analysis

### 4.3.1. Oracle Primavera Risk Analysis

There are various software programs in the market so in order to run Monte Carlo simulation. There are software tools that operate as extensions to Microsoft Office tools: Microsoft Project and Microsoft Excel like @Risk and Crystal Ball. However, there is also a Risk Analysis program of Oracle-Primavera Corp.

Oracle Primavera risk analysis is chosen primarily because it offers much more in terms of usability and its output capabilities. Moreover, Primavera is a special software developed for Project Management items. Also, the use of this type of software is advantageous for this study, since deterministic master schedule is developed with the aid of Primavera Project Management software. The structure and the outputs of the scheduling sub-process do not need to be modified. It does not override or change any of the algorithms already in place in the model. In that respect, the use of a Primavera tool is preferred in order to execute schedule risk analysis.

The Primavera P6 schedule developed in chapter 4.2.5 provides opportunity to achieve deterministic project duration and finish date for our case study project. Model developed in Oracle Primavera Risk Analysis provide opportunity to find the probable duration range, finish date range and cost range of the project in percentiles at the end of a Monte Carlo simulation with taking the identified risks and their effects on activity durations into account.

### 4.3.2. Validating schedule

To begin the risk analysis first the schedule developed in P6 is imported into Oracle Primavera Risk Analysis program. The schedule quality is validated with the schedule check report. The schedule check report checks the schedule for common problems that may affect a deterministic plan and risk analysis. The Schedule check report can be seen in Appendix D.

### 4.3.3. Identification of risks in this case study

Two techniques are used to conduct the risk identification process for the case study: checklist and brainstorming. For the risk identification of this specific project the Risk Check-list presented in Chapter 3 is used. Meetings are arranged for risk identification with the project team involving project manager (who was also the head of project board), construction chief, the Director of electro-mechanical group, electrical and mechanical engineers, technical office manager, a planning engineer, cost engineers, architects of the projects and others. After long hours of brainstorming with the project team 21 potential risks are foreseen for this specific project among 110 risks described in check list.

The major potential risks that will be taken into consideration along the risk analysis process are directly summarized in Table 4.2.

Table 4.2. Potential risks identified for the project

| **Risk ID** | **Risk Definition** |
|---|---|
| I-015 | Inadequate technical information |
| D-01 | Change in municipal plan |
| D-02 | Change in regulation (Changes in fire, earthquake, development regulations) |
| D-020 | Delays in selection of interior design materials |
| D-021 | Change in quantity/scope of work |
| D-023 | Design changes due to doctors' demand |
| D-024 | Inadequate coordination between medical consultant and design team |
| D-027 | Technological change |
| D-05 | Delay in obtaining Construction Permit for hospital |
| D-07 | Delay in obtaining Building Usage Permit for Hospital |
| D-12 | Inadequate design for meeting Private Hospital Act's requirements |
| R-028 | Late Procurement of Equipment / Material |
| R-04 | Interest rate changes of financial credits |
| R-07 | Procurement durations longer than expected |
| C-011 | Contractor's efficiency under standards |
| C-014 | Inadequate coordination |
| C-015 | Construction works methodology mistakes |
| C-016 | Electro-mechanical works methodology mistakes |
| C-02 | Unforeseen ground conditions. |
| C-03 | Exceptionally inclement weather |
| C-09 | Change in payment /cash flow program |

Inadequate technical information, design changes due to doctor's demand, Inadequate coordination between medical consultant and design team, technological change, delay in obtaining Construction Permit for hospital, delay in obtaining building usage Permit for hospital, inadequate design for meeting Private Hospital Act's requirements, late procurement of Equipment/material, electro-mechanical works methodology mistakes are encountered due to sophisticated structure of hospital projects.

Change in municipal plans, change in regulations of Private Hospital Act, interest rate change of financial credits ,unforeseen ground conditions and exceptionally inclement weather risks are encountered due to the political and economic instability of Turkey and some local and site related conditions.

Delay in selection of interior design materials, change in quantity scope of work, change in payment /cash flow program are project specific risks directly related to the Client.

Other risks containing procurement durations longer than expected, contractors' efficiency under standards and construction work methodology mistakes are the risks that may occur due to the nature of construction works.

The cause and effect of the risks, a brief description of the encountered risks are stated in Table 4.3. below.

Table 4.3. Details of identified risks for the project

| ID | Cause | Description | Impact |
|---|---|---|---|
| D-021 | Due to Client requests for the scope of work | Change in quantity/scope of work | Additional cost & duration for all project |
| D-024 | Due to lack of communication between design team and medical consultant | Inadequate coordination between medical consultant and design team | Design changes and reconstruction during construction phase Schedule delay and cost overrun |
| R-028 | Due to inadequate procurement plan | Late Procurement of Equipment / Material | Which increases the duration and cost of architectural works |
| R-04 | Due to economic crisis occurred in country | Interest rate changes of financial credits | Delay in Procurement of Medical Equipments and cost overruns due to credits obtained at a higher interest rate |
| D-020 | Due to the delay of approval of Client | Delays in selection of interior design materials | Additional time for tasks involved with interior works |
| C-016 | Due to lack of specifications or technical personnel | Electro-mechanical works methodology mistakes | Need for re-construction,additional duration and cost |
| D-029 | Due to an upper version of medical equipment come out | Technological change | Revised medical equipment selections. Additional Medical Equipment costs, additional duration due to design changes |
| D-02 | Due to often changes in Hospital design regulations | Change in regulations of Private Hospital Act | Design revisions and reconstruction Additional time and cost for both structural works and architectural works |
| C-04 | Due to level of the groundwater being more than estimated. | Unforeseen ground conditions. | Need for revised Ground Projects and additional soil improvement techniques Impact the cost and duration of revetment works |
| D-01 | Due to change in municipal plan that effects the hospital construction during construction e.g: a new subway station near hospital | Change in municipal plan | Need for new design and approvals Additional duration and cost for excavation and infrastructure works |

Table 4.3. Details of identified risks for the project (con't)

| | | | |
|---|---|---|---|
| D-07 | Bureaucratic Difficulties, Delay in getting pre-approvals for Building Usage Permit from Ministry of Health | Delay in obtaining Building Usage Permit for Hospital | Delay in opening date of Hospital and loss of income |
| C-09 | Due to changing cash flow program of the Client | Change in payment /cash flow program | Working with lesser resource or change in methodology of Construction Which increases the cost and duration of structural works |
| C-05 | Due to unexpected cold weather, continuous snow-fall | Exceptionally inclement weather | Causing a delay of structural works that requires warm climate. |
| D-023 | Due to a lack of a communication with doctors and administration. | Design changes due to doctors' demand | Administration needed some additional furniture or rooms for doctors. Additional time and for design and architectural works |
| C-014 | Due to inadequate coordination between electro-mechanical group and construction group on site | Inadequate coordination | Dismantling and re-construction works Which effects the schedule and cost. |
| D-05 | Due to internal politics, delayed project approvals from Municipality | Delay in obtaining Construction Permit for Hospital | Necessity for re-design and project approvals Which can delay start of excavation works |
| C-011 | Due to lack of experience of sub-contractor | Contractor's efficiency under standards | Inadequate quality of work or longer work duration than expected. Additional time and cost required. |
| R-07 | Due to longer procurement durations than estimated, Materials purchased from abroad often causes delays | Procurement durations longer than expected | Additional time |
| I-015 | Due to lack of technical information | Inadequate technical information | Delay or suspend of works and need for adequate information Additional time and cost for specific activities |
| C-015 | Due to lack of specifications or technical personnel | Construction works methodology mistakes | Need for re-construction , additional duration and cost usually occurred for architectural works |
| D-12 | Due to lack of knowledge of design team | Inadequate design for meeting Private Hospital Act's requirements | Additional duration for design works |

## 4.4. Qualitative Risk Analysis

The same technique used to conduct risk identification was used to determine the probability of occurrence and impacts of the identified risks.

The identified risks are prioritized through qualitative risk analysis. Performing qualitative risk analysis provides a summary table that indicates the outcomes of risk identification.

In the first step, the impact scales are determined with the project team considering the quantities of project in terms of duration and budget. For this specific project the probability and impact scales are determined as shown in Table 4.4. and 4.5. below.

Table 4.4. Definition of probability scales for the project

| Very Low | Low | Medium | High | Very High |
|---|---|---|---|---|
| Up to 10% | 10% to 20% | 20% to 40% | 40% to 60% | 60% or higher |

Table 4.5. Definition of impact scales for the project

| | Very Low | Low | Medium | High | Very High |
|---|---|---|---|---|---|
| **Schedule** | Up to 5 days | 5 to 10 days | 10 to 40 days | 40 to 60 days | 60 days or higher |
| **Cost** | Up to $10.000 | $10.000 to $50.000 | $50.000 to $100.000 | $100.000 to $500.000 | $500.000 or higher |

Then, each risk element is weighted based on its probability and impacts on the project in respect to the cost and schedule success criteria. The establishments of the probability and impact levels of project risks are foreseen by the project management team. The team members used their own experiences in their previous hospital projects as well as they used database of the company concerning risks associated with previous hospital constructions.

Determination of impact values is also important in terms of determining the risk scores. In the qualitative risk analysis the risks are weighted in terms of the defined probability and impact scales, as very low (VL), low (L), medium (M), high (H) or very high (VH) for each element. A risk may have an impact on only duration, only on cost or on both cost and schedule. For this reason, one of the impacts can be selected as negligible (N).

After each risk is weighted, the program automatically gives score in colors in order to identify the risk level based on the grid scores which have been presented in qualitative analyses literature review part in Chapter 2.2.2.3.

The result of a qualitative risk analysis obtained from the software is the probability impact matrix. This matrix is created by the system indicating the probability of risk versus its impact. Using this matrix, the project team can realize the risk picture of the project. The overall risk picture of the sample project is given in Table 4.6.

Table 4.6. Overall risk picture for the qualitative risk analysis

| **Risk ID** | **Title** | **Probability** | **Schedule** | **Cost** | **Score** |
|---|---|---|---|---|---|
| D-021 | Change in quantity/scope of work | M | VH | VH | 40 |
| D-02 | Change in regulations of Private Hospital Act | H | H | H | 28 |
| D-01 | Change in municipal plan | L | VH | L | 24 |
| C-016 | Electro-mechanical works methodology mistakes | M | H | L | 20 |
| R-04 | Interest rate changes of financial credits | M | H | H | 20 |
| C-05 | Exceptionally inclement weather | H | M | N | 14 |
| D-07 | Delay in obtaining Building Usage Permit for Hospital | L | H | H | 12 |
| D-029 | Technological change | L | M | H | 12 |
| C-09 | Change in payment /cash flow program of Client | L | H | M | 12 |
| D-020 | Delays in selection of interior design materials | M | M | N | 10 |
| D-023 | Design changes due to doctors' demands | M | M | M | 10 |
| D-024 | Inadequate coordination between medical consultant and design team | M | M | M | 10 |
| R-07 | Procurement durations longer than expected | L | M | N | 6 |
| D-05 | Delay in obtaining Construction Permit for Hospital | L | M | N | 6 |
| C-04 | Unforeseen ground conditions. | VL | M | H | 4 |
| R-028 | Late Procurement of Equipment / Material | VL | M | H | 4 |
| C-015 | Construction works methodology mistakes | L | L | N | 3 |
| C-014 | Inadequate coordination | VL | M | M | 2 |
| C-011 | Contractor’s efficiency under standards | VL | M | L | 2 |
| I-015 | Inadequate technical information | VL | M | L | 2 |
| D-12 | Inadequate design for meeting Private Hospital Act's requirements | VL | M | N | 2 |

### 4.4.1. Probability and Impact Matrix

There are twenty-one risks that are identified for the case study. Three of the twenty-one risks are in high risk zone for his project, as seen in Figure 4.4. , namely change in quantity scope of work, change in municipal plans and change in regulations of Private Hospital Act risks.

| | Very Low | Low | Medium | High | Very High |
|---|---|---|---|---|---|
| Very High | | | | | |
| High | | | C-05 - Exceptionally inclement weather | D-02 - Change in regulations of Private Hospital Act | |
| Medium | | | D-020 - Delays in selection of interior design materials, D-024 - Inadequate coordination between medical consultant and design team, D-023 - Design changes due to doctors' demands | R-04 - Interest rate changes of financial credits, C-016 - Electro-mechanical works methodology mistakes | D-021 - Change in quantity/scope of work |
| Low | | C-015 - Construction works methodology mistakes | R-07 - Procurement durations longer than expected, D-05 - Delay in obtaining Construction Permit for Hospital | D-07 - Delay in obtaining Building Usage Permit for Hospital, D-029 - Technological change , C-09 - Change in payment /cash flow program of Client | D-01 - Change in municipal plan |
| Very Low | | | C-011 - Contractor's efficiency under standards, C-014 - Inadequate coordination, I-015 - Inadequate technical information, D-12 - Inadequate design for meeting Private Hospital Act's requirements | R-028 - Late Procurement of Equipment / Material , C-04 - Unforeseen ground conditions. | |

Figure 4.4. Probability and impact matrix for the project

<u>4.4.1.1. Risks in High Risk Zone</u>: Since, the hospital structures are becoming an intensive and regularly developed technology hosting structures; they must have a sophisticated and integrated design. Design of a hospital building involves cooperation of many disciplines and systematically integration of these disciplines in design stage. A slight change in scope of work influencing whole architecture of a hospital project due to obligation of design integrity to be provided, while same change may influence only a few part in a housing project. The design and construction processes already contain a lot of uncertainty in their nature. However, it is becoming more risky for a hospital investment due to the necessity of changes in a living process. That means decisions that are given at the beginning of the investment need to be changed naturally, due to the long life time of construction process.

Since the hospital construction projects have a long operational process and the future government is unknown, it was anticipated that the score for these risks was high. These legislative changes usually result from politically motivated alterations of the current policies due to a change in the ruling government and to changes in the political climate resulting from election campaigns. These events are uncertain and beyond the control of project parties, so the high probability and the identical estimates made by project team for both approaches are reasonable. Changes in Municipal Plans and Healthcare Ministry regulations have the most important impacts on design.

During construction phase, design may need to be changed due to a new legislation even the design had been approved. For example, the Ministry of Health may explain a new commission that will evaluate In Vitro Fertilization (IVF) clinics from now on. The new commission may cause abrogation of IVF clinic because of the density of IVF clinics in that area which was approved before in the project that may result with changing all architectural design.

Change in municipal plans after the beginning of construction is also a significant risk for this case study. This risk is foreseen due to the probability of a new subway-station opening closer to the hospital. This can bring additional duration to design works and additional cost to oval project cost.

4.4.1.2. Risks in Medium Risk Zone : Delay in obtaining Building usage permit, Electro-mechanical works methodology mistakes, Interest rate change of financial credits , exceptionally inclement weather , technological change ,change in payment/cash flow program, delay in selection of interior design materials, design changes due to doctors demands, inadequate coordination between medical consultant and design team, procurement durations longer than expected, , delay in obtaining Construction Permit for Hospital are in medium risk zone.

Legal permissions are important processes in private hospital investments in Turkey that must be tracked starting from design phase through commissioning phase. There are many processes considering the eligibility criteria in regulations. Two of the most important licenses necessary for hospital projects are Construction Permit and Building Usage Permit license.

For obtaining construction permit, location selection, pre-approval, hospital type, services' products and quality (patient rooms, pharmacy, laboratory, intensive care, emergency units, stairs and elevators) related features must be provided as defined in Private Hospitals Act.

Properties of Structures and land in vicinity of hospital facility have great importance on obtaining Building usage permit license. Existent petrol stations, historic structures etc. in vicinity may impact the permit. Delay in opening date can lead to high rate of loss of profits.

4.4.1.3. Risks in Low Risk Zone : Unforeseen ground conditions, late procurement of equipment/material, Construction works methodology mistakes, inadequate coordination, and contractor's efficiency under standards, inadequate technical information and inadequate design for meeting Private Hospital Act requirements are the risks ranked as low.

Late procurement of equipment/material risk is very low probability; however the cost impact of this risk ranked as very high considering the probability of delay of medical equipment procurements. Some medical devices should be procured in early times of construction. For example, the devices installed to the ceiling of Operating Rooms have parts installed both inside the suspended ceiling and outside the ceiling. Therefore these devices should be procured earlier than the suspended ceiling works to prevent delays of ceiling and accordingly other architectural works.

Construction works methodology mistakes and inadequate design for meeting Private Hospital Act requirements is in low risks zone considering the experiences of members of design and construction team.

## 4.5. Quantitative Risk Analysis

The quantitative risk analysis is executed in 2 steps.

### 4.5.1. Methodology

In the first step, a risk model is developed by assigning uncertainties to activity's durations and budgets. For this, a minimum, most likely and a maximum duration and cost is assigned to each task and an appropriate distribution is defined. The minimum and maximum costs are obtained through detailed cost estimations can be seen in Appendix E.

In the second step, the impacts of risks that are listed in Table 4.6. are quantitatively analyzed with their appropriate distribution ranges in terms of cost and schedule and finally mapping the risks to related tasks.

Meetings were arranged to discover the parameters required for the simulation distributions for both of the studies. Not only the project team, but also the site engineers supplied valuable contributions by giving extra effort to give answers to the study inquiries. Also, the database of the company is used during the meetings to identify the most likely, minimum and maximum durations of all activities in the master schedule that is created. This provided the backbone for our model and much importance on accuracy was placed in producing it.

<u>4.5.1.1. First Step- Assigning Uncertainty to Activity Durations and Budgets:</u> In the first step, a risk model is developed by assigning uncertainty to activity durations and budgets. There are 4 distribution types to define activities' costs and durations which are Triangular, Uniform, Beta Pert or Enhanced distributions; however only the triangular distribution is used in this model. This distribution has widely been used in construction industry because of its more non-conservative approach, with the thought in mind that many of the activities will take on a more optimistic view [25]. A minimum, most likely and maximum duration and cost is assigned to each activity Table 4.7. and 4.8. Most likely durations are equal to the durations used in the deterministic schedule; similarly, most likely costs are equal to the costs used in deterministic plan. The level of minimum and maximum values is

estimated considering only the unit prices since the quantities are known due to quantity survey completed upon application projects. This was done by making unit price analysis and market search for resource prices and etc.

As it can be seen below the snapshots of the program, these uncertainties can be defined with a graphical interface shown in Figure 4.5. and 4.6. for duration and cost, respectively.

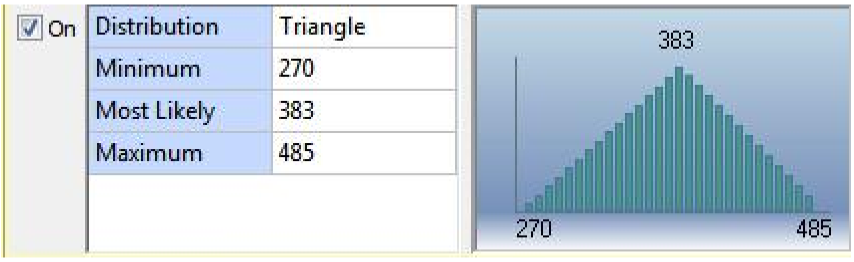



Figure 4.5. Graphical interface for duration uncertainty

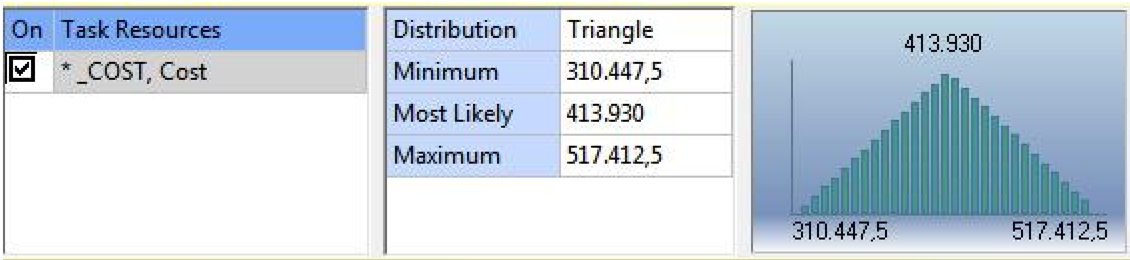



Figure 4.6. Graphical interface for cost uncertainty

Table 4.7. Schedule risk analysis model of the project

| TASK ID | Task Description | Minimum Duration (Day) | Most likely Duration (Day) | Maximum Duration (Day) |
|---|---|---|---|---|
| TASK01 | Project Start | 0 | 0 | 0 |
| TASK02 | Design & Project Drawings | 270 | 383 | 485 |
| TASK03 | Project Approvals Ministry of Culture and Tourism | 0 | 0 | 0 |
| TASK04 | Project Approvals from chamber of architects & Engineers | 0 | 0 | 0 |
| TASK05 | Project Approvals from municipality | 0 | 0 | 0 |
| TASK06 | Obtaining Construction Permit for Hospital | 0 | 0 | 0 |
| TASK07 | Excavation Works | 50 | 75 | 100 |
| TASK08 | Soil improvement & Revetment Works | 45 | 60 | 75 |
| TASK09 | Isolation Works | 220 | 260 | 325 |
| TASK10 | A-B-C Blocks' Structural Works | 110 | 150 | 200 |
| TASK11 | Infrastructure | 90 | 150 | 190 |
| TASK12 | Slab concrete works (Grouting works) | 90 | 120 | 150 |
| TASK13 | Partition walls with gypsum board &Suspended Ceiling works | 180 | 270 | 340 |
| TASK14 | D-E-F-G Blocks' Structural Works | 45 | 60 | 75 |
| TASK15 | Electrical Works | 270 | 360 | 450 |
| TASK16 | Mechanical Works | 270 | 360 | 450 |
| TASK17 | Medical Gas Installations | 200 | 300 | 375 |
| TASK18 | Pneumatic Conveying installation | 150 | 240 | 300 |
| TASK19 | Steel structure works | 90 | 120 | 150 |
| TASK20 | Plastering& Painting | 180 | 240 | 300 |
| TASK21 | Exterior Facade Cladding | 110 | 165 | 206 |
| TASK22 | Elevators | 110 | 180 | 225 |
| TASK23 | Doors | 113 | 150 | 188 |
| TASK24 | Wall & Floor Covering with marble, ceramic tile, PVC | 90 | 120 | 150 |
| TASK25 | Ceiling Covering works | 80 | 120 | 150 |
| TASK26 | Manufactured casework furnishing | 90 | 135 | 180 |
| TASK27 | Medical Equipment Installation | 135 | 180 | 225 |
| TASK28 | Landscaping | 56 | 75 | 94 |
| TASK29 | Obtaining Building Usage Permit for Hospital from Ministry of Health | 0 | 0 | 0 |
| TASK30 | Furniture supply &Furnishing | 56 | 75 | 94 |
| TASK31 | Installation of accessories | 45 | 60 | 75 |
| TASK32 | Test & Commissioning | 23 | 30 | 38 |
| TASK33 | Project Complete | 0 | 0 | 0 |

Table 4.8. Cost risk analysis model of the project

| TASK ID | Task Description | Minimum Cost ($) | Most likely Cost ($) | Maximum Cost ($) |
|---|---|---|---|---|
| TASK01 | Project Start | 0,00 | 0,00 | 0,00 |
| TASK02 | Design & Project Drawings | 393.233 | 413.930 | 428.157 |
| TASK03 | Project Approvals Ministry of Culture and Tourism | 0,00 | 0,00 | 0,00 |
| TASK04 | Project Approvals from Chamber of architects & Engineers | 0,00 | 0,00 | 0,00 |
| TASK05 | Project Approvals from Municipality | 0,00 | 0,00 | 0,00 |
| TASK06 | Obtaining Construction Permit for Hospital | 0,00 | 0,00 | 0,00 |
| TASK07 | Excavation Works | 1.988.601 | 2.093.265 | 2.239.793 |
| TASK08 | Soil improvement & Revetment Works | 1.025.758 | 1.079.746 | 1.155.328 |
| TASK09 | Isolation Works | 603.992 | 635.782 | 680.286 |
| TASK10 | A-B-C Blocks' Structural Works (Formwork, Reinforcement ,concrete columns, beams , stairs, exterior walls and curtain walls) | 2.363.367 | 2.487.755 | 2.661.897 |
| TASK11 | Infrastructure | 420.174 | 442.289 | 473.249 |
| TASK12 | Slab concrete works (Grouting works) | 290.937 | 306.250 | 327.687 |
| TASK13 | Partition walls with gypsum board &Suspended Ceiling works | 1.861.956 | 1.959.954 | 2.097.150 |
| TASK14 | D-E-F-G Blocks' Structural Works (Formwork, Reinforcement ,concrete columns, beams , stairs, exterior walls and curtain walls) | 3.230.000 | 3.400.000 | 3.638.000 |
| TASK15 | Electrical Works | 6.152.758 | 6.476.588 | 6.929.949 |
| TASK16 | Mechanical Works | 7.961.000 | 8.380.000 | 8.966.600 |
| TASK17 | Medical Gas Installations | 483.312 | 508.750 | 544.362 |
| TASK18 | Pneumatic Conveying Installation | 117.166 | 123.333 | 131.966 |
| TASK19 | Steel structure works | 2.131.562 | 2.243.750 | 2.400.812 |
| TASK20 | Plastering & Painting | 918.846 | 967.207 | 1.034.911 |
| TASK21 | Exterior Facade Cladding | 1.790.525 | 1.884.764 | 2.016.697 |
| TASK22 | Elevators | 626.554 | 659.531 | 705.698 |
| TASK23 | Doors | 701.138 | 738.041 | 789.703 |
| TASK24 | Wall & Floor Covering with marble, ceramic tile, PVC | 2.426.027 | 2.553.713 | 2.732.472 |
| TASK25 | Ceiling Covering works | 593.726 | 624.975 | 668.723 |
| TASK26 | Manufactured casework furnishing | 2.453.473 | 2.582.604 | 2.763.386 |
| TASK27 | Medical Equipment Installation | 28.500.000 | 30.000.000 | 32.100.000 |
| TASK28 | Landscaping | 633.332 | 666.666 | 713.332 |
| TASK29 | Obtaining Building Usage Permit for Hospital from Ministry of Health | 0,00 | 0,00 | 0,00 |
| TASK30 | Furniture supply &Furnishing | 2.893.513 | 3.045.804 | 3.259.010 |
| TASK31 | Installation of accessories | 475.000 | 500.000,00 | 535.000 |
| TASK32 | Test & Commissioning | 0,00 | 0,00 | 0,00 |
| TASK33 | Project Complete | 0,00 | 0,00 | 0,00 |

4.5.1.2. Second Step- Assigning risk impacts and mapping risks through tasks: Once the duration uncertainties have been defined in *Oracle Primavera Risk Analysis,* the next process is quantifying the impacts of risks with their appropriate distribution ranges in terms of cost and schedule and finally mapping the risks to related tasks.

Components of risks are probability of occurrence and impact. The duration of risk that causes delay of task and the cost of risk that causes overrun of task have also having an uncertainty. Triangular distribution is used to define the impact ranges of the risks on the tasks.

After defining the qualitative values of risks, their influence on the project duration is simulated by using Monte Carlo simulation technique. The registered risks are mapped through the related tasks. If a risk occurs it may have a quantifiable schedule and/or cost impact on the project. The impact is modeled by mapping risks to tasks. The cost and schedule impact of all the risks on the project are then quantified. Once the distributions are assigned, the Monte Carlo simulation is conducted with 1000 iterations.

During risk quantification, the program spreads the quantified durations and costs impacts across each task that the risk is assigned to. These distributions usually need to be intervened because a risk usually does not affect each activity equally. In this respect, after quantifying and mapping the risk through activities, the distributions are checked and some manual intervention are made to have more accurate results.

The outputs of quantitative schedule risk and cost risk analyses that have been performed will be examined further in the results of analysis in Chapter 5.

### 4.5.2. Analysis

The identified 21 risks are analyzed through quantitative risk analysis.

4.5.2.1. D-021 Change in quantity/scope of work: Change in quantity/scope of work is foreseen as potential risks that may cause additional cost and duration for all project activities.

As this risk is determined as having qualifications;

Probability: M

Schedule Impact: VH

Cost Impact: VH, then the affected tasks are selected and the risk is mapped through entire project as seen in Table 4.9.

Table 4.9. Impacts of risk D-021-Change in quantity /scope of work

| Impacts for Risk D-021 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| Project | Project | Triangle | 60 | 90 | 120 | Triangle | $500.000 | $750.000 | $1.000.000 |

4.5.2.2. D-02 Change in regulations of Private Hospital Act: Due to often changes in Hospital design regulations need for Revisions and reconstruction which results with additional time and cost for both electro-mechanical works and architectural works

As this risk is determined as having qualifications;

Probability: H

Schedule Impact: H

Cost Impact: H, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.10.

Table 4.10 Impacts of risk D-02-Change in regulations of Private Hospital Act

| Impacts for Risk D-02 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK19 | Steel structure works | Triangle | 5 | 10 | 15 | Triangle | $5.787 | $11.365 | $20.947 |
| TASK16 | Mechanical Works | Triangle | 5 | 10 | 15 | Triangle | $15.151 | $45.455 | $75.755 |
| TASK13 | Partition walls with gypsumboard &S... | Triangle | 5 | 7 | 10 | Triangle | $7.575 | $22.727 | $37.879 |
| TASK05 | Project Approvals from Municipality | Triangle | 0 | 2 | 3 | Triangle | $0 | $0 | $0 |
| TASK06 | Obtaining Construction Permit for Ho... | Triangle | 0 | 2 | 3 | Triangle | $0 | $0 | $0 |
| TASK15 | Electrical Works | Triangle | 5 | 10 | 15 | Triangle | $15.151 | $45.455 | $75.755 |
| TASK02 | Design & Project Drawings | Triangle | 5 | 10 | 30 | Triangle | $2.791 | $11.363 | $16.939 |

4.5.2.3. D-01 Change in municipal plan: Due to the risk of change in municipal plan design and new approvals might be necessary.

As this risk is determined as having qualifications;

Probability: L

Schedule Impact: VH

Cost Impact: L, then the affected tasks are selected and the risk is mapped through the tasks as seen Table 4.11. The Schedule effects of this risk will be higher for design works and the cost of the risk will affect all project, for this reason the quantification is distributed manually for this risk.

Table 4.11. Impacts of risk D-01-Change in municipal plan

| Impacts for Risk D-01 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| Project | Project | Triangle | 0 | 0 | 0 | Triangle | $10.000 | $30.000 | $50.000 |
| TASK02 | Design & Project Drawings | Triangle | 40 | 50 | 60 | Triangle | $0 | $0 | $0 |
| TASK03 | Project Approvals Ministry of Culture ... | Triangle | 4 | 5 | 6 | Triangle | $0 | $0 | $0 |
| TASK06 | Obtaining Construction Permit for Ho... | Triangle | 4 | 5 | 6 | Triangle | $0 | $0 | $0 |
| TASK04 | Project Approvals from Chamber of ar... | Triangle | 4 | 5 | 6 | Triangle | $0 | $0 | $0 |
| TASK05 | Project Approvals from Municipality | Triangle | 4 | 5 | 6 | Triangle | $0 | $0 | $0 |

4.5.2.4. C-016 Electro-mechanical works methodology mistakes: As this risk is determined as having qualifications;

Probability: M

Schedule Impact: H

Cost Impact: L, then the affected tasks are selected and the risk is mapped through the tasks as seen Table 4.12.

Table 4.12. Impacts of risk C-016-Electro-mechanical works methodology mistakes

| Impacts for Risk C-016 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK15 | Electrical Works | Triangle | 20 | 30 | 40 | Triangle | $0 | $2.500 | $5.000 |
| TASK16 | Mechanical Works | Triangle | 20 | 30 | 40 | Triangle | $0 | $2.500 | $5.000 |

<u>4.5.2.5. R-04 Interest rate changes of financial credits:</u> As this risk is determined as having qualifications;

Probability: M

Schedule Impact: H

Cost Impact: H, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.13.

Table 4.13. Impacts of risk R-04 Interest rate changes of financial credits

| Impacts for Risk R-04 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK27 | Medical Equipment Installation | Triangle | 30 | 40 | 60 | Triangle | $100.000 | $300.000 | $500.000 |

<u>4.5.2.6. C-05 Exceptionally inclement weather:</u> As this risk is determined as having qualifications;

Probability: H

Schedule Impact: M

Cost Impact: N, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.14.

Table 4.14. Impacts of risk C-05- Exceptionally inclement weather

| Impacts for Risk C-05 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK14 | D-E-F-G Blocks' Structural Works (For... | Triangle | 3 | 8 | 13 | Triangle | $0 | $0 | $0 |
| TASK10 | A-B-C Blocks' Structural Works (Form... | Triangle | 3 | 8 | 13 | Triangle | $0 | $0 | $0 |
| TASK12 | Slab concrete works (Grouting works) | Triangle | 3 | 8 | 13 | Triangle | $0 | $0 | $0 |

4.5.2.7. D-07 Delay in obtaining Building Usage Permit for Hospital: As this risk is determined as having qualifications;

Probability: L

Schedule Impact: H

Cost Impact: H, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.15.

Table 4.15. Impacts of risk D-07- Delay in obtaining Building Usage Permit for Hospital

| Impacts for Risk D-07 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK29 | Obtaining Building Usage Permit for ... | Triangle | 20 | 40 | 60 | Triangle | $100.000 | $300.000 | $500.000 |

4.5.2.8. D-029 Technological change: Technological change is foreseen as potential risks for the probability of coming out an upper version of medical equipment which causes additional medical equipment co and additional duration to design works.

As this risk is determined as having qualifications;

Probability: L

Schedule Impact: M

Cost Impact: H, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.16.

Table 4.16. Impacts of risk D-029- Technological change

| Impacts for Risk D-029 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK27 | Medical Equipment Installation | Single Value | | 0 | | Triangle | $100.000 | $150.000 | $300.000 |
| TASK02 | Design & Project Drawings | Triangle | 5 | 10 | 30 | Single Val... | | $0 | |

4.5.2.9. C-09 Change in payment /cash flow program of Client: As this risk is determined as having qualifications;

Probability: L

Schedule Impact: H

Cost Impact: M, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.17.

Table 4.17. Impacts of risk C-09-Change in payment /cash flow program of Client

| Impacts for Risk C-09 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK13 | Partition walls with gypsumboard &S... | Triangle | 4 | 5 | 6 | Triangle | $5.556 | $8.333 | $11.111 |
| TASK19 | Steel structure works | Triangle | 4 | 5 | 6 | Triangle | $5.556 | $8.333 | $11.111 |
| TASK15 | Electrical Works | Triangle | 4 | 5 | 6 | Triangle | $5.556 | $8.333 | $11.111 |
| TASK16 | Mechanical Works | Triangle | 4 | 5 | 6 | Triangle | $5.556 | $8.333 | $11.111 |
| TASK18 | Pneumatic Conveying Installation | Triangle | 4 | 5 | 6 | Triangle | $5.556 | $8.333 | $11.111 |
| TASK26 | Manufactured casework furnishing | Triangle | 4 | 5 | 6 | Triangle | $5.556 | $8.333 | $11.111 |
| TASK30 | Furniture supply &Furnishing | Triangle | 4 | 5 | 6 | Triangle | $5.556 | $8.333 | $11.111 |
| TASK22 | Elevators | Triangle | 4 | 5 | 6 | Triangle | $5.556 | $8.333 | $11.111 |
| TASK17 | Medical Gas Installations | Triangle | 4 | 5 | 6 | Triangle | $5.556 | $8.333 | $11.111 |

<u>4.5.2.10. D-20 Delays in selection of interior design materials:</u> This risk is Client delays for material selections may cause schedule delay of for works related with interior design.

As this risk is determined as having qualifications;

Probability: M

Schedule Impact: M

Cost Impact: N, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.18.

Table 4.18. Impacts of risk D-20-Delays in selection of interior design materials

| Impacts for Risk D-020 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK30 | Furniture supply &Furnishing | Triangle | 2 | 4 | 5 | Triangle | $0 | $0 | $0 |
| TASK24 | Wall & Floor Covering with marble,ce... | Triangle | 2 | 4 | 5 | Triangle | $0 | $0 | $0 |
| TASK25 | Ceiling Covering works | Triangle | 2 | 4 | 5 | Triangle | $0 | $0 | $0 |
| TASK22 | Elevators | Triangle | 2 | 4 | 5 | Triangle | $0 | $0 | $0 |
| TASK23 | Doors | Triangle | 2 | 4 | 5 | Triangle | $0 | $0 | $0 |
| TASK31 | Installation of accessories | Triangle | 2 | 4 | 5 | Triangle | $0 | $0 | $0 |
| TASK21 | Exterior Facade Cladding | Triangle | 2 | 4 | 5 | Triangle | $0 | $0 | $0 |
| TASK20 | Plastering&Painting | Triangle | 2 | 4 | 5 | Triangle | $0 | $0 | $0 |

<u>4.5.2.11. D-023 Design changes due to doctors' demands:</u> As this risk is determined as having qualifications;

Probability: M

Schedule Impact: M

Cost Impact: M, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.19.

Table 4.19. Impacts of risk D-023 Design changes due to doctors' demands

| Impacts for Risk D-023 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK30 | Furniture supply &Furnishing | Triangle | 5 | 7 | 10 | Triangle | $27.143 | $40.712 | $54.286 |
| TASK20 | Plastering&Painting | Triangle | 1 | 3 | 5 | Triangle | $300 | $449 | $600 |
| TASK13 | Partition walls with gypsumboard &S... | Triangle | 1 | 3 | 5 | Triangle | $1.200 | $1.800 | $2.400 |
| TASK02 | Design & Project Drawings | Triangle | 1 | 3 | 5 | Triangle | $500 | $750 | $1.000 |
| TASK26 | Manufactured casework furnishing | Triangle | 5 | 7 | 10 | Triangle | $17.143 | $25.714 | $34.286 |
| TASK24 | Wall & Floor Covering with marble,ce... | Triangle | 1 | 3 | 5 | Triangle | $1.857 | $2.785 | $3.714 |
| TASK25 | Ceiling Covering works | Triangle | 1 | 3 | 5 | Triangle | $1.857 | $2.785 | $3.714 |

<u>4.5.2.12. D-024 Inadequate coordination between medical consultant and design team:</u> Inadequate coordination between medical consultant and design team is foreseen as potential risks that may cause additional cost and duration for electro-mechanical works.

As this risk is determined as having qualifications;

Probability: M

Schedule Impact: M

Cost Impact: M, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.20.

Table 4.20. Impacts of risk D-024-Inadequate coordination between medical consultant and design team

| Impacts for Risk D-024 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK15 | Electrical Works | Triangle | 5 | 7 | 8 | Triangle | $10.000 | $15.000 | $20.000 |
| TASK18 | Pneumatic Conveying Installation | Triangle | 2 | 4 | 5 | Triangle | $10.000 | $15.000 | $20.000 |
| TASK16 | Mechanical Works | Triangle | 5 | 7 | 8 | Triangle | $10.000 | $15.000 | $20.000 |
| TASK17 | Medical Gas Installations | Triangle | 2 | 4 | 5 | Triangle | $10.000 | $15.000 | $20.000 |

<u>4.5.2.13. R-07-Procurement durations longer than expected:</u> As this risk is determined as having qualifications;

Probability: L

Schedule Impact: M

Cost Impact: N, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.21.

Table 4.21. Impacts of risk R-07-Procurement durations longer than expected

| Impacts for Risk R-07 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK30 | Furniture supply &Furnishing | Triangle | 10 | 20 | 30 | Triangle | $0 | $0 | $0 |

4.5.2.14. D-05 Delay in obtaining Construction Permit for Hospital: Delay in obtaining Construction Permit for Hospital is foreseen as potential risks may occur due to project approval delays that may cause a delay for excavation works.

As this risk is determined as having qualifications;

Probability: L

Schedule Impact: M

Cost Impact: N, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.22.

Table 4.22. Impacts of risk D-05 Delay in obtaining Construction Permit for Hospital

| Impacts for Risk D-05 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK07 | Excavation Works | Triangle | 2 | 6 | 10 | Triangle | $0 | $0 | $0 |
| TASK06 | Obtaining Construction Permit for Ho... | Triangle | 2 | 6 | 10 | Triangle | $0 | $0 | $0 |

4.5.2.15. C-04 Unforeseen ground conditions: As this risk is determined as having qualifications;

Probability: VL

Schedule Impact: M

Cost Impact: H , then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.23.

Table 4.23. Impacts of risk C-04-Unforeseen ground conditions

| Impacts for Risk C-04 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK08 | Soil improvement & Revetment Works | Triangle | 14 | 20 | 40 | Triangle | $100.000 | $300.000 | $500.000 |

4.5.2.16. R-028 Late Procurement of Equipment / Material: As this risk is determined as having qualifications;

Probability: VL

Schedule Impact: M

Cost Impact: H, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.24.

Table 4.24. Impacts of risk R-028 Late Procurement of Equipment / Material

| Impacts for Risk R-028 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK27 | Medical Equipment Installation | Triangle | 16 | 29 | 45 | Triangle | $100.000 | $300.000 | $500.000 |

4.5.2.17. C-015 Construction works methodology mistakes: As this risk is determined as having qualifications;

Probability: L

Schedule Impact: L

Cost Impact: N, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.25.

Table 4.25. Impacts of risk C-015-Construction works methodology mistakes

| Impacts for Risk C-015 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK11 | Infrastructure | Triangle | 2 | 3 | 5 | Triangle | $0 | $0 | $0 |
| TASK09 | Isolation Works | Triangle | 2 | 3 | 5 | Triangle | $0 | $0 | $0 |

4.5.2.18. C-014 Inadequate coordination: As this risk is determined as having qualifications;

Probability: VL

Schedule Impact: M

Cost Impact: M, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.26.

Table 4.26. Impacts of risk C-014 Inadequate coordination

| Impacts for Risk C-014 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK16 | Mechanical Works | Triangle | 5 | 7 | 8 | Triangle | $20.000 | $30.000 | $40.000 |
| TASK15 | Electrical Works | Triangle | 5 | 7 | 8 | Triangle | $20.000 | $30.000 | $40.000 |
| TASK13 | Partition walls with gypsumboard &S... | Triangle | 3 | 5 | 6 | Triangle | $10.000 | $15.000 | $20.000 |

<u>4.5.2.19. C-011-Contractor's efficiency under standards:</u> As this risk is determined as having qualifications;

Probability: VL

Schedule Impact: M

Cost Impact: L, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.27.

Table 4.27. Impacts of risk C-011-Contractor's efficiency under standards

| Impacts for Risk C-011 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK21 | Exterior Facade Cladding | Triangle | 10 | 25 | 40 | Triangle | $10.000 | $30.000 | $50.000 |

<u>4.5.2.20. I-015 Inadequate Technical Information:</u> Inadequate technical information and need for adequate information are foreseen as potential risks that may cause a delay or suspend time on infrastructure, isolation, electrical and mechanical works.

As this risk is determined as having qualifications;

Probability: VL

Schedule Impact: M

Cost Impact: L , then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.28. The Schedule effects of this risk will be higher for electrical and mechanical works for this reason the quantification is distributed manually for this risk.

Table 4.28. Impacts of risk I-015-Inadequate Technical Information

| Impacts for Risk I-015 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK16 | Mechanical Works | Triangle | 4 | 5 | 7 | Triangle | $3.500 | $8.500 | $13.500 |
| TASK15 | Electrical Works | Triangle | 4 | 5 | 7 | Triangle | $3.500 | $8.500 | $13.500 |
| TASK09 | Isolation Works | Triangle | 2 | 4 | 5 | Triangle | $1.500 | $6.500 | $11.500 |
| TASK11 | Infrastructure | Triangle | 2 | 4 | 5 | Triangle | $1.500 | $6.500 | $11.500 |

4.5.2.21. D-012 Inadequate design for meeting Private Hospital Act's requirements: As this risk is determined as having qualifications;

Probability: VL

Schedule Impact: M

Cost Impact: N, then the affected tasks are selected and the risk is mapped through the tasks as seen in Table 4.29.

Table 4.29. Impacts of risk D-012 Inadequate design for meeting Private Hospital Act's requirements

| Impacts for Risk D-12 | | Schedule | | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task ID | Description | Shape | Min | Likely | Max | Shape | Min | Likely | Max |
| TASK02 | Design & Project Drawings | Triangle | 10 | 14 | 20 | Triangle | $0 | $0 | $0 |
| TASK03 | Project Approvals Ministry of Culture ... | Triangle | 2 | 6 | 10 | Triangle | $0 | $0 | $0 |
| TASK04 | Project Approvals from Chamber of ar... | Triangle | 2 | 6 | 10 | Triangle | $0 | $0 | $0 |
| TASK05 | Project Approvals from Municipality | Triangle | 2 | 6 | 10 | Triangle | $0 | $0 | $0 |

# 5. RESULTS of RISK ANALYSIS

## 5.1. Distribution Analysis

### 5.1.1. Finish Date Distribution

As a risk analysis is made the start and finish of each task and the finish of the entire project is recorded for each iteration. For duration uncertainties and risk assignments 1000 simulation and the resulting distribution graph of project finish date is shown below.

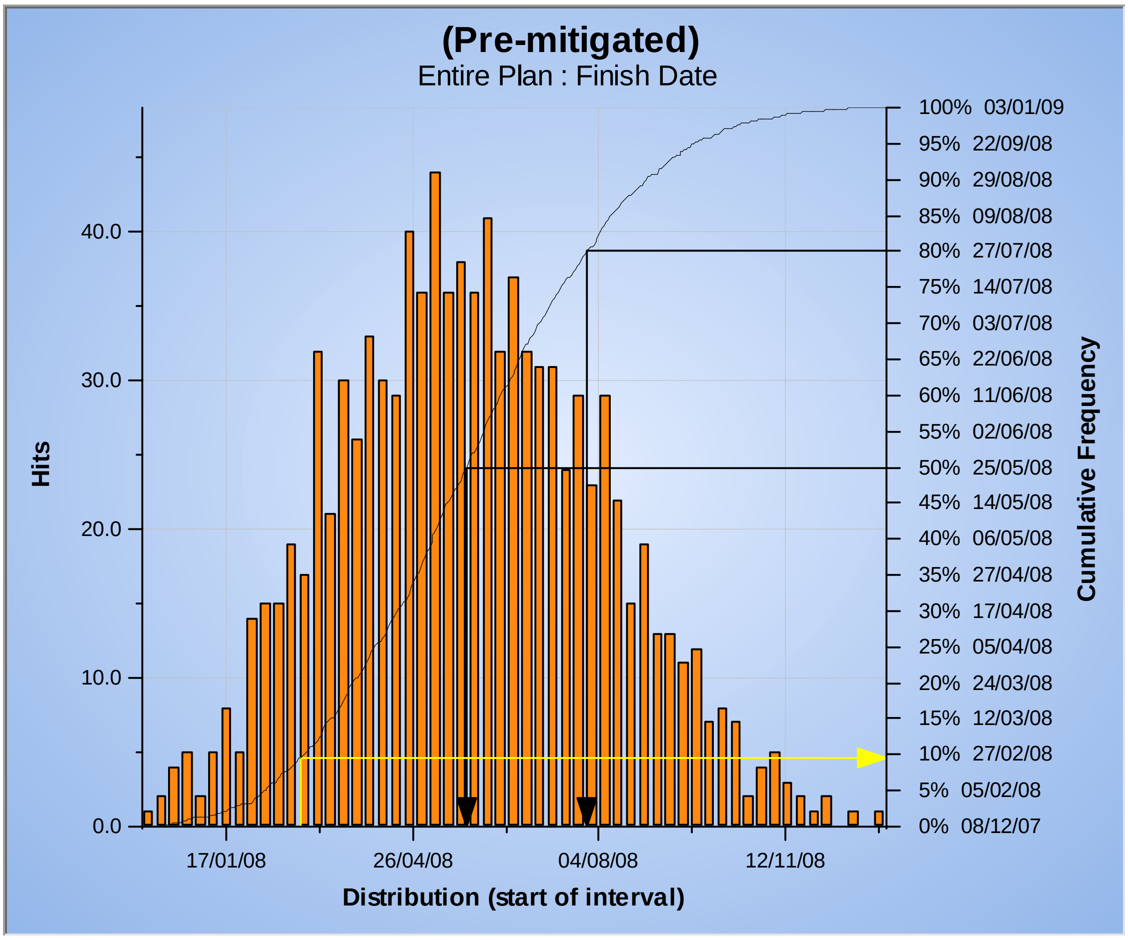



Figure 5.1. Project finish date simulation distribution graph

Analysis shows that the earliest finish date of the entire Project is 08.12.2007 and the latest finish date is 03.01.2009. Deterministic plan had shown that the Project completion date as 24.02.2008 whereas the probabilistic risk analysis shows that the probability of the project to be completed at that date is in 10% confidence level.

For a 50% confidence level the finish date of the project is 25.05.2008, which means with a 50% probability the project will be completed approximately 3 months later than the deterministic finish date.

### 5.1.2. Duration Distribution Graph

For duration uncertainties and risk assignments, 1000 simulation runs with *Oracle Primavera Risk Analysis* were performed and the resulting distribution graph of the project duration is shown below.

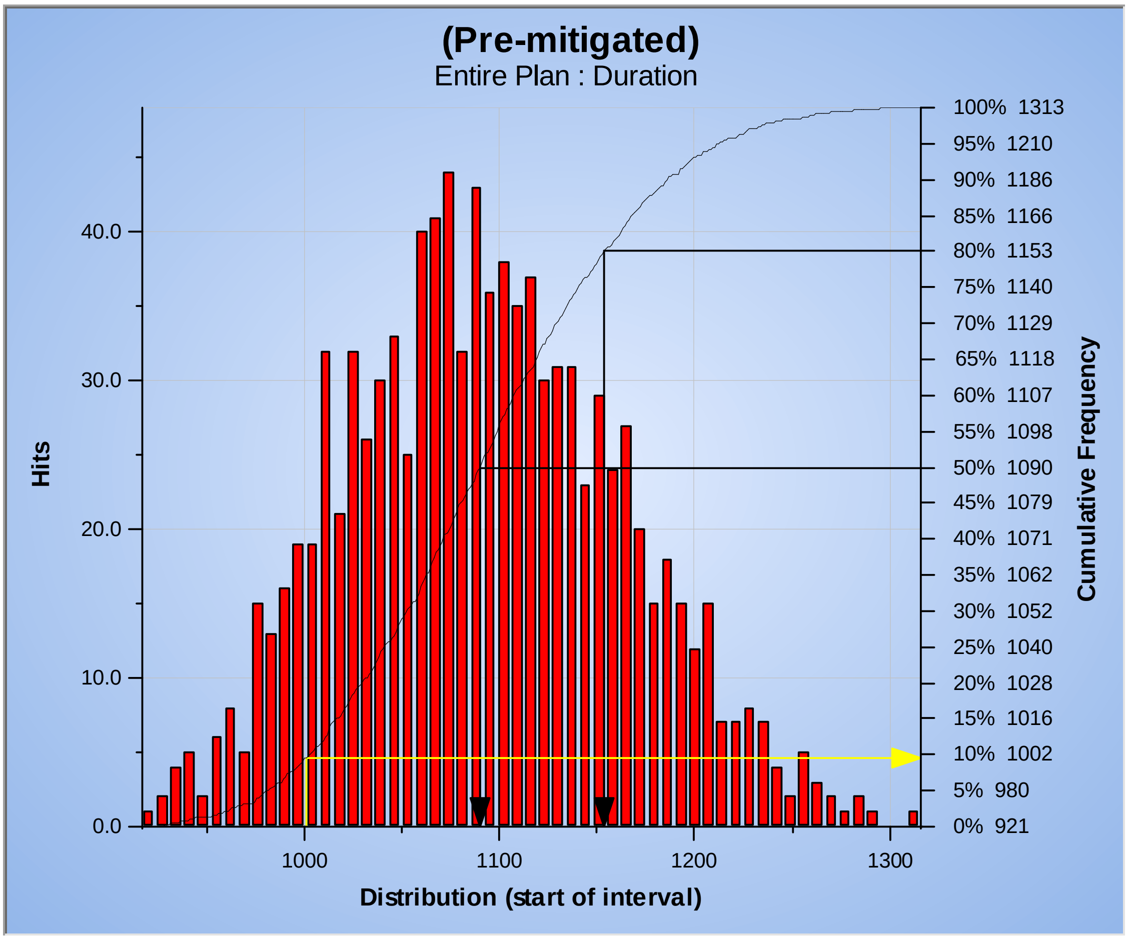



Figure 5.2. Project duration simulation distribution graph

Distribution shows there is a 50% probability of completing the project 1090 days. The minimum duration of the entire Project is 921 days and the maximum duration is 1313 days. Deterministic plan had shown that the Project duration as 989 days whereas the risk analysis shows that the probability of finishing the project in that duration is less than 10 percent.

### 5.1.3. Cost Distribution

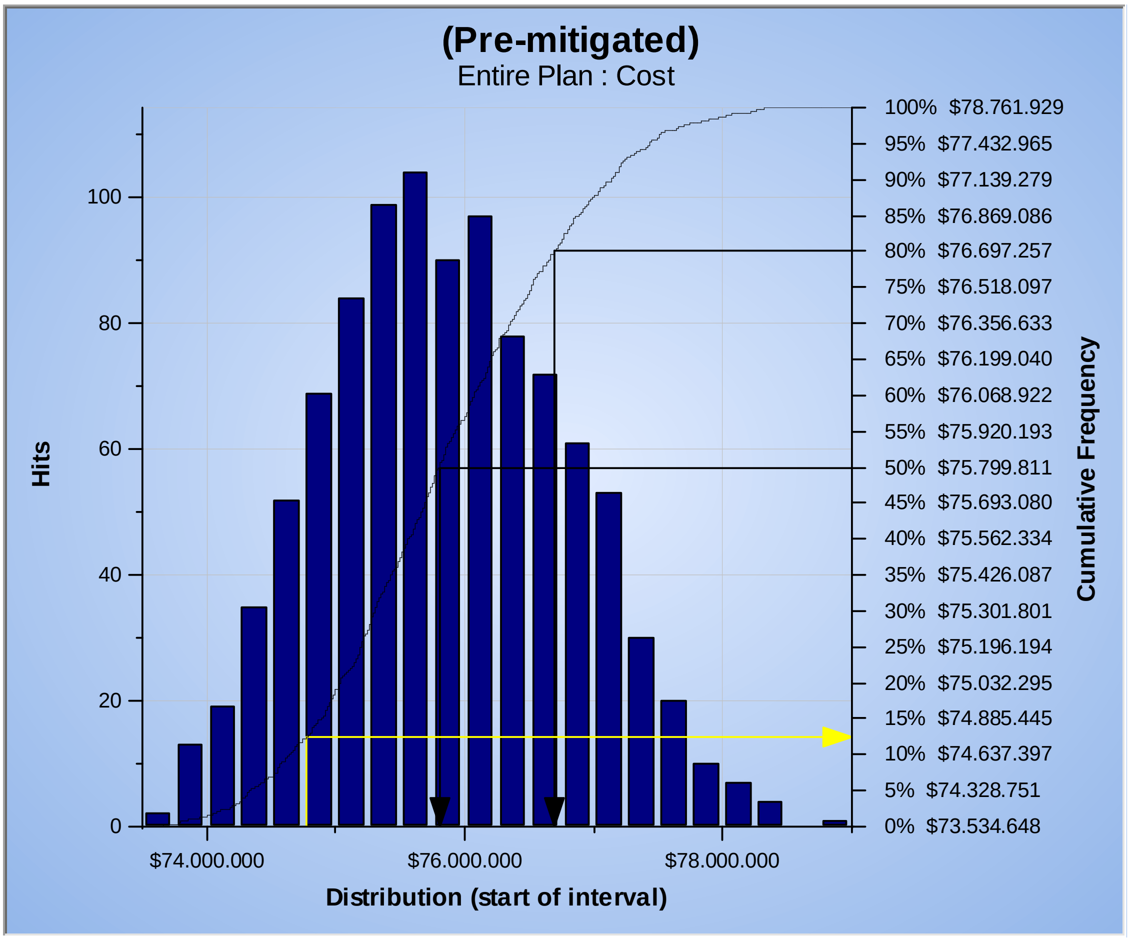



Figure 5.3. Project cost simulation distribution graph

This shows the cost range of the entire Project with a minimum $73.534.648 and the maximum $ 78.761.929. Deterministic plan had shown that the Project cost as $74.774.697. There is a risk that the project might be completed with $3.987.232 overrun.

## 5.2. Sensitivity Analysis

Sensitivity gives an indication of how much the duration of each task affects completion of other tasks or the entire project. Also it shows, the tasks that are most likely to cause delay or increase the cost of a project.

### 5.2.1. Schedule Sensitivity Index

During risk analysis tasks can join or leave the critical path. The criticality index expresses as a percentage, how often a particular task was on the critical path during the analysis. Tasks with a high criticality index are more likely to cause delay to the project as they are more likely to be on the critical path.

The Schedule Sensitivity Index (SSI) identifies and ranks the tasks most likely to influence the project duration or finish.

SSI is expressed as a percentage using the following calculation:

SSI = (Criticality Index x Task Standard Deviation) / Project Standard Deviation

Combining criticality with the task standard deviation gives the highest values to tasks which are on the critical path and have a large range of uncertainty. This overcomes the fact that criticality takes no account of uncertainty on an individual task and consequently a task with no uncertainty can still have a 100% criticality.

The Project standard deviation is likely to be larger than any individual tasks standard deviation. If a task dominates a schedules uncertainty its SSI will therefore tend towards 100%.

### 5.2.2. Tornado Graph

The tornado graph is used to identify key risk drivers and pinpoint the task or risk event that’s preventing the schedule from performing as expected. The program has built in the sensitivity analysis that is used to determine the activities sensitivity to the project duration. A tornado chart which is similar in nature to sensitivity graph was produced to show how each individual activity affects the project duration independently of the other activities.

The plan has been built from the Risk Register as an impacted risk plan then a risk tornado is displayed. This tornado ranks the risks in the risk register according to their impact on the project schedule.

### 5.2.3. Schedule Sensitivity Tornado Graph

To get a better understanding of what activities are either 'making or braking" the project a sensitivity analysis was conducted on the project duration. As it can be seen in figure the activity Design & Project Drawings has the highest sensitivity index as 43%, followed by as electrical works with 23% and mechanical works comes in third with 22%. This means that these 3 major activities are the ones that the management should control during the project.

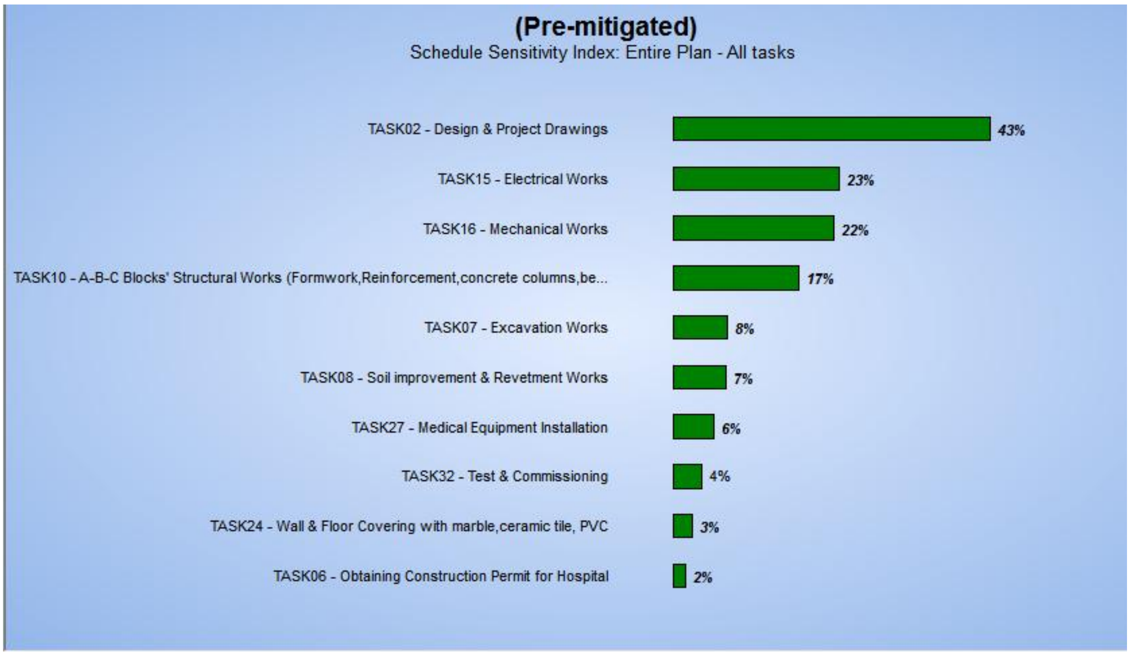



Figure 5.4. Schedule sensitivity tornado graph

### 5.2.4. Cost Sensitivity

The cost sensitivity is a measure of the correlation between the cost of a task and the cost of the project. It is similar to that of the duration sensitivity but looks at costs instead of durations. The task with the highest cost sensitivity is the task that is most likely to increase the project cost. As it can be seen in figure the activity medical equipment installation is the most cost sensitive activity with 88% which is followed by electrical works with 37% and mechanical works with 35% and furnishing works with 34% .This means that these 4 major activities are the ones that can cause the highest cost overruns during project.

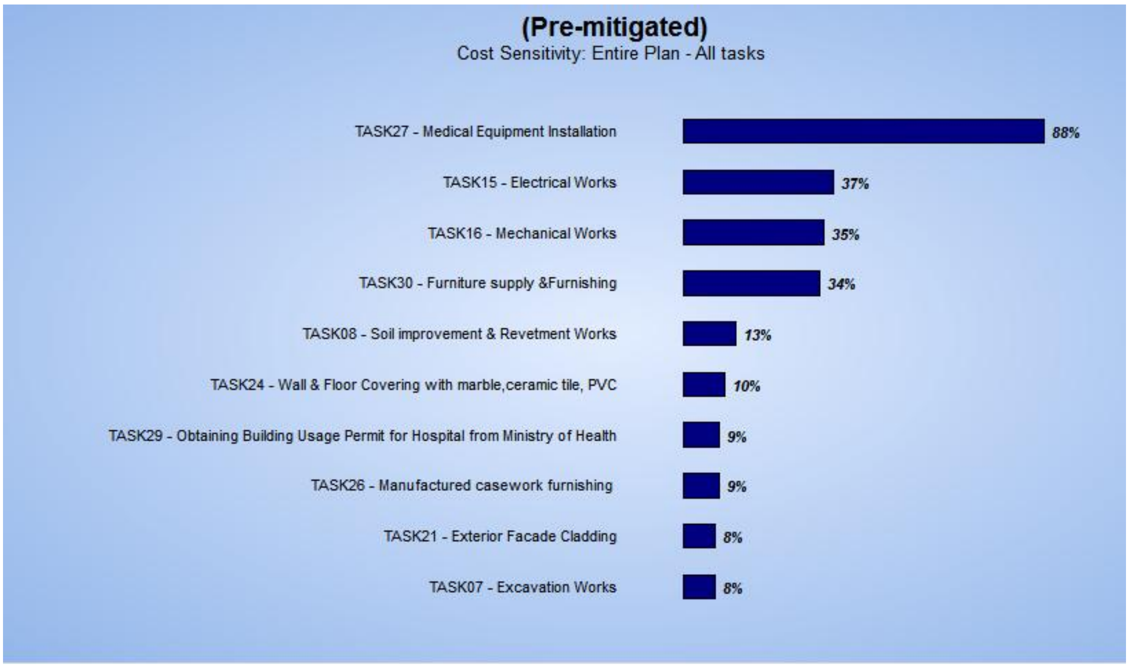



Figure 5.5. Cost sensitivity tornado graph

## 5.3. Scatter Plot

The scatter plot shows the relationship between two outputs of a risk analysis. Each point on the scatter plot represents two values for one iteration of the risk analysis. The total number of points is equal to the number of iterations that were run in the risk analysis.

The graph below shows the relationship between the time and cost of the plan. It shows that the time to finish the plan is correlated to the cost of the plan that means, as the time to complete the project increases so does the cost.

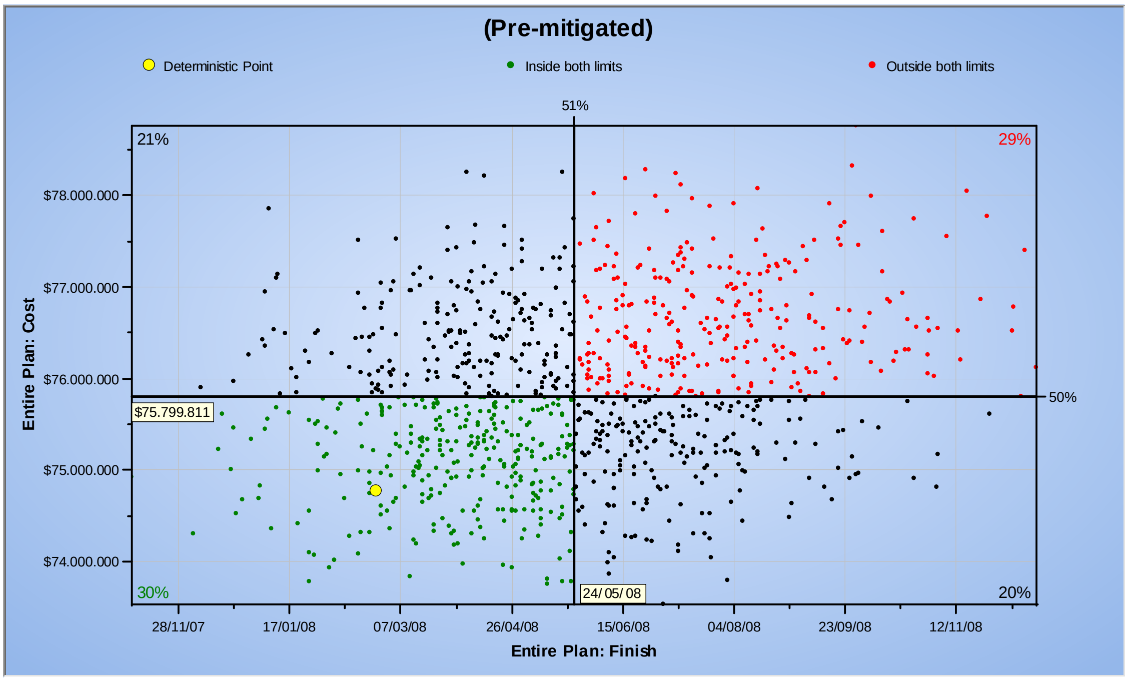



Figure 5.6. Integrated cost and schedule scatter plot

This graph shows 26% likely to meet both schedule and cost, means, to be in 50% confidence level for both cost and schedule target. Considering the 50% confidence interval, the probability of finishing the project within the target duration and budget is 30%.

# 6. CONCLUSIONS

The benefits and results of risk analysis for hospital projects in Turkey have been evaluated in this research. The following is a list of conclusions from this study:

- A risk checklist containing 110 potential risks for private hospital investments related to schedule and cost is developed. This checklist can be used as a risk identification technique for the project shareholders and potential healthcare sector investors.

- On the case study, it is shown that by qualitative risk analysis the risks having highest impact in terms of cost and schedule targets of the project can be identified clearly. For this case study 21 potential risks were identified and 3 of them were in high risk zone which were: change in quantity scope of work, change in municipal plans and change in regulations of Private Hospital Act risks.

- By quantitative analysis, a distribution range can be evaluated which provides schedule and cost values obtained for each confidence level in percents. This can be used to stay in safe side wherever a punishment is conducted in case of duration and cost overruns.

- For the case study, the deterministic schedule and cost plan was less than 10% confidence level, there were a 324 days delay and $3.987.232 cost overrun risk. This situation proves the necessity of schedule and cost risk analysis in private hospital projects. Furthermore, for hospital projects the delay of opening date is very important in terms of reaching the end user late and income loss. This situation proves the necessity of schedule and cost risk analysis in private hospital projects.

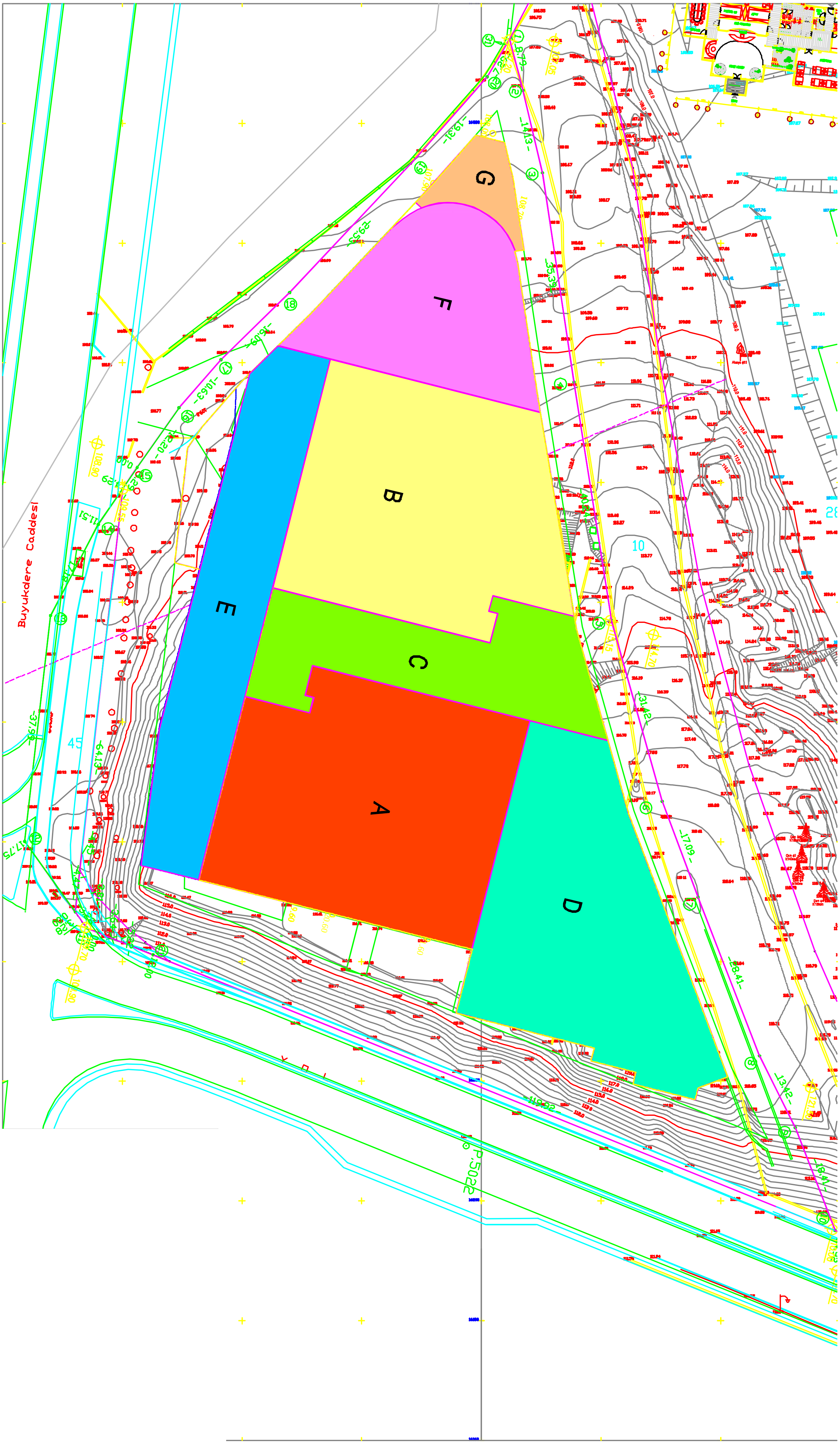
- The results of duration sensitivity analysis enable identifying the highest sensitive activities for schedule. For the case study there were 3 major activities that pushed the end date according to the sensitivity analysis performed: design and project drawings 43%, electrical 23% and mechanical Works 22% .These activities should be of high concern for project managers who are on a fast track schedule like many hospital projects are nowadays.

- Similarly, with cost sensitivity analysis the tasks that are most likely to increase the project cost are defined. For the case study, medical equipment installation, electrical works, mechanical works and furnishing works are the most cost sensitive activities .The management should control the cost and financing plan of these activities during the project life time.

The significance of this study is that it will provide insight on how effectively risks should be managed by Investors in achieving successful projects in private healthcare sector.

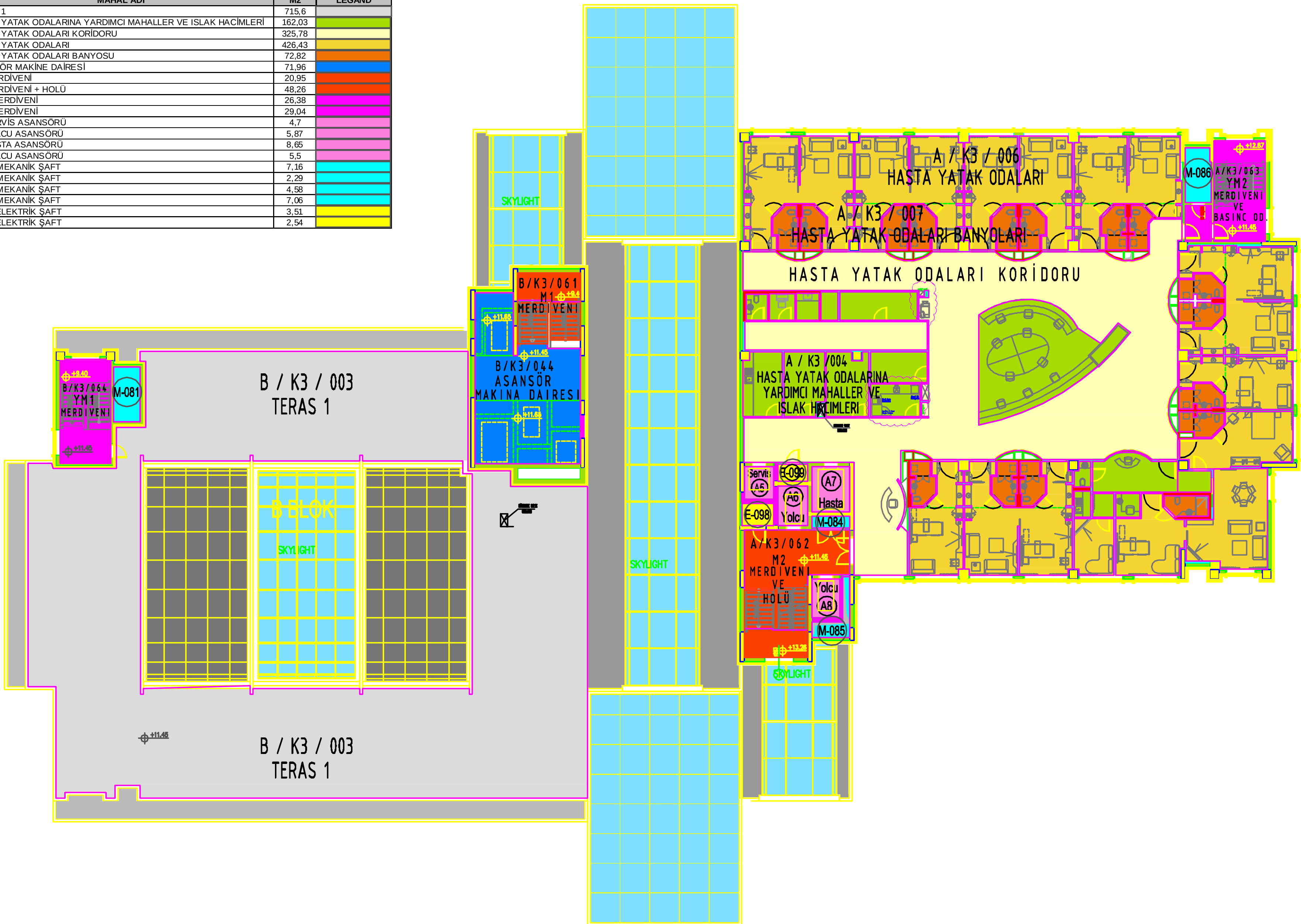
Also, findings from this case study can be used as a milestone to increase the awareness of private hospital investors of the possible consequences to such projects if risk identification and analysis processes are not conducted in an effective and efficient manner.

# APPENDIX A : THE SITE PLANS AND FLOOR PLANS


A
B
C
D
E
F
G
Buyukdere Caddesi

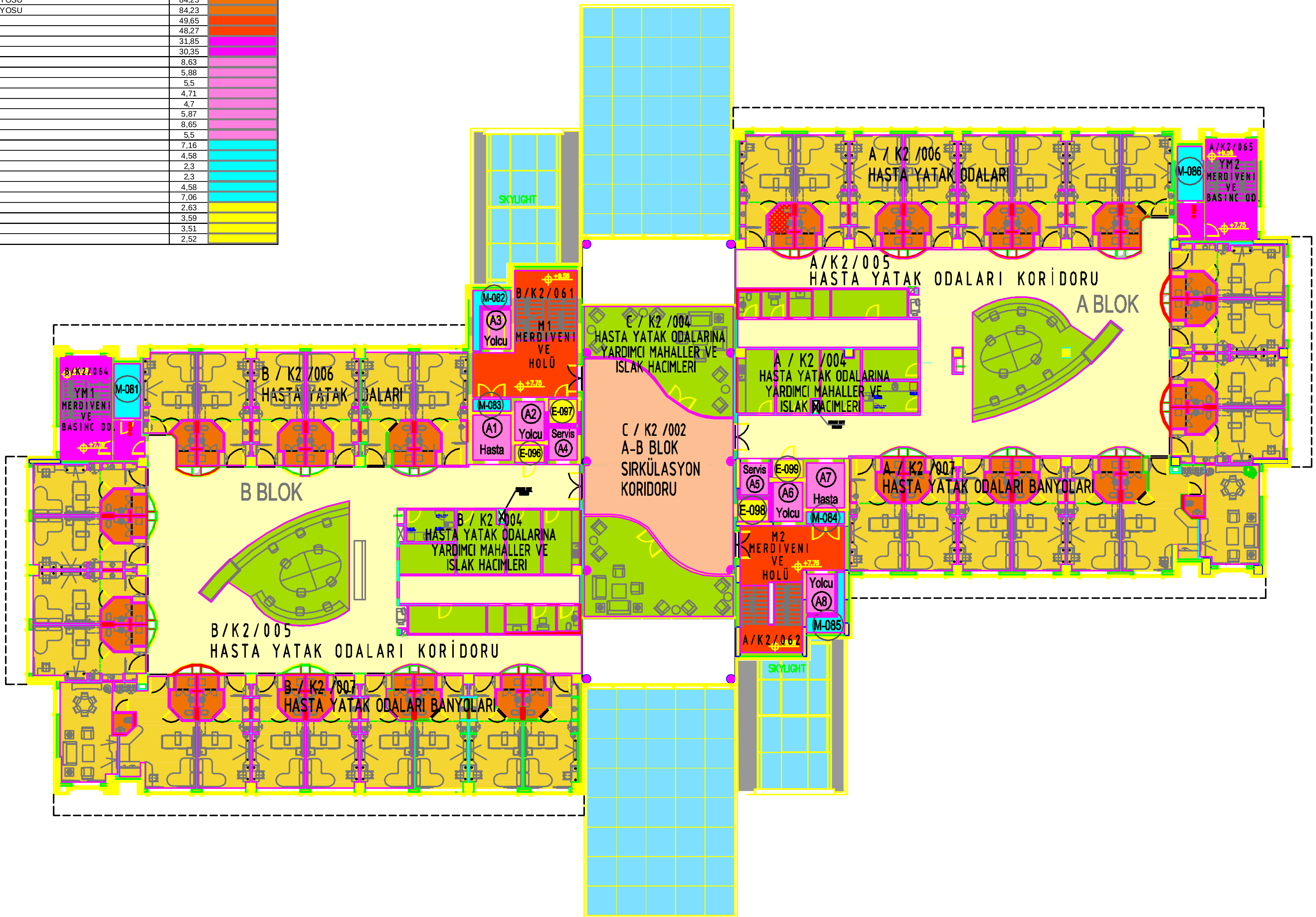
## 3.KAT PLANI

| 3. KAT BLOK | KAT | ZONE NO | MAHAL ADI | M2 | LEGAND |
|---|---|---|---|---|---|
| B | K3 | 003 | TERAS 1 | 715,6 | |
| A | K3 | 004 | HASTA YATAK ODALARINA YARDIMCI MAHALLER VE ISLAK HACİMLERİ | 162,03 | |
| A | K3 | 005 | HASTA YATAK ODALARI KORİDORU | 325,78 | |
| A | K3 | 006 | HASTA YATAK ODALARI | 426,43 | |
| A | K3 | 007 | HASTA YATAK ODALARI BANYOSU | 72,82 | |
| B | K3 | 044 | ASANSÖR MAKİNE DAİRESİ | 71,96 | |
| B | K3 | 061 | M1 MERDİVENİ | 20,95 | |
| A | K3 | 062 | M2 MERDİVENİ + HOLÜ | 48,26 | |
| B | K3 | 064 | YM1 MERDİVENİ | 26,38 | |
| A | K3 | 065 | YM2 MERDİVENİ | 29,04 | |
| A | K3 | 074 | A5 SERVİS ASANSÖRÜ | 4,7 | |
| A | K3 | 075 | A6 YOLCU ASANSÖRÜ | 5,87 | |
| A | K3 | 076 | A7 HASTA ASANSÖRÜ | 8,65 | |
| A | K3 | 077 | A8 YOLCU ASANSÖRÜ | 5,5 | |
| B | K3 | 081 | M-081 MEKANİK ŞAFT | 7,16 | |
| A | K3 | 084 | M-084 MEKANİK ŞAFT | 2,29 | |
| A | K3 | 085 | M-085 MEKANİK ŞAFT | 4,58 | |
| A | K3 | 086 | M-086 MEKANİK ŞAFT | 7,06 | |
| A | K3 | 098 | E-098 ELEKTRİK ŞAFT | 3,51 | |
| A | K3 | 099 | E-099 ELEKTRİK ŞAFT | 2,54 | |



# 2.KAT PLANI

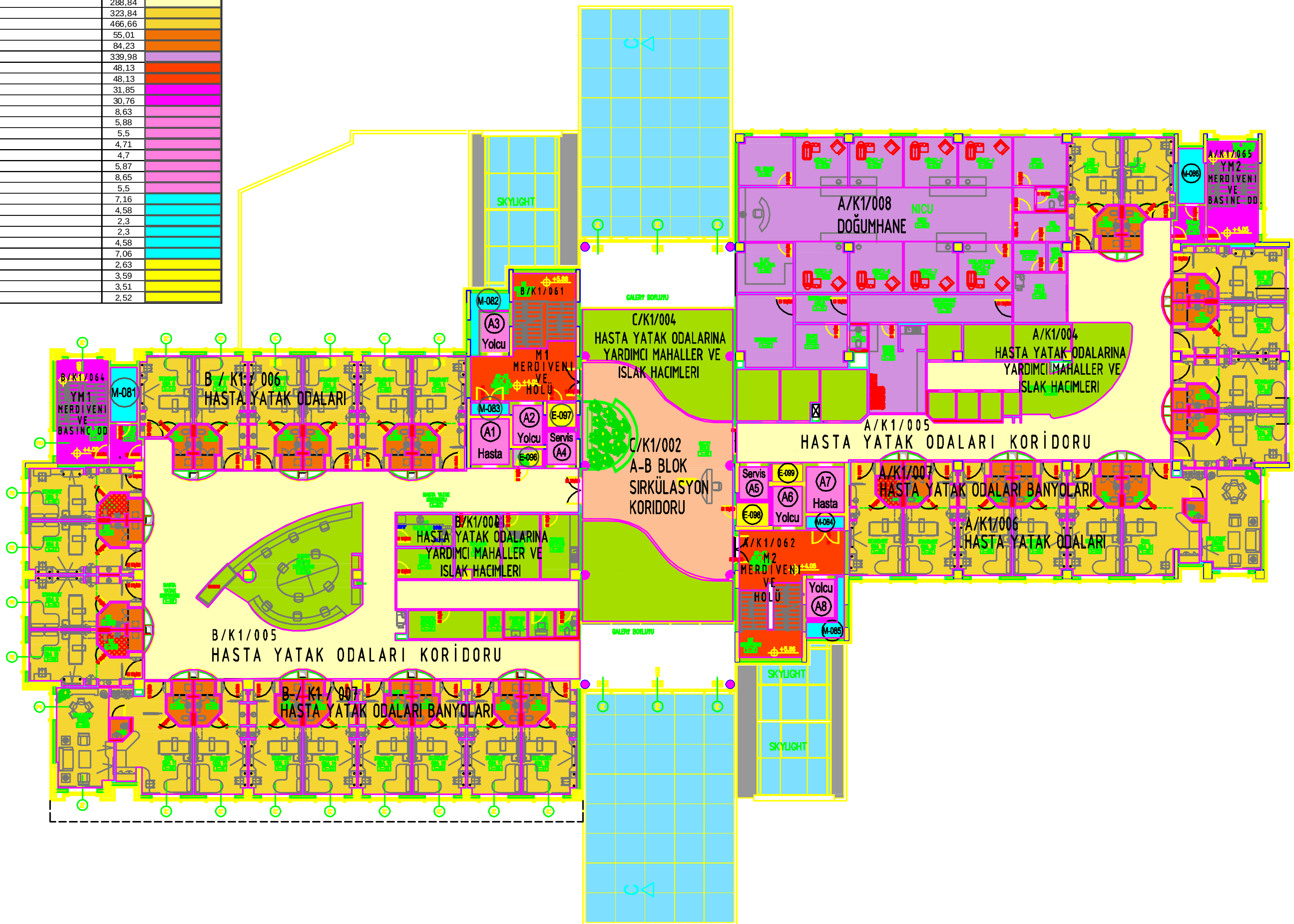
| 2. KAT | | | | | |
|---|---|---|---|---|---|
| BLOK | KAT | ZONE NO | MAHAL ADI | M2 | LEGAND |
| C | K2 | 002 | A-B BLOK SİRKÜLASYON KORİDORU | 117,39 | |
| A | K2 | 004 | HASTA YATAK ODALARINA YARDIMCI MAHALLER VE ISLAK HACİMLERİ | 194,36 | |
| B | K2 | 004 | HASTA YATAK ODALARINA YARDIMCI MAHALLER VE ISLAK HACİMLERİ | 134,43 | |
| C | K2 | 004 | HASTA YATAK ODALARINA YARDIMCI MAHALLER VE ISLAK HACİMLERİ | 53,88 | |
| A | K2 | 005 | HASTA YATAK ODALARI KORİDORU | 297,55 | |
| B | K2 | 005 | HASTA YATAK ODALARI KORİDORU | 298,88 | |
| A | K2 | 006 | HASTA YATAK ODALARI | 468,94 | |
| B | K2 | 006 | HASTA YATAK ODALARI | 466,89 | |
| A | K2 | 007 | HASTA YATAK ODALARI BANYOSU | 84,23 | |
| B | K2 | 007 | HASTA YATAK ODALARI BANYOSU | 84,23 | |
| B | K2 | 061 | M1 MERDİVENİ | 49,65 | |
| A | K2 | 062 | M2 MERDİVENİ | 48,27 | |
| B | K2 | 064 | YM1 MERDİVENİ | 31,85 | |
| A | K2 | 065 | YM2 MERDİVENİ | 30,35 | |
| B | K2 | 070 | A1 HASTA ASANSÖRÜ | 8,63 | |
| B | K2 | 071 | A2 YOLCU ASANSÖRÜ | 5,88 | |
| B | K2 | 072 | A3 YOLCU ASANSÖRÜ | 5,5 | |
| B | K2 | 073 | A4 SERVİS ASANSÖRÜ | 4,71 | |
| A | K2 | 074 | A5 SERVİS ASANSÖRÜ | 4,7 | |
| A | K2 | 075 | A6 YOLCU ASANSÖRÜ | 5,87 | |
| A | K2 | 076 | A7 HASTA ASANSÖRÜ | 8,65 | |
| A | K2 | 077 | A8 YOLCU ASANSÖRÜ | 5,5 | |
| B | K2 | 081 | M-081 MEKANİK ŞAFT | 7,16 | |
| B | K2 | 082 | M-082 MEKANİK ŞAFT | 4,58 | |
| B | K2 | 083 | M-083 MEKANİK ŞAFT | 2,3 | |
| A | K2 | 084 | M-084 MEKANİK ŞAFT | 2,3 | |
| A | K2 | 085 | M-085 MEKANİK ŞAFT | 4,58 | |
| A | K2 | 086 | M-086 MEKANİK ŞAFT | 7,06 | |
| B | K2 | 096 | E-096 ELEKTRİK ŞAFT | 2,63 | |
| B | K2 | 097 | E-097 ELEKTRİK ŞAFT | 3,59 | |
| A | K2 | 098 | E-098 ELEKTRİK ŞAFT | 3,51 | |
| A | K2 | 099 | E-099 ELEKTRİK ŞAFT | 2,52 | |




PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

# 1.KAT PLANI

| 1. KAT | | | | | |
|---|---|---|---|---|---|
| BLOK | KAT | ZONE NO | MAHAL ADI | M2 | LEGAND |
| C | K1 | 002 | A-B BLOK SİRKÜLASYON KORİDORU | 117,39 | |
| A | K1 | 004 | HASTA YATAK ODALARINA YARDIMCI MAHALLER VE ISLAK HACİMLERİ | 101,59 | |
| B | K1 | 004 | HASTA YATAK ODALARINA YARDIMCI MAHALLER VE ISLAK HACİMLERİ | 143,34 | |
| C | K1 | 004 | HASTA YATAK ODALARINA YARDIMCI MAHALLER VE ISLAK HACİMLERİ | 113,29 | |
| A | K1 | 005 | HASTA YATAK ODALARI KORİDORU | 161,19 | |
| B | K1 | 005 | HASTA YATAK ODALARI KORİDORU | 288,84 | |
| A | K1 | 006 | HASTA YATAK ODALARI | 323,84 | |
| B | K1 | 006 | HASTA YATAK ODALARI | 466,66 | |
| A | K1 | 007 | HASTA YATAK ODALARI BANYOSU | 55,01 | |
| B | K1 | 007 | HASTA YATAK ODALARI BANYOSU | 84,23 | |
| A | K1 | 008 | DOĞUMHANE | 339,98 | |
| B | K1 | 061 | M1 MERDİVENİ | 48,13 | |
| A | K1 | 062 | M2 MERDİVENİ | 48,13 | |
| B | K1 | 064 | YM1 MERDİVENİ | 31,85 | |
| A | K1 | 065 | YM2 MERDİVENİ | 30,76 | |
| B | K1 | 070 | A1 HASTA ASANSÖRÜ | 8,63 | |
| B | K1 | 071 | A2 YOLCU ASANSÖRÜ | 5,88 | |
| B | K1 | 072 | A3 YOLCU ASANSÖRÜ | 5,5 | |
| B | K1 | 073 | A4 SERVİS ASANSÖRÜ | 4,71 | |
| A | K1 | 074 | A5 SERVİS ASANSÖRÜ | 4,7 | |
| A | K1 | 075 | A6 YOLCU ASANSÖRÜ | 5,87 | |
| A | K1 | 076 | A7 HASTA ASANSÖRÜ | 8,65 | |
| A | K1 | 077 | A8 YOLCU ASANSÖRÜ | 5,5 | |
| B | K1 | 081 | M-081 MEKANİK ŞAFT | 7,16 | |
| B | K1 | 082 | M-082 MEKANİK ŞAFT | 4,58 | |
| B | K1 | 083 | M-083 MEKANİK ŞAFT | 2,3 | |
| A | K1 | 084 | M-084 MEKANİK ŞAFT | 2,3 | |
| A | K1 | 085 | M-085 MEKANİK ŞAFT | 4,58 | |
| A | K1 | 086 | M-086 MEKANİK ŞAFT | 7,06 | |
| B | K1 | 096 | E-096 ELEKTRİK ŞAFT | 2,63 | |
| B | K1 | 097 | E-097 ELEKTRİK ŞAFT | 3,59 | |
| A | K1 | 098 | E-098 ELEKTRİK ŞAFT | 3,51 | |
| A | K1 | 099 | E-099 ELEKTRİK ŞAFT | 2,52 | |

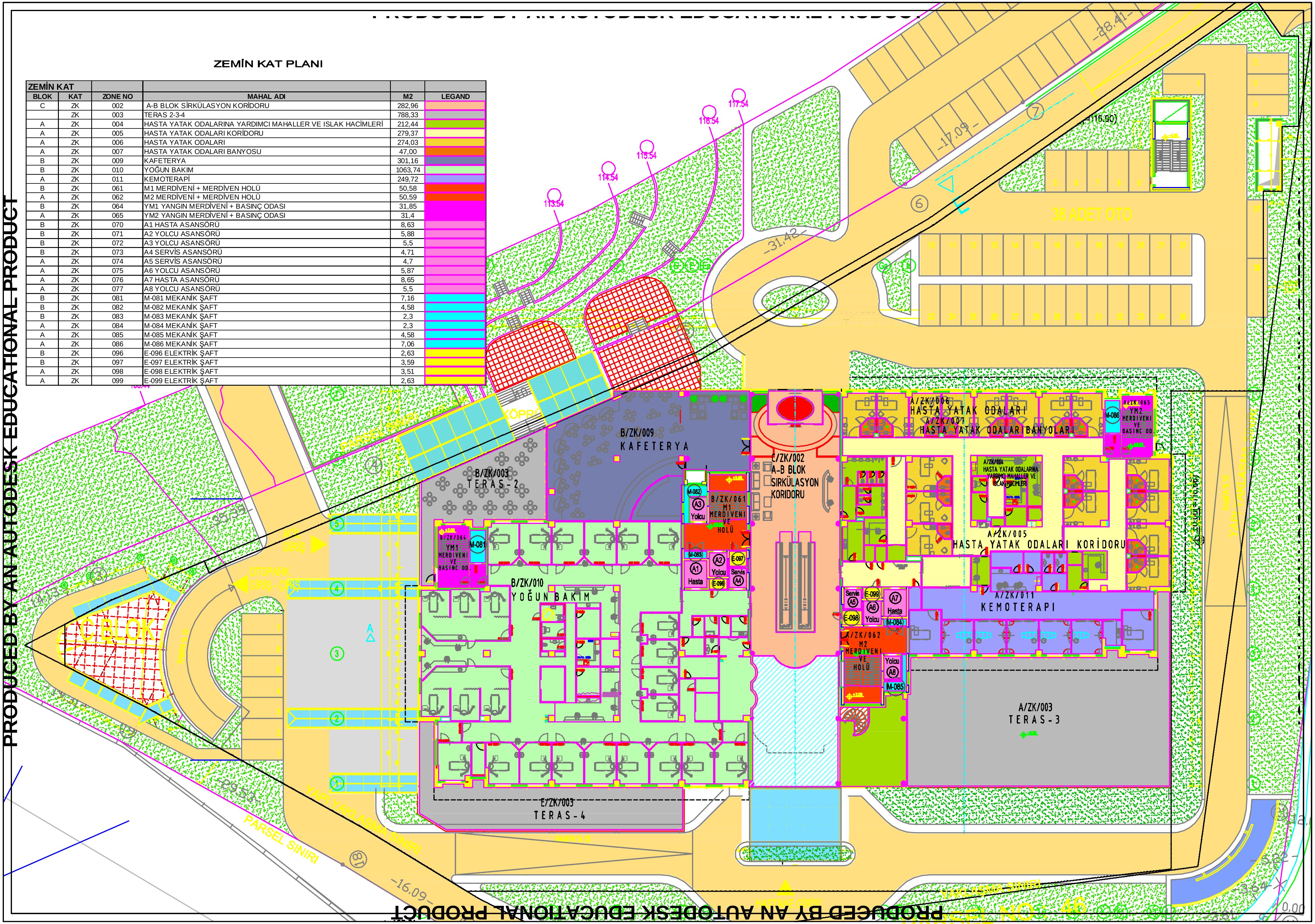




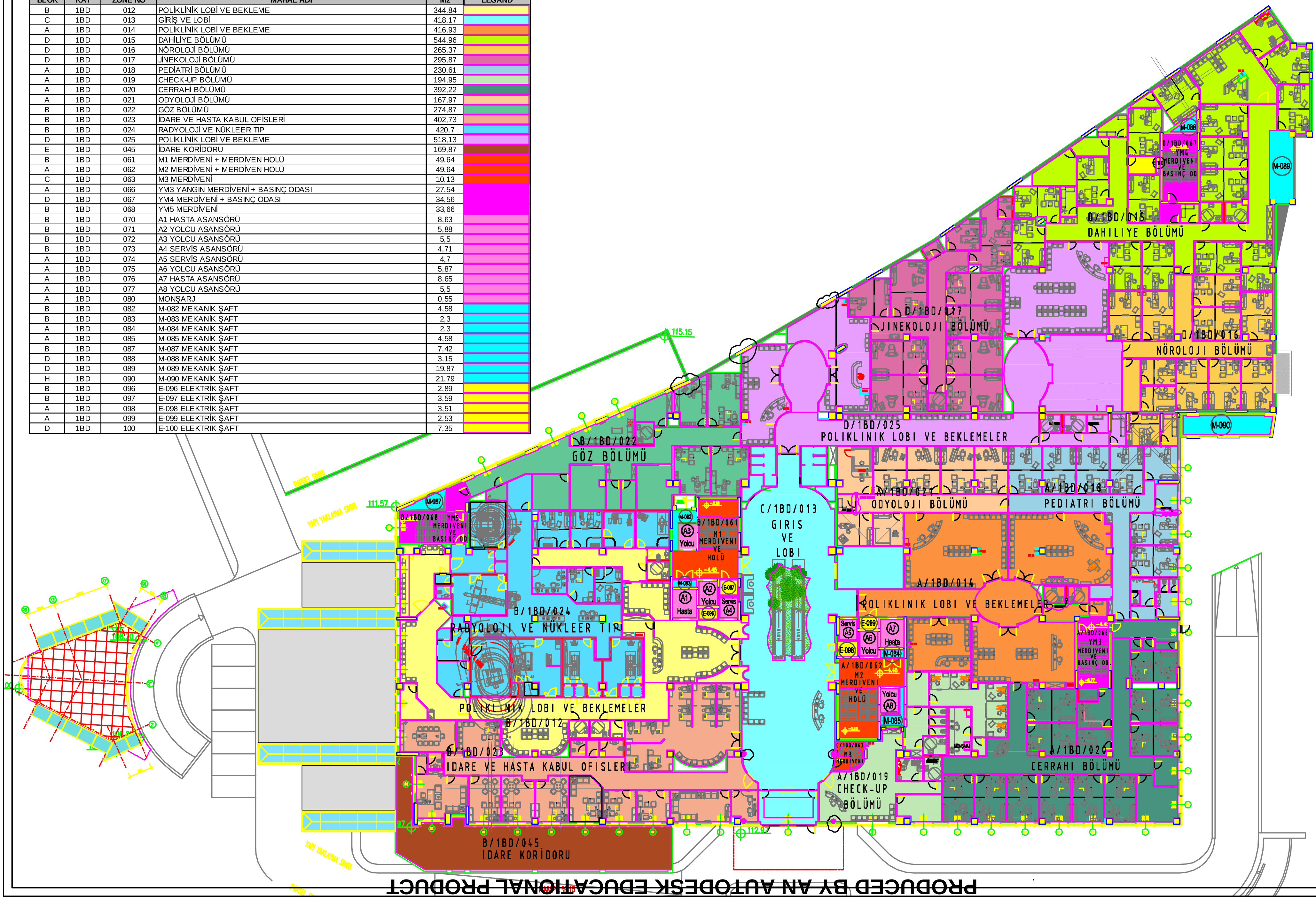

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

## ZEMİN KAT PLANI

| ZEMİN KAT | | | | | |
|---|---|---|---|---|---|
| BLOK | KAT | ZONE NO | MAHAL ADI | M2 | LEGAND |
| C | ZK | 002 | A-B BLOK SİRKÜLASYON KORİDORU | 282,96 | |
| | ZK | 003 | TERAS 2-3-4 | 788,33 | |
| A | ZK | 004 | HASTA YATAK ODALARINA YARDIMCI MAHALLER VE ISLAK HACİMLERİ | 212,44 | |
| A | ZK | 005 | HASTA YATAK ODALARI KORİDORU | 279,37 | |
| A | ZK | 006 | HASTA YATAK ODALARI | 274,03 | |
| A | ZK | 007 | HASTA YATAK ODALARI BANYOSU | 47,00 | |
| B | ZK | 009 | KAFETERYA | 301,16 | |
| B | ZK | 010 | YOĞUN BAKIM | 1063,74 | |
| A | ZK | 011 | KEMOTERAPİ | 249,72 | |
| B | ZK | 061 | M1 MERDİVENİ + MERDİVEN HOLÜ | 50,58 | |
| A | ZK | 062 | M2 MERDİVENİ + MERDİVEN HOLÜ | 50,59 | |
| B | ZK | 064 | YM1 YANGIN MERDİVENİ + BASINÇ ODASI | 31,85 | |
| A | ZK | 065 | YM2 YANGIN MERDİVENİ + BASINÇ ODASI | 31,4 | |
| B | ZK | 070 | A1 HASTA ASANSÖRÜ | 8,63 | |
| B | ZK | 071 | A2 YOLCU ASANSÖRÜ | 5,88 | |
| B | ZK | 072 | A3 YOLCU ASANSÖRÜ | 5,5 | |
| B | ZK | 073 | A4 SERVİS ASANSÖRÜ | 4,71 | |
| A | ZK | 074 | A5 SERVİS ASANSÖRÜ | 4,7 | |
| A | ZK | 075 | A6 YOLCU ASANSÖRÜ | 5,87 | |
| A | ZK | 076 | A7 HASTA ASANSÖRÜ | 8,65 | |
| A | ZK | 077 | A8 YOLCU ASANSÖRÜ | 5,5 | |
| B | ZK | 081 | M-081 MEKANİK ŞAFT | 7,16 | |
| B | ZK | 082 | M-082 MEKANİK ŞAFT | 4,58 | |
| B | ZK | 083 | M-083 MEKANİK ŞAFT | 2,3 | |
| A | ZK | 084 | M-084 MEKANİK ŞAFT | 2,3 | |
| A | ZK | 085 | M-085 MEKANİK ŞAFT | 4,58 | |
| A | ZK | 086 | M-086 MEKANİK ŞAFT | 7,06 | |
| B | ZK | 096 | E-096 ELEKTRİK ŞAFT | 2,63 | |
| B | ZK | 097 | E-097 ELEKTRİK ŞAFT | 3,59 | |
| A | ZK | 098 | E-098 ELEKTRİK ŞAFT | 3,51 | |
| A | ZK | 099 | E-099 ELEKTRİK ŞAFT | 2,63 | |



| 1.BODRUM KAT | | | | | |
|---|---|---|---|---|---|
| BLOK | KAT | ZONE NO | MAHAL ADI | M2 | LEGAND |
| B | 1BD | 012 | POLİKLİNİK LOBİ VE BEKLEME | 344,84 | |
| C | 1BD | 013 | GİRİŞ VE LOBİ | 418,17 | |
| A | 1BD | 014 | POLİKLİNİK LOBİ VE BEKLEME | 416,93 | |
| D | 1BD | 015 | DAHİLİYE BÖLÜMÜ | 544,96 | |
| D | 1BD | 016 | NÖROLOJİ BÖLÜMÜ | 265,37 | |
| D | 1BD | 017 | JİNEKOLOJİ BÖLÜMÜ | 295,87 | |
| A | 1BD | 018 | PEDİATRİ BÖLÜMÜ | 230,61 | |
| A | 1BD | 019 | CHECK-UP BÖLÜMÜ | 194,95 | |
| A | 1BD | 020 | CERRAHİ BÖLÜMÜ | 392,22 | |
| A | 1BD | 021 | ODYOLOJİ BÖLÜMÜ | 167,97 | |
| B | 1BD | 022 | GÖZ BÖLÜMÜ | 274,87 | |
| B | 1BD | 023 | İDARE VE HASTA KABUL OFİSLERİ | 402,73 | |
| B | 1BD | 024 | RADYOLOJİ VE NÜKLEER TIP | 420,7 | |
| D | 1BD | 025 | POLİKLİNİK LOBİ VE BEKLEME | 518,13 | |
| E | 1BD | 045 | İDARE KORİDORU | 169,87 | |
| B | 1BD | 061 | M1 MERDİVENİ + MERDİVEN HOLÜ | 49,64 | |
| A | 1BD | 062 | M2 MERDİVENİ + MERDİVEN HOLÜ | 49,64 | |
| C | 1BD | 063 | M3 MERDİVENİ | 10,13 | |
| A | 1BD | 066 | YM3 YANGIN MERDİVENİ + BASINÇ ODASI | 27,54 | |
| D | 1BD | 067 | YM4 MERDİVENİ + BASINÇ ODASI | 34,56 | |
| B | 1BD | 068 | YM5 MERDİVENİ | 33,66 | |
| B | 1BD | 070 | A1 HASTA ASANSÖRÜ | 8,63 | |
| B | 1BD | 071 | A2 YOLCU ASANSÖRÜ | 5,88 | |
| B | 1BD | 072 | A3 YOLCU ASANSÖRÜ | 5,5 | |
| B | 1BD | 073 | A4 SERVİS ASANSÖRÜ | 4,71 | |
| A | 1BD | 074 | A5 SERVİS ASANSÖRÜ | 4,7 | |
| A | 1BD | 075 | A6 YOLCU ASANSÖRÜ | 5,87 | |
| A | 1BD | 076 | A7 HASTA ASANSÖRÜ | 8,65 | |
| A | 1BD | 077 | A8 YOLCU ASANSÖRÜ | 5,5 | |
| A | 1BD | 080 | MONŞARJ | 0,55 | |
| B | 1BD | 082 | M-082 MEKANİK ŞAFT | 4,58 | |
| B | 1BD | 083 | M-083 MEKANİK ŞAFT | 2,3 | |
| A | 1BD | 084 | M-084 MEKANİK ŞAFT | 2,3 | |
| A | 1BD | 085 | M-085 MEKANİK ŞAFT | 4,58 | |
| B | 1BD | 087 | M-087 MEKANİK ŞAFT | 7,42 | |
| D | 1BD | 088 | M-088 MEKANİK ŞAFT | 3,15 | |
| D | 1BD | 089 | M-089 MEKANİK ŞAFT | 19,87 | |
| H | 1BD | 090 | M-090 MEKANİK ŞAFT | 21,79 | |
| B | 1BD | 096 | E-096 ELEKTRİK ŞAFT | 2,89 | |
| B | 1BD | 097 | E-097 ELEKTRİK ŞAFT | 3,59 | |
| A | 1BD | 098 | E-098 ELEKTRİK ŞAFT | 3,51 | |
| A | 1BD | 099 | E-099 ELEKTRİK ŞAFT | 2,53 | |
| D | 1BD | 100 | E-100 ELEKTRİK ŞAFT | 7,35 | |

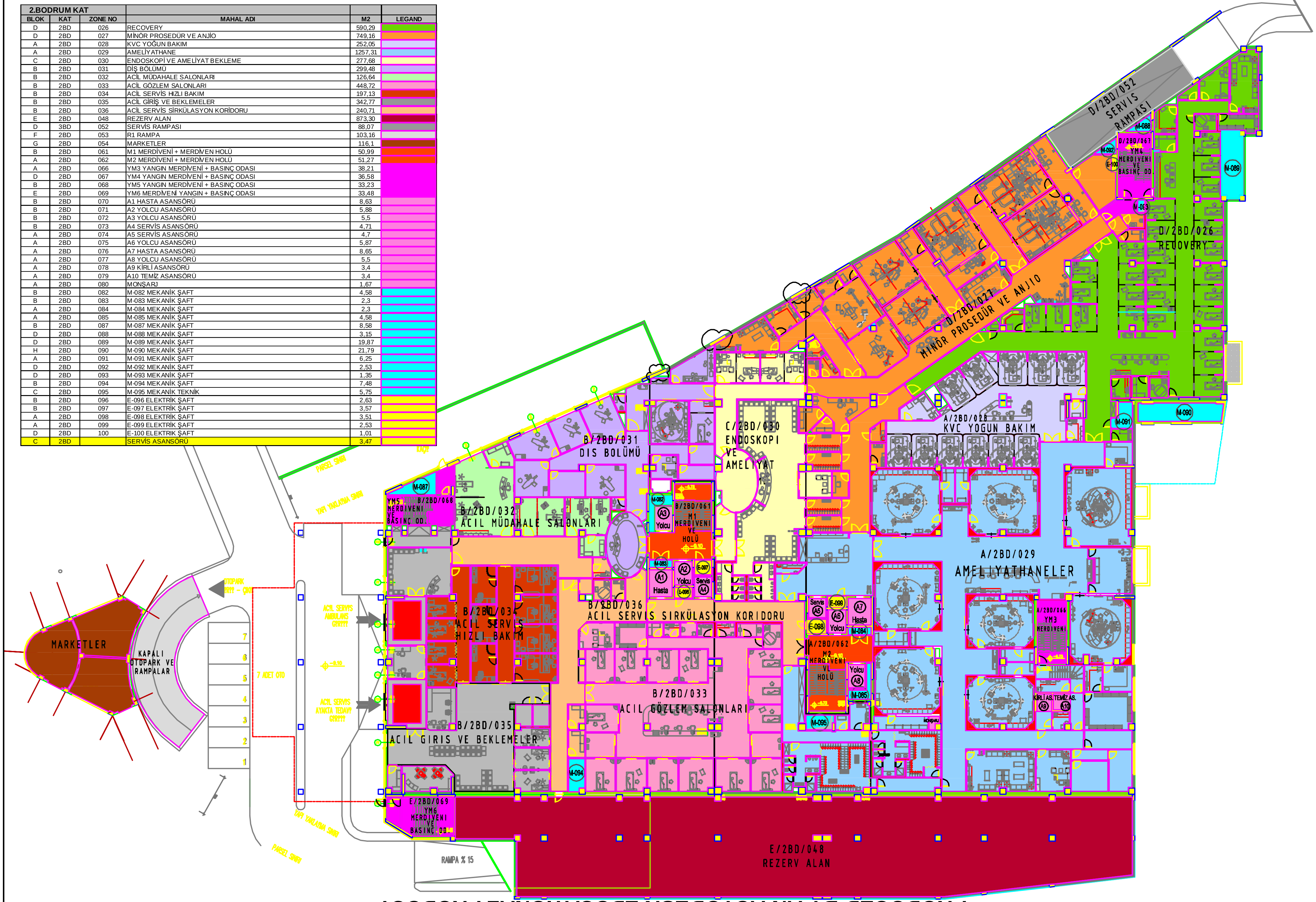



PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

## 2. BODRUM KAT

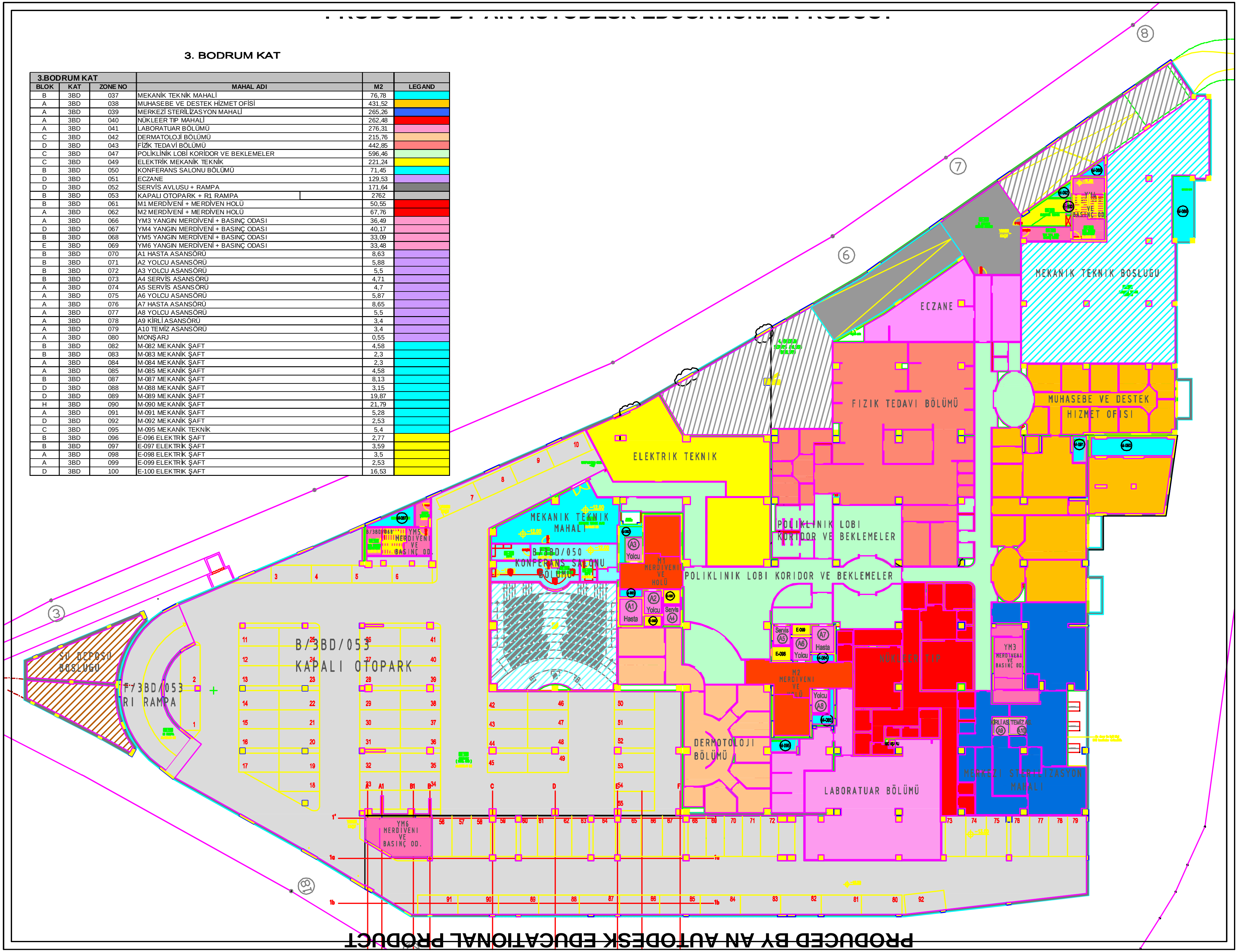
| 2.BODRUM KAT | | | | | |
|---|---|---|---|---|---|
| BLOK | KAT | ZONE NO | MAHAL ADI | M2 | LEGAND |
| D | 2BD | 026 | RECOVERY | 590,29 | |
| D | 2BD | 027 | MİNÖR PROSEDÜR VE ANJİO | 749,16 | |
| A | 2BD | 028 | KVC YOĞUN BAKIM | 252,05 | |
| A | 2BD | 029 | AMELİYATHANE | 1257,31 | |
| C | 2BD | 030 | ENDOSKOPİ VE AMELİYAT BEKLEME | 277,68 | |
| B | 2BD | 031 | DİŞ BÖLÜMÜ | 299,48 | |
| B | 2BD | 032 | ACİL MÜDAHALE SALONLARI | 126,64 | |
| B | 2BD | 033 | ACİL GÖZLEM SALONLARI | 448,72 | |
| B | 2BD | 034 | ACİL SERVİS HIZLI BAKIM | 197,13 | |
| B | 2BD | 035 | ACİL GİRİŞ VE BEKLEMELER | 342,77 | |
| B | 2BD | 036 | ACİL SERVİS SİRKÜLASYON KORİDORU | 240,71 | |
| E | 2BD | 048 | REZERV ALAN | 873,30 | |
| D | 3BD | 052 | SERVİS RAMPASI | 88,07 | |
| F | 2BD | 053 | R1 RAMPA | 103,16 | |
| G | 2BD | 054 | MARKETLER | 116,1 | |
| B | 2BD | 061 | M1 MERDİVENİ + MERDİVEN HOLÜ | 50,99 | |
| A | 2BD | 062 | M2 MERDİVENİ + MERDİVEN HOLÜ | 51,27 | |
| A | 2BD | 066 | YM3 YANGIN MERDİVENİ + BASINÇ ODASI | 38,21 | |
| D | 2BD | 067 | YM4 YANGIN MERDİVENİ + BASINÇ ODASI | 36,58 | |
| B | 2BD | 068 | YM5 YANGIN MERDİVENİ + BASINÇ ODASI | 33,23 | |
| E | 2BD | 069 | YM6 MERDİVENİ YANGIN + BASINÇ ODASI | 33,48 | |
| B | 2BD | 070 | A1 HASTA ASANSÖRÜ | 8,63 | |
| B | 2BD | 071 | A2 YOLCU ASANSÖRÜ | 5,88 | |
| B | 2BD | 072 | A3 YOLCU ASANSÖRÜ | 5,5 | |
| B | 2BD | 073 | A4 SERVİS ASANSÖRÜ | 4,71 | |
| A | 2BD | 074 | A5 SERVİS ASANSÖRÜ | 4,7 | |
| A | 2BD | 075 | A6 YOLCU ASANSÖRÜ | 5,87 | |
| A | 2BD | 076 | A7 HASTA ASANSÖRÜ | 8,65 | |
| A | 2BD | 077 | A8 YOLCU ASANSÖRÜ | 5,5 | |
| A | 2BD | 078 | A9 KİRLİ ASANSÖRÜ | 3,4 | |
| A | 2BD | 079 | A10 TEMİZ ASANSÖRÜ | 3,4 | |
| A | 2BD | 080 | MONŞARJ | 1,67 | |
| B | 2BD | 082 | M-082 MEKANİK ŞAFT | 4,58 | |
| B | 2BD | 083 | M-083 MEKANİK ŞAFT | 2,3 | |
| A | 2BD | 084 | M-084 MEKANİK ŞAFT | 2,3 | |
| A | 2BD | 085 | M-085 MEKANİK ŞAFT | 4,58 | |
| B | 2BD | 087 | M-087 MEKANİK ŞAFT | 8,58 | |
| D | 2BD | 088 | M-088 MEKANİK ŞAFT | 3,15 | |
| D | 2BD | 089 | M-089 MEKANİK ŞAFT | 19,87 | |
| H | 2BD | 090 | M-090 MEKANİK ŞAFT | 21,79 | |
| A | 2BD | 091 | M-091 MEKANİK ŞAFT | 6,25 | |
| D | 2BD | 092 | M-092 MEKANİK ŞAFT | 2,53 | |
| D | 2BD | 093 | M-093 MEKANİK ŞAFT | 1,35 | |
| B | 2BD | 094 | M-094 MEKANİK ŞAFT | 7,48 | |
| C | 2BD | 095 | M-095 MEKANİK TEKNİK | 5,75 | |
| B | 2BD | 096 | E-096 ELEKTRİK ŞAFT | 2,63 | |
| B | 2BD | 097 | E-097 ELEKTRİK ŞAFT | 3,57 | |
| A | 2BD | 098 | E-098 ELEKTRİK ŞAFT | 3,51 | |
| A | 2BD | 099 | E-099 ELEKTRİK ŞAFT | 2,53 | |
| D | 2BD | 100 | E-100 ELEKTRIK ŞAFT | 1,01 | |
| C | 2BD | | SERVİS ASANSÖRÜ | 3,47 | |




PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

## 3. BODRUM KAT

| 3.BODRUM KAT | | | | | |
|---|---|---|---|---|---|
| BLOK | KAT | ZONE NO | MAHAL ADI | M2 | LEGAND |
| B | 3BD | 037 | MEKANİK TEKNİK MAHALİ | 76,78 | |
| A | 3BD | 038 | MUHASEBE VE DESTEK HİZMET OFİSİ | 431,52 | |
| A | 3BD | 039 | MERKEZİ STERİLİZASYON MAHALİ | 265,26 | |
| A | 3BD | 040 | NÜKLEER TIP MAHALİ | 262,48 | |
| A | 3BD | 041 | LABORATUAR BÖLÜMÜ | 276,31 | |
| C | 3BD | 042 | DERMATOLOJİ BÖLÜMÜ | 215,76 | |
| D | 3BD | 043 | FİZİK TEDAVİ BÖLÜMÜ | 442,85 | |
| C | 3BD | 047 | POLİKLİNİK LOBİ KORİDOR VE BEKLEMELER | 596,46 | |
| C | 3BD | 049 | ELEKTRİK MEKANİK TEKNİK | 221,24 | |
| B | 3BD | 050 | KONFERANS SALONU BÖLÜMÜ | 71,45 | |
| D | 3BD | 051 | ECZANE | 129,53 | |
| D | 3BD | 052 | SERVİS AVLUSU + RAMPA | 171,64 | |
| B | 3BD | 053 | KAPALI OTOPARK + R1 RAMPA | 2762 | |
| B | 3BD | 061 | M1 MERDİVENİ + MERDİVEN HOLÜ | 50,55 | |
| A | 3BD | 062 | M2 MERDİVENİ + MERDİVEN HOLÜ | 67,76 | |
| A | 3BD | 066 | YM3 YANGIN MERDİVENİ + BASINÇ ODASI | 36,49 | |
| D | 3BD | 067 | YM4 YANGIN MERDİVENİ + BASINÇ ODASI | 40,17 | |
| B | 3BD | 068 | YM5 YANGIN MERDİVENİ + BASINÇ ODASI | 33,09 | |
| E | 3BD | 069 | YM6 YANGIN MERDİVENİ + BASINÇ ODASI | 33,48 | |
| B | 3BD | 070 | A1 HASTA ASANSÖRÜ | 8,63 | |
| B | 3BD | 071 | A2 YOLCU ASANSÖRÜ | 5,88 | |
| B | 3BD | 072 | A3 YOLCU ASANSÖRÜ | 5,5 | |
| B | 3BD | 073 | A4 SERVİS ASANSÖRÜ | 4,71 | |
| A | 3BD | 074 | A5 SERVİS ASANSÖRÜ | 4,7 | |
| A | 3BD | 075 | A6 YOLCU ASANSÖRÜ | 5,87 | |
| A | 3BD | 076 | A7 HASTA ASANSÖRÜ | 8,65 | |
| A | 3BD | 077 | A8 YOLCU ASANSÖRÜ | 5,5 | |
| A | 3BD | 078 | A9 KİRLİ ASANSÖRÜ | 3,4 | |
| A | 3BD | 079 | A10 TEMİZ ASANSÖRÜ | 3,4 | |
| A | 3BD | 080 | MONŞARJ | 0,55 | |
| B | 3BD | 082 | M-082 MEKANİK ŞAFT | 4,58 | |
| B | 3BD | 083 | M-083 MEKANİK ŞAFT | 2,3 | |
| A | 3BD | 084 | M-084 MEKANİK ŞAFT | 2,3 | |
| A | 3BD | 085 | M-085 MEKANİK ŞAFT | 4,58 | |
| B | 3BD | 087 | M-087 MEKANİK ŞAFT | 8,13 | |
| D | 3BD | 088 | M-088 MEKANİK ŞAFT | 3,15 | |
| D | 3BD | 089 | M-089 MEKANİK ŞAFT | 19,87 | |
| H | 3BD | 090 | M-090 MEKANİK ŞAFT | 21,79 | |
| A | 3BD | 091 | M-091 MEKANİK ŞAFT | 5,28 | |
| D | 3BD | 092 | M-092 MEKANİK ŞAFT | 2,53 | |
| C | 3BD | 095 | M-095 MEKANİK TEKNİK | 5,4 | |
| B | 3BD | 096 | E-096 ELEKTRİK ŞAFT | 2,77 | |
| B | 3BD | 097 | E-097 ELEKTRİK ŞAFT | 3,59 | |
| A | 3BD | 098 | E-098 ELEKTRİK ŞAFT | 3,5 | |
| A | 3BD | 099 | E-099 ELEKTRİK ŞAFT | 2,53 | |
| D | 3BD | 100 | E-100 ELEKTRIK ŞAFT | 16,53 | |

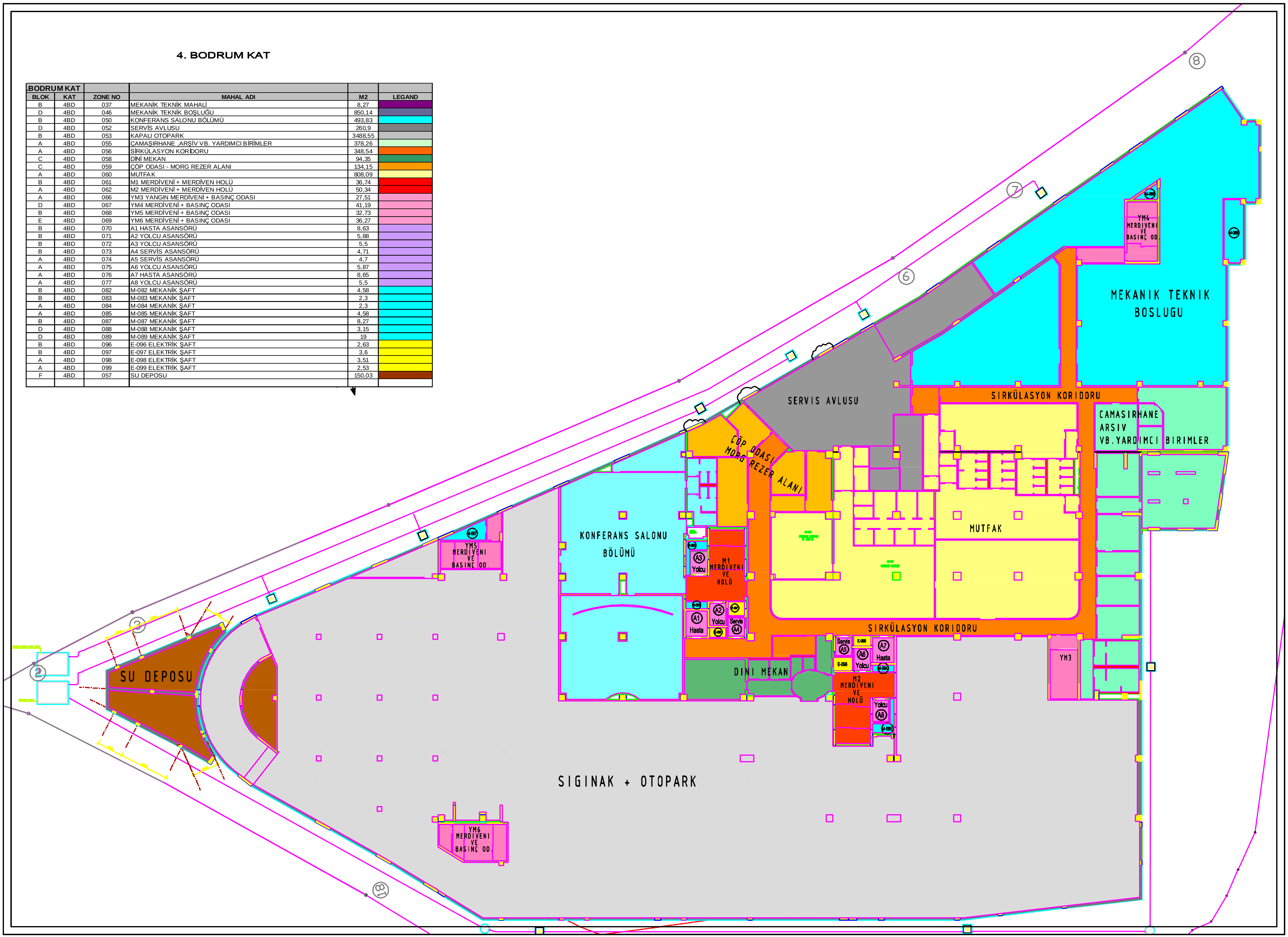





PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

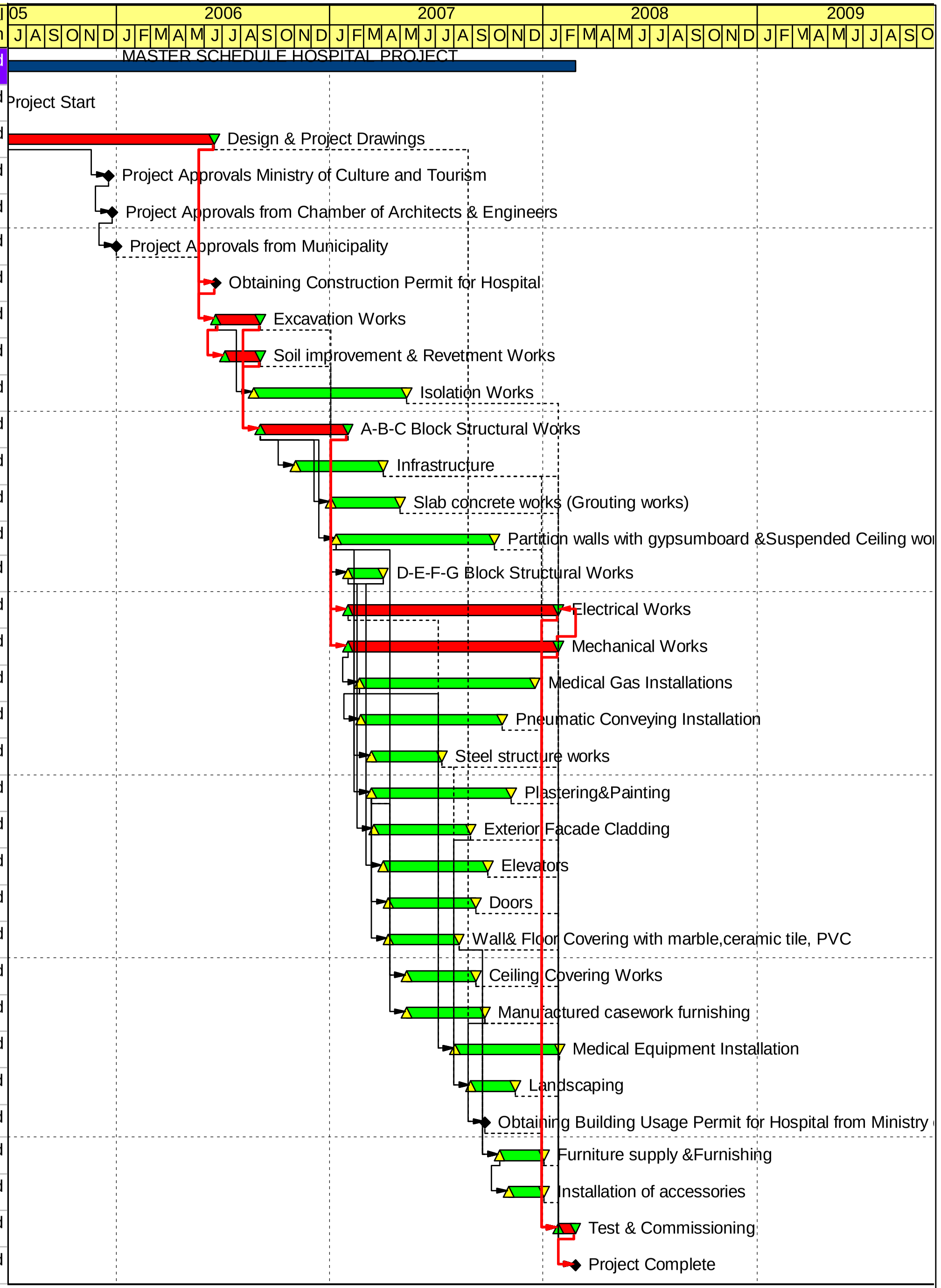
## 4. BODRUM KAT

| BODRUM KAT | | | | | |
|---|---|---|---|---|---|
| BLOK | KAT | ZONE NO | MAHAL ADI | M2 | LEGAND |
| B | 4BD | 037 | MEKANİK TEKNİK MAHALİ | 8,27 | |
| D | 4BD | 046 | MEKANİK TEKNİK BOŞLUĞU | 850,14 | |
| B | 4BD | 050 | KONFERANS SALONU BÖLÜMÜ | 493,83 | |
| D | 4BD | 052 | SERVİS AVLUSU | 260,9 | |
| B | 4BD | 053 | KAPALI OTOPARK | 3488,55 | |
| A | 4BD | 055 | ÇAMAŞIRHANE ,ARŞİV VB. YARDIMCI BİRİMLER | 378,26 | |
| A | 4BD | 056 | SİRKÜLASYON KORİDORU | 348,54 | |
| C | 4BD | 058 | DİNİ MEKAN | 94,35 | |
| C | 4BD | 059 | ÇÖP ODASI - MORG REZER ALANI | 134,15 | |
| A | 4BD | 060 | MUTFAK | 808,09 | |
| B | 4BD | 061 | M1 MERDİVENİ + MERDİVEN HOLÜ | 36,74 | |
| A | 4BD | 062 | M2 MERDİVENİ + MERDİVEN HOLÜ | 50,34 | |
| A | 4BD | 066 | YM3 YANGIN MERDİVENİ + BASINÇ ODASI | 27,51 | |
| D | 4BD | 067 | YM4 MERDİVENİ + BASINÇ ODASI | 41,19 | |
| B | 4BD | 068 | YM5 MERDİVENİ + BASINÇ ODASI | 32,73 | |
| E | 4BD | 069 | YM6 MERDİVENİ + BASINÇ ODASI | 36,27 | |
| B | 4BD | 070 | A1 HASTA ASANSÖRÜ | 8,63 | |
| B | 4BD | 071 | A2 YOLCU ASANSÖRÜ | 5,88 | |
| B | 4BD | 072 | A3 YOLCU ASANSÖRÜ | 5,5 | |
| B | 4BD | 073 | A4 SERVİS ASANSÖRÜ | 4,71 | |
| A | 4BD | 074 | A5 SERVİS ASANSÖRÜ | 4,7 | |
| A | 4BD | 075 | A6 YOLCU ASANSÖRÜ | 5,87 | |
| A | 4BD | 076 | A7 HASTA ASANSÖRÜ | 8,65 | |
| A | 4BD | 077 | A8 YOLCU ASANSÖRÜ | 5,5 | |
| B | 4BD | 082 | M-082 MEKANİK ŞAFT | 4,58 | |
| B | 4BD | 083 | M-083 MEKANİK ŞAFT | 2,3 | |
| A | 4BD | 084 | M-084 MEKANİK ŞAFT | 2,3 | |
| A | 4BD | 085 | M-085 MEKANİK ŞAFT | 4,58 | |
| B | 4BD | 087 | M-087 MEKANİK ŞAFT | 8,27 | |
| D | 4BD | 088 | M-088 MEKANİK ŞAFT | 3,15 | |
| D | 4BD | 089 | M-089 MEKANİK ŞAFT | 19 | |
| B | 4BD | 096 | E-096 ELEKTRİK ŞAFT | 2,63 | |
| B | 4BD | 097 | E-097 ELEKTRİK ŞAFT | 3,6 | |
| A | 4BD | 098 | E-098 ELEKTRİK ŞAFT | 3,51 | |
| A | 4BD | 099 | E-099 ELEKTRİK ŞAFT | 2,53 | |
| F | 4BD | 057 | SU DEPOSU | 150,03 | |

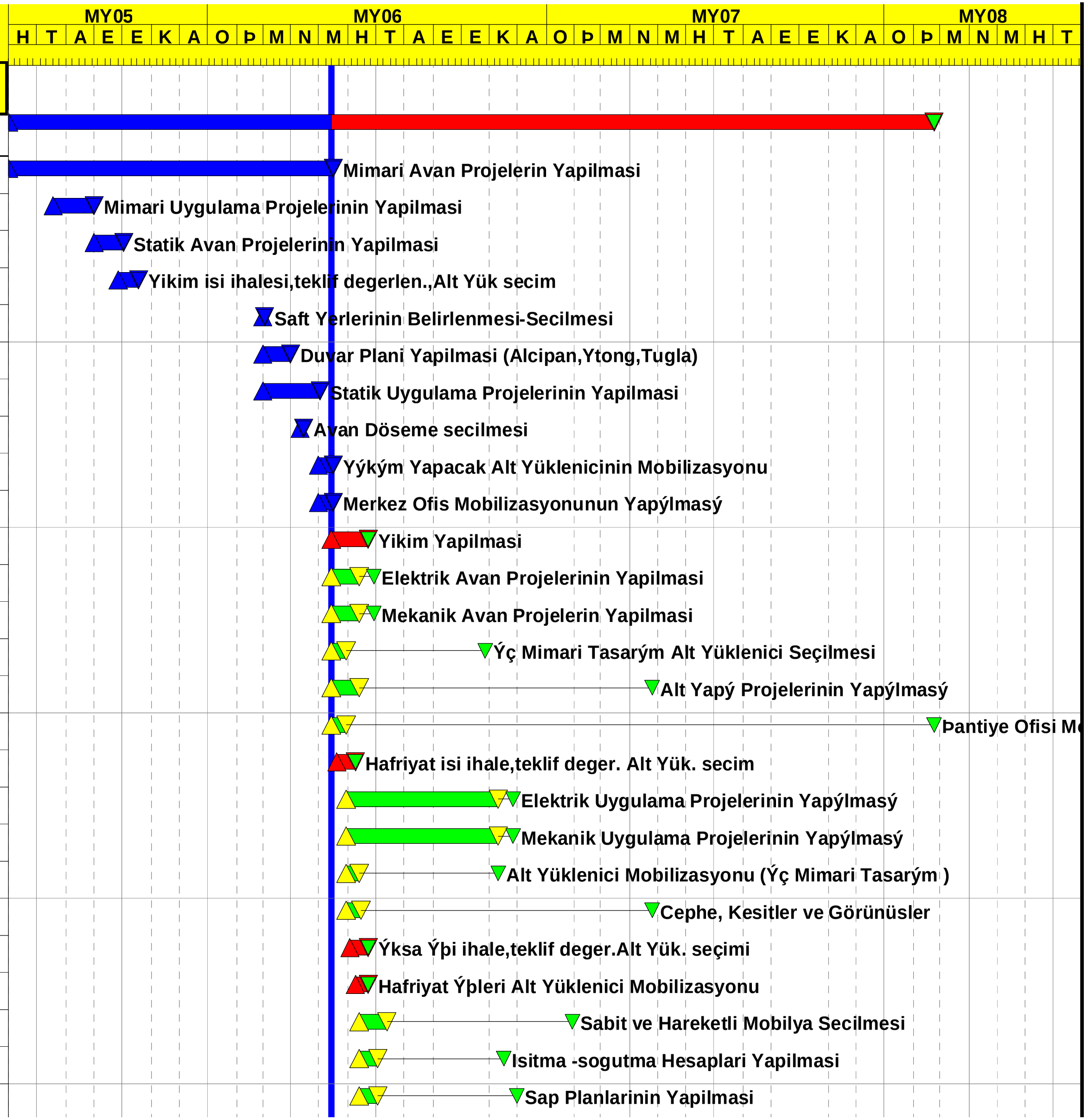


# APPENDIX B : THE MASTER SCHEDULE AND DETAILED SCHEDULE

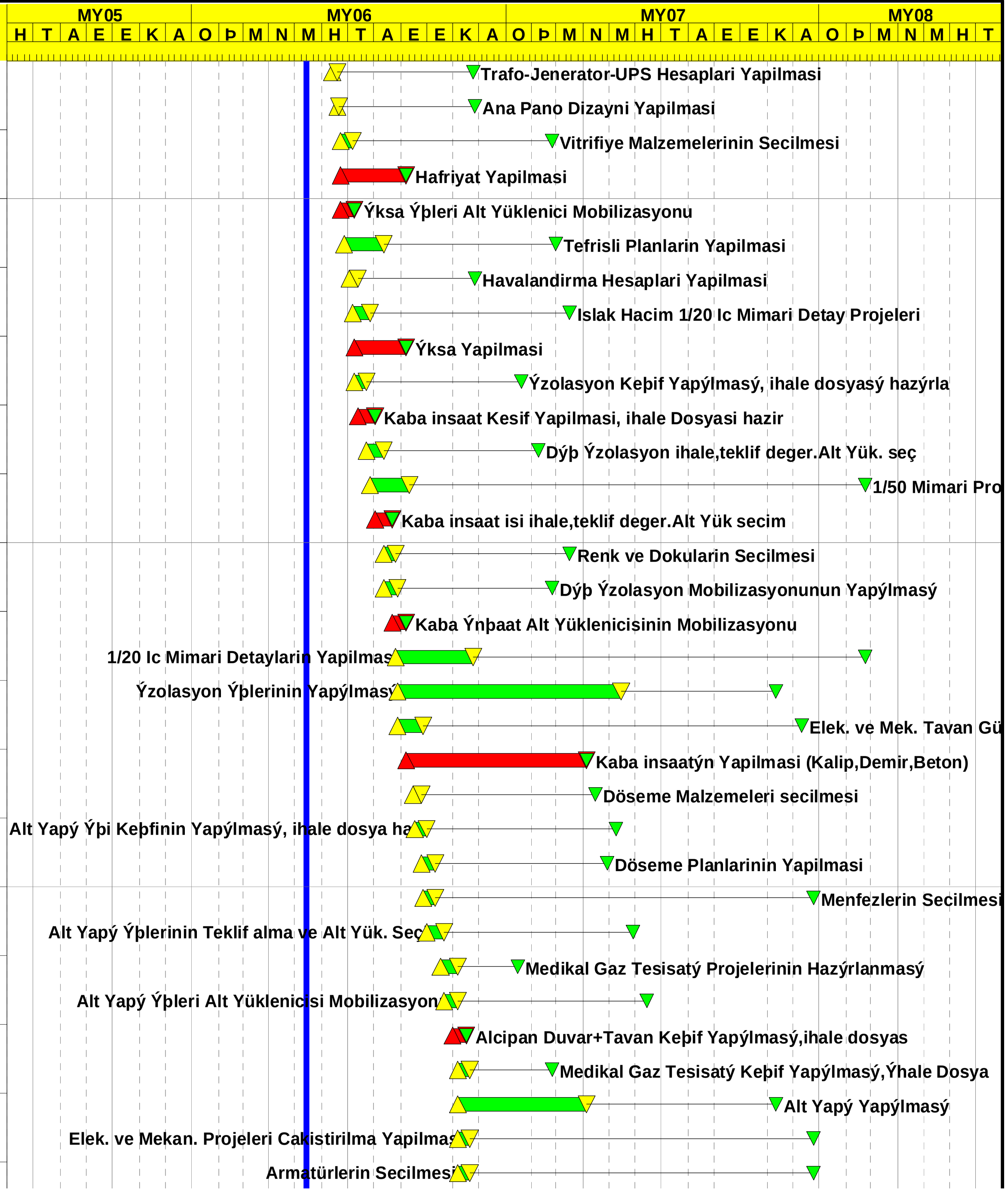
| Activity ID | Activity Name | Start | Finish | Original Duration |
|---|---|---|---|---|
| | **MASTER SCHEDULE HOSPITAL PROJECT** | 01.06.05 | 24.02.08 | 989d |
| TASK01 | Project Start | 01.06.05 | 01.06.05 | 0d |
| TASK02 | Design & Project Drawings | 01.06.05 | 19.06.06 | 383d |
| TASK03 | Project Approvals Ministry of Culture and Tourism | 19.12.05 | | 0d |
| TASK04 | Project Approvals from Chamber of Architects & Engineers | 26.12.05 | | 0d |
| TASK05 | Project Approvals from Municipality | 02.01.06 | | 0d |
| TASK06 | Obtaining Construction Permit for Hospital | 20.06.06 | | 0d |
| TASK07 | Excavation Works | 21.06.06 | 04.09.06 | 75d |
| TASK08 | Soil improvement & Revetment Works | 06.07.06 | 04.09.06 | 60d |
| TASK09 | Isolation Works | 25.08.06 | 12.05.07 | 260d |
| TASK10 | A-B-C Block Structural Works | 04.09.06 | 01.02.07 | 150d |
| TASK11 | Infrastructure | 03.11.06 | 02.04.07 | 150d |
| TASK12 | Slab concrete works (Grouting works) | 02.01.07 | 02.05.07 | 120d |
| TASK13 | Partition walls with gypsumboard &Suspended Ceiling works | 12.01.07 | 09.10.07 | 270d |
| TASK14 | D-E-F-G Block Structural Works | 01.02.07 | 02.04.07 | 60d |
| TASK15 | Electrical Works | 01.02.07 | 26.01.08 | 359d |
| TASK16 | Mechanical Works | 01.02.07 | 26.01.08 | 359d |
| TASK17 | Medical Gas Installations | 21.02.07 | 18.12.07 | 300d |
| TASK18 | Pneumatic Conveying Installation | 24.02.07 | 22.10.07 | 240d |
| TASK19 | Steel structure works | 13.03.07 | 11.07.07 | 120d |
| TASK20 | Plastering&Painting | 13.03.07 | 08.11.07 | 240d |
| TASK21 | Exterior Facade Cladding | 18.03.07 | 30.08.07 | 165d |
| TASK22 | Elevators | 02.04.07 | 29.09.07 | 180d |
| TASK23 | Doors | 12.04.07 | 09.09.07 | 150d |
| TASK24 | Wall& Floor Covering with marble,ceramic tile, PVC | 12.04.07 | 10.08.07 | 120d |
| TASK25 | Ceiling Covering Works | 12.05.07 | 09.09.07 | 120d |
| TASK26 | Manufactured casework furnishing | 12.05.07 | 24.09.07 | 135d |
| TASK27 | Medical Equipment Installation | 03.08.07 | 30.01.08 | 180d |
| TASK28 | Landscaping | 30.08.07 | 13.11.07 | 75d |
| TASK29 | Obtaining Building Usage Permit for Hospital from Ministry of Health | 24.09.07 | | 0d |
| TASK30 | Furniture supply &Furnishing | 19.10.07 | 02.01.08 | 75d |
| TASK31 | Installation of accessories | 03.11.07 | 02.01.08 | 60d |
| TASK32 | Test & Commissioning | 26.01.08 | 24.02.08 | 29d |
| TASK33 | Project Complete | | 24.02.08 | 0d |



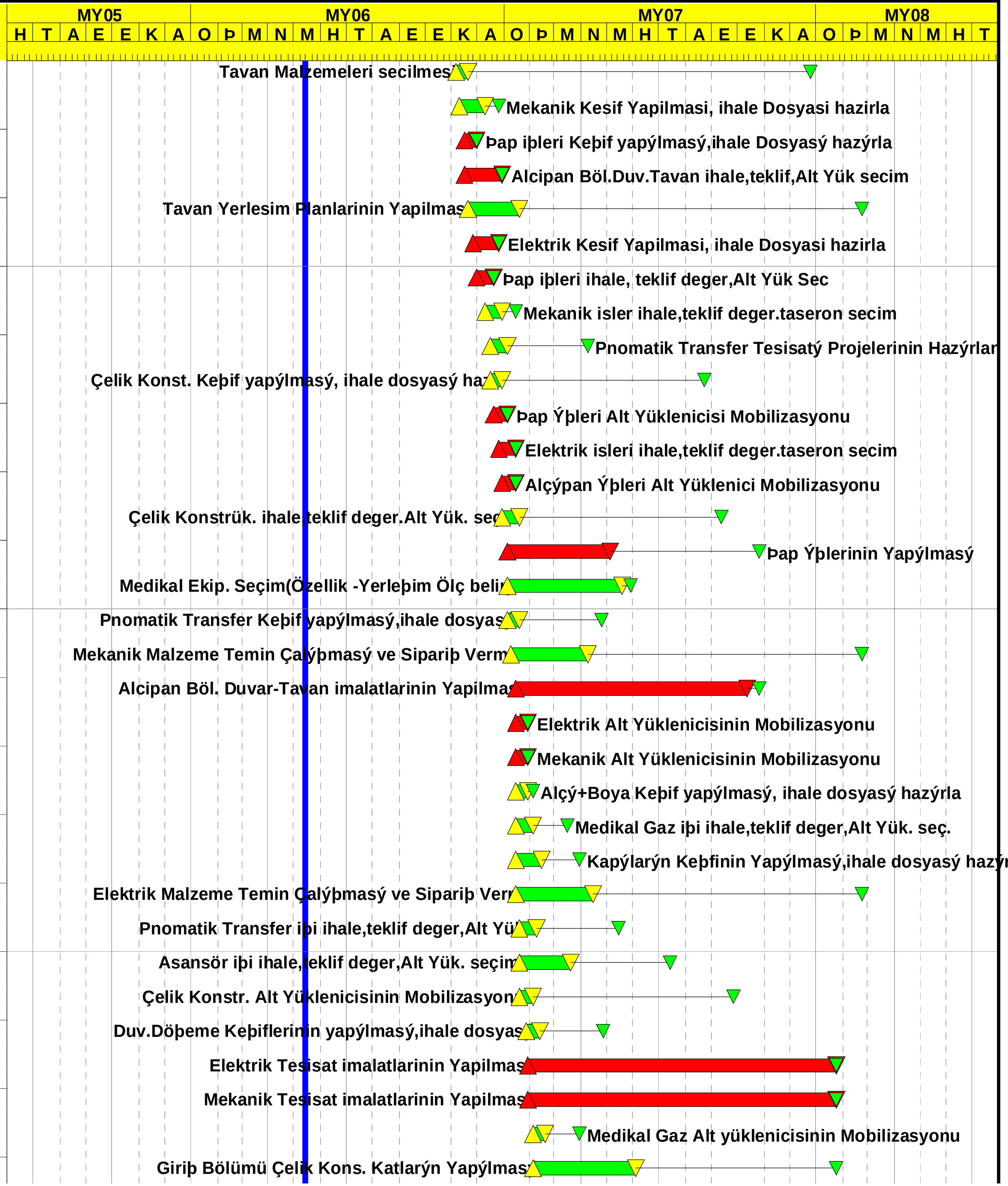
| GRUP | Akt ID | Aktivite Açýklamasý | Orij Süre | Erken Baþl. | Erken Bitiþ |
|---|---|---|---|---|---|
| DETAILED SCHEDULE | | | | | |
| | | | 998 | 01HAZ05G | 23ŞUB08 |
| IN | PR00 | Mimari Avan Projelerin Yapilmasi | 45 | 01HAZ05G | 15MAY06G |
| IN | PR01 | Mimari Uygulama Projelerinin Yapilmasi | 45 | 18TEM05G | 31AĞU05G |
| IN | S00 | Statik Avan Projelerinin Yapilmasi | 30 | 01EYL05G | 01EKM05G |
| IN | TE01 | Yikim isi ihalesi,teklif degerlen.,Alt Yük secim | 20 | 26EYL05G | 17EKM05G |
| OR | O01 | Saft Yerlerinin Belirlenmesi-Secilmesi | 2 | 01MAR06G | 03MAR06G |
| IN | PR03 | Duvar Plani Yapilmasi (Alcipan,Ytong,Tugla) | 30 | 01MAR06G | 31MAR06G |
| IN | S01 | Statik Uygulama Projelerinin Yapilmasi | 60 | 01MAR06G | 01MAY06G |
| IC | SE16-1 | Avan Döseme secilmesi | 5 | 10NİS06G | 14NİS06G |
| IN | MO01 | Yıkım Yapacak Alt Yüklenicinin Mobilizasyonu | 15 | 01MAY06G | 15MAY06G |
| OR | MOMO | Merkez Ofis Mobilizasyonunun Yapılması | 15 | 01MAY06G | 15MAY06G |
| IN | IM01 | Yikim Yapilmasi | 40 | 15MAY06* | 23HAZ06 |
| EL | PR10-1 | Elektrik Avan Projelerinin Yapilmasi | 30 | 15MAY06 | 13HAZ06 |
| ME | T00 | Mekanik Avan Projelerin Yapilmasi | 30 | 15MAY06 | 13HAZ06 |
| IC | TE-PR | İç Mimari Tasarım Alt Yüklenici Seçilmesi | 15 | 15MAY06 | 29MAY06 |
| IN | PR24 | Alt Yapı Projelerinin Yapılması | 30 | 15MAY06 | 13HAZ06 |
| OR | MOSO | Şantiye Ofisi Mobilizasyonunun Yapılması | 15 | 15MAY06 | 29MAY06 |
| IN | TE02 | Hafriyat isi ihale,teklif deger. Alt Yük. secim | 20 | 20MAY06 | 08HAZ06 |
| EL | PR10-2 | Elektrik Uygulama Projelerinin Yapılması | 165 | 30MAY06 | 10KAS06 |
| ME | T01 | Mekanik Uygulama Projelerinin Yapılması | 165 | 30MAY06 | 10KAS06 |
| IC | MO1 | Alt Yüklenici Mobilizasyonu (İç Mimari Tasarım ) | 15 | 30MAY06 | 13HAZ06 |
| IN | PR04 | Cephe, Kesitler ve Görünüsler | 15 | 31MAY06 | 14HAZ06 |
| IN | TE03 | İksa İşi ihale,teklif deger.Alt Yük. seçimi | 20 | 04HAZ06 | 23HAZ06 |
| IN | MO002 | Hafriyat İşleri Alt Yüklenici Mobilizasyonu | 15 | 09HAZ06 | 23HAZ06 |
| IC | SE07 | Sabit ve Hareketli Mobilya Secilmesi | 30 | 13HAZ06 | 12TEM06 |
| ME | T06 | Isitma -sogutma Hesaplari Yapilmasi | 20 | 14HAZ06 | 03TEM06 |
| IC | PR08 | Sap Planlarinin Yapilmasi | 20 | 14HAZ06 | 03TEM06 |



| GRUP | Akt ID | Aktivite Açýklamasý | Orij Süre | Erken Baþl. | Erken Bitiþ |
|---|---|---|---|---|---|
| EL | HE10-1 | Trafo-Jenerator-UPS Hesaplari Yapilmasi | 5 | 14HAZ06 | 18HAZ06 |
| EL | HE10-2 | Ana Pano Dizayni Yapilmasi | 2 | 19HAZ06 | 20HAZ06 |
| IC | SE06 | Vitrifiye Malzemelerinin Secilmesi | 15 | 23HAZ06 | 07TEM06 |
| IN | IM02 | Hafriyat Yapilmasi | 75 | 24HAZ06 | 06EYL06 |
| IN | MO03 | İksa İşleri Alt Yüklenici Mobilizasyonu | 15 | 24HAZ06 | 08TEM06 |
| IC | PR07 | Tefrisli Planlarin Yapilmasi | 45 | 28HAZ06 | 11AĞU06 |
| ME | T07 | Havalandirma Hesaplari Yapilmasi | 10 | 04TEM06 | 13TEM06 |
| IC | PR06 | Islak Hacim 1/20 Ic Mimari Detay Projeleri | 20 | 08TEM06 | 27TEM06 |
| IN | IM03 | İksa Yapilmasi | 60 | 09TEM06 | 06EYL06 |
| IN | KE04 | İzolasyon Keşif Yapılması, ihale dosyası hazırla | 15 | 09TEM06 | 23TEM06 |
| IN | KE05 | Kaba insaat Kesif Yapilmasi, ihale Dosyasi hazir | 20 | 14TEM06 | 02AĞU06 |
| IN | TE04 | Dış İzolasyon ihale,teklif deger.Alt Yük. seç | 20 | 24TEM06 | 12AĞU06 |
| IC | PR09 | 1/50 Mimari Projeler Yapılması (Böl. Duv.içi Taş | 45 | 28TEM06 | 10EYL06 |
| IN | TE05 | Kaba insaat isi ihale,teklif deger.Alt Yük secim | 20 | 03AĞU06 | 22AĞU06 |
| IC | SE10 | Renk ve Dokularin Secilmesi | 15 | 12AĞU06 | 26AĞU06 |
| IN | MO04 | Dış İzolasyon Mobilizasyonunun Yapılması | 15 | 13AĞU06 | 27AĞU06 |
| IN | MO05 | Kaba İnşaat Alt Yüklenicisinin Mobilizasyonu | 15 | 23AĞU06 | 06EYL06 |
| IC | PR10 | 1/20 Ic Mimari Detaylarin Yapilmasi | 90 | 27AĞU06 | 24KAS06 |
| IN | IM04 | İzolasyon İşlerinin Yapılması | 260 | 28AĞU06 | 14MAY07 |
| OR | O02 | Elek. ve Mek. Tavan Güzergahlarinin Belirlenmesi | 30 | 28AĞU06 | 26EYL06 |
| IN | IM05 | Kaba insaatın Yapilmasi (Kalip,Demir,Beton) | 210 | 07EYL06 | 04NİS07 |
| IC | SE16-2 | Döseme Malzemeleri secilmesi | 10 | 16EYL06 | 25EYL06 |
| IN | KE24 | Alt Yapı İşi Keşfinin Yapılması, ihale dosya haz | 15 | 17EYL06 | 01EKM06 |
| IC | PR16 | Döseme Planlarinin Yapilmasi | 15 | 26EYL06 | 10EKM06 |
| ME | T20 | Menfezlerin Secilmesi | 15 | 27EYL06 | 11EKM06 |
| IN | TE24 | Alt Yapı İşlerinin Teklif alma ve Alt Yük. Seçil | 20 | 02EKM06 | 21EKM06 |
| ME | PRMG | Medikal Gaz Tesisatı Projelerinin Hazırlanması | 20 | 17EKM06 | 05KAS06 |
| IN | MO24 | Alt Yapı İşleri Alt Yüklenicisi Mobilizasyonu | 15 | 22EKM06 | 05KAS06 |
| IN | KE09 | Alcipan Duvar+Tavan Keşif Yapılması,ihale dosyas | 15 | 01KAS06 | 15KAS06 |
| ME | KE12 | Medikal Gaz Tesisatı Keşif Yapılması,İhale Dosya | 15 | 06KAS06 | 20KAS06 |
| IN | IM24 | Alt Yapı Yapılması | 150 | 06KAS06 | 04NİS07 |
| OR | O03 | Elek. ve Mekan. Projeleri Cakistirilma Yapilmasi | 15 | 06KAS06 | 20KAS06 |
| EL | SE10-1 | Armatürlerin Secilmesi | 15 | 06KAS06 | 20KAS06 |

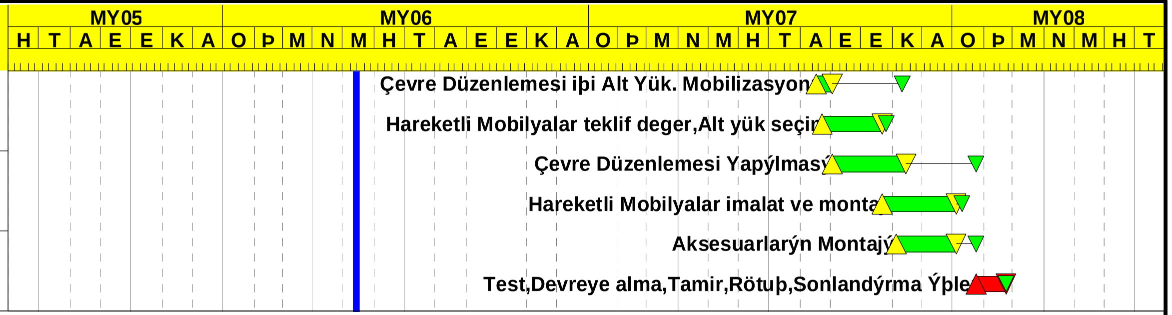


| GRUP | Akt ID | Aktivite Açýklamasý | Orij Süre | Erken Baþl. | Erken Bitiþ |
|---|---|---|---|---|---|
| IC | SE11 | Tavan Malzemeleri secilmesi | 15 | 06KAS06 | 20KAS06 |
| ME | KE11 | Mekanik Kesif Yapilmasi, ihale Dosyasi hazirla | 30 | 11KAS06 | 10ARA06 |
| IN | KE08 | Şap işleri Keşif yapılması,ihale Dosyası hazırla | 15 | 16KAS06 | 30KAS06 |
| IN | TE09 | Alcipan Böl.Duv.Tavan ihale,teklif,Alt Yük secim | 45 | 16KAS06 | 30ARA06 |
| IC | PR11 | Tavan Yerlesim Planlarinin Yapilmasi | 60 | 21KAS06 | 19OCK07 |
| EL | KE10 | Elektrik Kesif Yapilmasi, ihale Dosyasi hazirla | 30 | 26KAS06 | 25ARA06 |
| IN | TE08 | Şap işleri ihale, teklif deger,Alt Yük Sec | 20 | 01ARA06 | 20ARA06 |
| ME | TE11 | Mekanik isler ihale,teklif deger.taseron secim | 20 | 11ARA06 | 30ARA06 |
| ME | PRPT | Pnomatik Transfer Tesisatı Projelerinin Hazırlan | 20 | 16ARA06 | 04OCK07 |
| IN | KE07 | Çelik Konst. Keşif yapılması, ihale dosyası haz. | 15 | 16ARA06 | 30ARA06 |
| IN | MO08 | Şap İşleri Alt Yüklenicisi Mobilizasyonu | 15 | 21ARA06 | 04OCK07 |
| EL | TE10 | Elektrik isleri ihale,teklif deger.taseron secim | 20 | 26ARA06 | 14OCK07 |
| IN | MO09 | Alçıpan İşleri Alt Yüklenici Mobilizasyonu | 15 | 31ARA06 | 14OCK07 |
| IN | TE07 | Çelik Konstrük. ihale,teklif deger.Alt Yük. seç. | 20 | 31ARA06 | 19OCK07 |
| IN | IM08 | Şap İşlerinin Yapılması | 120 | 05OCK07 | 04MAY07 |
| ME | SE12 | Medikal Ekip. Seçim(Özellik -Yerleşim Ölç belir) | 135 | 05OCK07 | 19MAY07 |
| ME | KE13 | Pnomatik Transfer Keşif yapılması,ihale dosyası | 15 | 05OCK07 | 19OCK07 |
| ME | SA11 | Mekanik Malzeme Temin Çalışması ve Sipariş Verme | 90 | 10OCK07 | 09NİS07 |
| IN | IM09 | Alcipan Böl. Duvar-Tavan imalatlarinin Yapilmasi | 270 | 15OCK07 | 11EKM07 |
| EL | MO10 | Elektrik Alt Yüklenicisinin Mobilizasyonu | 15 | 15OCK07 | 29OCK07 |
| ME | MO11 | Mekanik Alt Yüklenicisinin Mobilizasyonu | 15 | 15OCK07 | 29OCK07 |
| MI | KE15 | Alçı+Boya Keşif yapılması, ihale dosyası hazırla | 15 | 15OCK07 | 29OCK07 |
| ME | TE12 | Medikal Gaz işi ihale,teklif deger,Alt Yük. seç. | 20 | 15OCK07 | 03ŞUB07 |
| MI | KE21 | Kapıların Keşfinin Yapılması,ihale dosyası hazır | 30 | 15OCK07 | 13ŞUB07 |
| EL | SA10 | Elektrik Malzeme Temin Çalışması ve Sipariş Verm | 90 | 15OCK07 | 14NİS07 |
| ME | TE13 | Pnomatik Transfer işi ihale,teklif deger,Alt Yük | 20 | 20OCK07 | 08ŞUB07 |
| MI | TE20 | Asansör işi ihale,teklif deger,Alt Yük. seçimi | 60 | 20OCK07 | 20MAR07 |
| IN | MO07 | Çelik Konstr. Alt Yüklenicisinin Mobilizasyonu | 15 | 20OCK07 | 03ŞUB07 |
| MI | KE16 | Duv.Döşeme Keşiflerinin yapılması,ihale dosyası | 15 | 28OCK07 | 11ŞUB07 |
| EL | IM10 | Elektrik Tesisat imalatlarinin Yapilmasi | 360 | 30OCK07 | 24OCK08 |
| ME | IM11 | Mekanik Tesisat imalatlarinin Yapilmasi | 360 | 30OCK07 | 24OCK08 |
| ME | MO12 | Medikal Gaz Alt yüklenicisinin Mobilizasyonu | 15 | 04ŞUB07 | 18ŞUB07 |
| IN | IM07 | Giriş Bölümü Çelik Kons. Katların Yapılması | 120 | 04ŞUB07 | 03HAZ07 |



| GRUP | Akt ID | Aktivite Açýklamasý | Orij Süre | Erken Baþl. | Erken Bitiþ |
|---|---|---|---|---|---|
| MI | TE15 | Alçı+Boya işi ihale,teklif deger,Alt Yük. seçim | 20 | 09ŞUB07 | 28ŞUB07 |
| ME | MO13 | Pnomatik Transfer Alt Yüklenici Mobilizasyonu | 15 | 09ŞUB07 | 23ŞUB07 |
| MI | TE16 | Duv.-Döş. işi ihale,teklif deger,Alt Yük. seçimi | 45 | 12ŞUB07 | 28MAR07 |
| MI | KE17 | Ahsap Kaplama Kesif Yapılması,ihale dosyası haz. | 15 | 14ŞUB07 | 28ŞUB07 |
| MI | TE21 | Kapılar ihale,teklif deger,Alt Yüklenici seçimi | 60 | 14ŞUB07 | 14NİS07 |
| IN | TE06 | Dis Cephe isi ihale,teklif deger.Alt Yük. secim | 20 | 14ŞUB07 | 05MAR07 |
| MI | SA16 | Duv-Döş.Malzeme Temin Çalışmaları (Ser.,Mer.PVC) | 60 | 14ŞUB07 | 14NİS07 |
| ME | IM12 | Medikal Gaz Tesisatı İmalatının Yapılması | 300 | 19ŞUB07 | 15ARA07 |
| IN | SA06 | Dış Cephe Taş Temin Çalışması ve Sipariş Verilme | 90 | 19ŞUB07 | 19MAY07 |
| ME | IM13 | Pnomatik Transfer Tesisat İmalatının Yapılması | 240 | 24ŞUB07 | 21EKM07 |
| MI | MO15 | Alçı +Boya Alt Yüklenicisinin Mobilizasyonu | 15 | 01MAR07 | 15MAR07 |
| MI | KE18 | Sabit Mobilya Keşfinin Yapılması, ihale dosyası | 15 | 01MAR07 | 15MAR07 |
| MI | TE17 | Ahşap kapl işi ihale,teklif deger,Alt Yük. seçim | 60 | 01MAR07 | 29NİS07 |
| IN | MO06 | Dış Cephe Alt Yüklenicisi Mobilizasyonu | 15 | 06MAR07 | 20MAR07 |
| MI | IM15 | Alçı Sıva - Boya İşleri İmalatının Yapılması | 240 | 16MAR07 | 10KAS07 |
| MI | TE18 | Sabit Mobilya işi ihale,teklif deger,Alt Yük.seç | 60 | 16MAR07 | 14MAY07 |
| IN | IM06 | Dis Cephe Kaplamasi Yapilmasi | 165 | 21MAR07 | 01EYL07 |
| MI | MO20 | Asansör işi Alt Yüklenicisinin Mobilizasyonu | 15 | 21MAR07 | 04NİS07 |
| MI | MO16 | Duv.-Döş. Kaplama Alt Yüklenicileri Mobilizasyon | 15 | 31MAR07 | 14NİS07 |
| MI | IM20 | Asansörlerin imali ve montajı | 180 | 05NİS07 | 01EKM07 |
| MI | IM21 | Kapıların imalat ve montajı | 150 | 15NİS07 | 11EYL07 |
| MI | IM16 | Duvar-Döseme Kaplaması  (Mermer,Seramik,PVC vb.) | 120 | 15NİS07 | 12AĞU07 |
| MI | MO17 | Ahşap İşleri Alt Yüklenicilerinin Mobilizasyonu | 15 | 30NİS07 | 14MAY07 |
| MI | KE22 | Aksesuarların Keşfinin Yapılması | 15 | 30NİS07 | 14MAY07 |
| MI | IM18 | Sabit Mobilya imalat-montajı(Çarpma Bandı dahil) | 135 | 15MAY07 | 26EYL07 |
| MI | IM17 | Ahşap Kaplama İmalatları ve Montajları | 120 | 15MAY07 | 11EYL07 |
| MI | PR05 | Peyzaj Projelerinin Yapılması | 30 | 15MAY07 | 13HAZ07 |
| MI | SA22 | Aksesuarların Temin Çalışması ve Sipariş Verilme | 45 | 15MAY07 | 28HAZ07 |
| IN | KE23 | Çevre Düzenlemesi Keşif Yapılması, ihale dosyası | 15 | 19HAZ07 | 03TEM07 |
| IN | TE23 | Çevre Düzenleme ihale,teklif deger,Alt Yük. seçi | 45 | 04TEM07 | 17AĞU07 |
| ME | SA12 | Medikal Cihaz Siparişlerinin Verilmesi | 15 | 24TEM07 | 07AĞU07 |
| ME | IM14 | Medikal Cihaz Montajlarının Yapılması | 180 | 08AĞU07 | 03ŞUB08 |
| MI | KE19 | Hareketli Mobilya Keşfinin Yapılması,ihale dosya | 15 | 08AĞU07 | 22AĞU07 |

| GRUP | Akt ID | Aktivite Açýklamasý | Orij Süre | Erken Baþl. | Erken Bitiþ |
|---|---|---|---|---|---|
| **IN** | MO23 | Çevre Düzenlemesi işi Alt Yük. Mobilizasyonu | 15 | 18AĞU07 | 01EYL07 |
| **MI** | TE19 | Hareketli Mobilyalar teklif deger,Alt yük seçim | 60 | 23AĞU07 | 21EKM07 |
| **IN** | IM23 | Çevre Düzenlemesi Yapılması | 75 | 02EYL07 | 15KAS07 |
| **MI** | IM19 | Hareketli Mobilyalar imalat ve montaj | 75 | 22EKM07 | 04OCK08 |
| **MI** | IM22 | Aksesuarların Montajı | 60 | 06KAS07 | 04OCK08 |
| **OR** | IM25 | Test,Devreye alma,Tamir,Rötuş,Sonlandırma İşleri | 30 | 25OCK08 | 23ŞUB08 |



## APPENDIX C : DETAILED COST ESTIMATES

| Detailed Cost Estimation | |
|---|---|
| **Total Cost** | **$74.774.697** |
| Design | $413.930 |
| **Complete Design** | $284.555 |
| Statical Project Costs | $63.750 |
| Infrastructure Project Costs | $0 |
| Architectural Project Costs | $36.847 |
| Mechanical Project Costs | $0 |
| Cogeneration Project Costs | $15.417 |
| Interion Design Project Costs | $125.000 |
| Medical Planning Project Costs | $35.625 |
| Electrical MV Project Costs | $6.250 |
| Electrical LV Project Costs | $0 |
| Topographic Project Costs | $0 |
| Architectural quantity survey Project Costs | $1.667 |
| **Consultancy** | $129.375 |
| Electrical Project Consultancy Costs | $0 |
| Building Inspection Consultancy | $0 |
| Architectural Consultany | $33.333 |
| Co-generation Consultancy | $0 |
| Mechanical Consultancy | $38.542 |
| Statical Consultancy | $0 |
| Topographic Works Consultacy | $57.500 |
| Construction | $74.360.767 |
| **Site Improvement and Excavation Works** | $3.615.301 |
| Excavation Costs | $2.093.265 |
| Revetment Costs | $911.696 |
| Backfilling Costs | $168.050 |
| Infrastructure Costs | $442.284 |
| **Structural Works** | $5.887.756 |
| Concrete works | $1.631.840 |
| Lean concrete works | $77.000 |
| Molding | $1.082.742 |
| Reinforcement | $3.096.174 |
| **Civil Works** | $18.042.846 |
| Wall Partitions | $1.959.954 |
| Slab Concrete Works | $306.250 |
| Floor Coverings | $1.238.527 |
| Wall Coverings | $1.315.186 |

| | |
|---|---|
| Ceiling Covering | $624.975 |
| Doors and Windows | $738.042 |
| Plastering & Painting | $967.208 |
| Facade Works | $1.884.764 |
| Thermal and Moisture Isolation | $635.782 |
| Steel Structure Works | $2.243.750 |
| Furniture and Special Technical Equipment Works | $3.045.804 |
| Installation of Accessories | $500.000 |
| Manufactured casework furnishing | $2.582.604 |
| **Mechanical Works** | $8.380.000 |
| Ventilation | $2.721.458 |
| Heating& Cooling | $4.070.417 |
| Sanitary | $578.125 |
| Fire Extinguishing | $308.333 |
| Otomation | $447.083 |
| Laundry Equipment | $15.417 |
| Kitchen Equipment | $208.333 |
| Cold-room equipment | $30.833 |
| **Medical Gas Works** | $508.750 |
| **Pneumatic Transfer Works** | $123.333 |
| **Electrical Works** | $6.476.589 |
| Medium Pressure Current System | $263.625 |
| Earthing Installation | $117.719 |
| Lighting Installation | $93.333 |
| Fire Alarm System | $148.324 |
| Sound System | $119.404 |
| Security and CCTV System | $148.510 |
| TV Distribution | $172.667 |
| Nurce Call | $97.428 |
| Data Distribution | $254.375 |
| Cable Conveying | $620.451 |
| Halogen free pipes | $248.180 |
| Busbar System | $231.313 |
| Power Systems | $3.938.136 |
| PC Based Operation Room Control System | $23.125 |
| Projection System | $0 |
| **Medical Equipment Works** | $30.000.000 |
| Medical Equipments | $30.000.000 |
| **Elevators** | $659.531 |
| Elevators | $659.531 |
| **Landscaping** | $666.667 |
| Lanscaping | $666.667 |

# APPENDIX D: SCHEDULE CHECK REPORT BY ORACLE PRIMAVERA RISK ANALYSIS SOFTWARE

## Constraints

Schedule constraints have a significant effect on risk analysis results. They should be used sparingly, and only when the constraint reflects reality. Constraints to be particularly aware of are: • Must start on and Must finish on – preceding delays will not delay the task, and preceding time savings will not bring it earlier • Start on or after (SNET) and Finish on or after (FNET) – preceding time savings will not bring the task earlier Consider removing these constraints and replacing them with logic (e.g. Finish-to-Start links) instead. Other types of constraints are less significant because they do not influence the tasks' dates, only their floats. For example, you can use a Finish on or before constraint to indicate a desired completion date of a task – this will not force the task to finish on that day, but the shortfall will be indicated in the task's float.

None found.

## Open-ended tasks (Does not include ignored links)

Options selected:Predecessors, Successors

For a schedule risk analysis to be meaningful, it is important that tasks' dates are set by logic (e.g. Finish-to-Start links) rather than constraints. This is so that the risk analysis will recognize the knock-on effect of delays. An open-ended task is one that does not have at least one predecessor and one successor – it indicates a possible lack of logic. Consider closing open-ended tasks: • If a task has no predecessor, try to find some other tasks which could potentially delay it. Leave it as open-ended if it is the project start milestone. • If a task has no successors, try to find some other tasks which it could potentially delay. Leave it as open-ended if it is a project finish or reporting milestone.

| ID | Description | Type | Remaining Duration | Detail |
|---|---|---|---|---|
| TASK01 | Project Start | Start milestone | 0 | No predecessors |
| TASK33 | Project Complete | Finish milestone | 0 | No successors |

## Out of sequence updates ("broken logic")

The logic in a plan can be broken when tasks have started or finished before their predecessors. It is recommended that any broken logic is removed or corrected to ensure the project schedules as expected. For example, if task A has a Finish-to-Start link to task B, but B has been started (by giving it an Actual Start date), this is broken logic. It is not clear whether B's remaining work should wait for task A to finish, or start straight away. Consider fixing the broken logic by either removing the link or removing the actual dates. Also consider using the retained logic / progress override options on the Scheduling tab of the Plan | Options dialog box.

None found.

## Lags longer than 0 units

Option selected: Display lags greater then 0 Day

A lag is a gap in the logic between two tasks – a delay between the dates of two tasks that are linked together. Lags cannot have risk or uncertainty. In reality it is likely that the lag represents either work or a delay, whose duration is uncertain. This is particularly significant for long lags. Consider replacing the lag with a task, so that uncertainty and risks can be assessed against it. Use the Convert Lags to Tasks tool when a project contains a large number of long lags.

| From Task | | | To Task | | | |
|---|---|---|---|---|---|---|

| ID | Description | Type | ID | Description | Type | Link |
|---|---|---|---|---|---|---|
| TASK07 | Excavation Works | Normal | TASK09 | Isolation Works | Normal | SS[65] |
| TASK07 | Excavation Works | Normal | TASK08 | Soil improvement & Revetment Works | Normal | SS[15] |
| TASK14 | D-E-F-G Blocks' Structural Works (Formwork,Reinforcement,concrete columns,beams , stairs,exterior walls and curtain walls) | Normal | TASK21 | Exterior Facade Cladding | Normal | SS[45] |
| TASK13 | Partition walls with gypsumboard &Suspended Ceiling works | Normal | TASK15 | Electrical Works | Normal | SS[15] |
| TASK13 | Partition walls with gypsumboard &Suspended Ceiling works | Normal | TASK16 | Mechanical Works | Normal | SS[15] |
| TASK13 | Partition walls with gypsumboard &Suspended Ceiling works | Normal | TASK25 | Ceiling Covering works | Normal | SS[120] |
| TASK13 | Partition walls with gypsumboard &Suspended Ceiling works | Normal | TASK20 | Plastering&Painting | Normal | SS[60] |
| TASK15 | Electrical Works | Normal | TASK17 | Medical Gas Installations | Normal | SS[20] |
| TASK16 | Mechanical Works | Normal | TASK17 | Medical Gas Installations | Normal | SS[20] |
| TASK17 | Medical Gas Installations | Normal | TASK18 | Pneumatic Conveying Installation | Normal | SS[3] |
| TASK20 | Plastering&Painting | Normal | TASK24 | Wall & Floor Covering with marble,ceramic tile, PVC | Normal | SS[30] |
| TASK20 | Plastering&Painting | Normal | TASK25 | Ceiling Covering works | Normal | SS[20] |
| TASK20 | Plastering&Painting | Normal | TASK26 | Manufactured casework furnishing | Normal | SS[60] |
| TASK20 | Plastering&Painting | Normal | TASK23 | Doors | Normal | SS[30] |
| TASK24 | Wall & Floor Covering with marble,ceramic tile, PVC | Normal | TASK30 | Furniture supply &Furnishing | Normal | FS[70] |
| TASK30 | Furniture supply &Furnishing | Normal | TASK31 | Installation of accessories | Normal | SS[15] |
| TASK02 | Design & Project Drawings | Normal | TASK03 | Project Approvals Ministry of Culture and Tourism | Start milestone | SS[200] |
| TASK10 | A-B-C Blocks' Structural Works (Formwork,Reinforcement,concrete columns,beams , stairs,exterior walls and curtain walls) | Normal | TASK19 | Steel structure works | Normal | FS[40] |
| TASK10 | A-B-C Blocks' Structural Works (Formwork,Reinforcement,concrete columns,beams , stairs,exterior walls and curtain walls) | Normal | TASK13 | Partition walls with gypsumboard &Suspended Ceiling works | Normal | SS[130] |
| TASK10 | A-B-C Blocks' Structural Works (Formwork,Reinforcement,concrete columns,beams , stairs,exterior walls and curtain walls) | Normal | TASK12 | Slab concrete works (Grouting works) | Normal | SS[120] |
| TASK10 | A-B-C Blocks' Structural Works (Formwork,Reinforcement,concrete columns,beams , stairs,exterior walls and curtain walls) | Normal | TASK11 | Infrastructure | Normal | SS[60] |
| TASK06 | Obtaining Construction Permit for Hospital | Start milestone | TASK07 | Excavation Works | Normal | FS[1] |
| TASK04 | Project Approvals from Chamber of architects & Engineers | Start milestone | TASK05 | Project Approvals from Municipality | Start milestone | FS[7] |
| | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| TASK03 | Project Approvals Ministry of Culture and Tourism | Start milestone | TASK04 | Project Approvals from Chamber of architects & Engineers | Start milestone | FS[7] |

## Negative lags ("leads")

A negative lag is an overlap in the logic between two tasks – often it is used to represent a task starting earlier, with sufficient time allow some other work to happen. Lags cannot have risk or uncertainty. In reality it is likely that the negative lag represents an necessary overlap, whose duration is uncertain. Consider replacing a negative lag with another kind of link that does not need the lag. For example: • Replace a negative lag on a Finish-to-Start link with a positive lag on a Start-to-Start link. • Split the tasks so that the overlap is explicitly represented by a task.

| From Task | | | To Task | | | |
|---|---|---|---|---|---|---|
| ID | Description | Type | ID | Description | Type | Link |
| TASK24 | Wall & Floor Covering with marble,ceramic tile, PVC | Normal | TASK27 | Medical Equipment Installation | Normal | FS[-7] |

## Positive lags on Finish-to-Start links

A lag is a gap in the logic between two tasks – a delay after one task finishes before the next one starts. Lags cannot have risk or uncertainty. In reality it is likely that the lag represents either work or a delay, whose duration is uncertain. Consider replacing the lag with a task, so that uncertainty and risks can be assessed against it. Use the Convert Lags to Tasks tool when a project contains a large number of long lags.

| From Task | | | To Task | | | |
|---|---|---|---|---|---|---|
| ID | Description | Type | ID | Description | Type | Link |
| TASK24 | Wall & Floor Covering with marble,ceramic tile, PVC | Normal | TASK30 | Furniture supply &Furnishing | Normal | FS[70] |
| TASK10 | A-B-C Blocks' Structural Works (Formwork,Reinforcement,concrete columns,beams , stairs,exterior walls and curtain walls) | Normal | TASK19 | Steel structure works | Normal | FS[40] |
| TASK06 | Obtaining Construction Permit for Hospital | Start milestone | TASK07 | Excavation Works | Normal | FS[1] |
| TASK04 | Project Approvals from Chamber of architects & Engineers | Start milestone | TASK05 | Project Approvals from Municipality | Start milestone | FS[7] |
| TASK03 | Project Approvals Ministry of Culture and Tourism | Start milestone | TASK04 | Project Approvals from Chamber of architects & Engineers | Start milestone | FS[7] |

## Start-to-Finish links

Start-to-Finish links are used deliberately very rarely, because they have the unusual effect that the successor happens before the predecessor. Consider whether this logic might be a mistake, especially if it is between tasks that are not milestones.

None found.

## Lags between tasks with different calendars

Options selected:FS

A lag is a gap in the logic between two tasks – a delay between the dates of two tasks that are linked together. When the two tasks have different calendars, it is not clear which calendar the task will use – whether it is the preceding task's or the succeeding task's calendar. Consider replacing the lag with a task, so that its calendar can be explicitly defined. Use the Convert Lags to Tasks tool when a project contains a large number of long lags.

None found.

## Links to / from summary tasks

Many people prefer not to put predecessors or successors against summary tasks, because other project management tools (such as Primavera P6) do not support them. Consider removing logic on a summary task, by using a milestone to represent the start or finish of all the tasks in the summary heading, and putting the link on the milestone instead of the summary task.

None found.

## Duration uncertainty distribution shape

Tasks identified where: Maximum - Most Likely duration divided by the Most Likely - Minimum duration is greater than 2. The validation is only applied to the following distributions:

- Triangle
- Trigen
- BetaPert

The check also tells you whether the numbers entered for Min, Most Likely and Max create a valid distribution.
A task's duration can have a "skewed" three-point estimate, which means it is not symmetrical. Usually three-point estimates are skewed on the "pessimistic" side, where the maximum is further away from the most likely than the minimum. The ratio of (Maximum - Most Likely) to (Most Likely - Minimum) is used to measure this skew. When the skew is significant (for example minimum = 1, most likely = 10, maximum = 100), this may be an indication that there are low-probability events that cause this pessimism. Consider using the risk register to represent these risks events, and reduce the amount of skew on the task's uncertainty.

None found.

ORACLE

PRIMAVERA RISK ANALYSIS

# Schedule Check Report

## Plan Summary

| | | | |
|---|---|---|---|
| Title | | | |
| File name | C:\Users\Exper\Desktop\program rev4\program-Rev9.plan | | |
| Plan finish date | 24/02/08 | Tasks with no progress | 34 |
| Plan remaining duration | 989 | In progress tasks | 0 |
| Normal tasks | 26 | Completed tasks | 0 |
| Summary tasks | 1 | Total tasks | 34 |
| Milestone tasks | 7 | Resource assignments | 26 |
| Hammock tasks | 0 | Budget cost | $74.774.697 |
| Monitor tasks | 0 | Remaining cost | $74.774.697 |
| Calendars | 1 | Actual cost | $0 |
| Links | 68 | Total cost | $74.774.697 |
| Resources | 1 | | |

## Report Summary

| | |
|---|---|
| Task view | All tasks |
| Constraints | 0 |
| Open-ended tasks (Does not include ignored links) | 2 |
| Out of sequence updates ("broken logic") | 0 |
| Lags longer than 0 units | 24 |
| Negative lags ("leads") | 1 |
| Positive lags on Finish-to-Start links | 5 |
| Start-to-Finish links | 0 |
| Lags between tasks with different calendars | 0 |
| Links to / from summary tasks | 0 |
| Duration uncertainty distribution shape 2 | 0 |
| Total number of items found | 35 |

## APPENDIX E : DETAILED COST ESTIMATES CONTAINING UNCERTAINITIES

| Detailed Cost Estimation | Minimum | Most Likely | Maximum |
|---|---|---|---|
| Design | $393.233 | $413.930 | $428.158 |
| **Complete Design** | $263.858 | $284.555 | $298.783 |
| Statical Project Costs | $60.563 | $63.750 | $66.938 |
| Infrastructure Project Costs | $0 | $0 | $0 |
| Architectural Project Costs | $35.004 | $36.847 | $38.689 |
| Mechanical Project Costs | $0 | $0 | $0 |
| Cogeneration Project Costs | $14.646 | $15.417 | $16.188 |
| Interion Design Project Costs | $112.281 | $125.000 | $131.250 |
| Medical Planning Project Costs | $33.844 | $35.625 | $37.406 |
| Electrical MV Project Costs | $5.938 | $6.250 | $6.563 |
| Electrical LV Project Costs | $0 | $0 | $0 |
| Topographic Project Costs | $0 | $0 | $0 |
| Architectural quantity survey Project Costs | $1.583 | $1.667 | $1.750 |
| **Consultancy** | $129.375 | $129.375 | $129.375 |
| Electrical Project Consultancy Costs | $0 | $0 | $0 |
| Building Inspection Consultancy | $0 | $0 | $0 |
| Architectural Consultany | $33.333 | $33.333 | $33.333 |
| Co-generation Consultancy | $0 | $0 | $0 |
| Mechanical Consultancy | $38.542 | $38.542 | $38.542 |
| Statical Consultancy | $0 | $0 | $0 |
| Topographic Works Consultacy | $57.500 | $57.500 | $57.500 |
| Construction | $70.642.727 | $74.360.767 | $79.566.021 |
| **Site Improvement and Excavation Works** | $3.434.530 | $3.615.301 | $3.868.365 |
| Excavation Costs | $1.988.602 | $2.093.265 | $2.239.794 |
| Revetment Costs | $866.111 | $911.696 | $975.514 |
| Backfilling Costs | $159.648 | $168.050 | $179.814 |
| Infrastructure Costs | $420.170 | $442.284 | $473.244 |
| **Structural Works** | $5.593.367 | $5.887.756 | $6.299.899 |
| Concrete works | $1.566.566 | $1.631.840 | $1.746.069 |
| Lean concrete works | $73.920 | $77.000 | $82.390 |
| Molding | $980.553 | $1.082.742 | $1.158.534 |
| Reinforcement | $2.972.327 | $3.096.174 | $3.312.907 |
| **Civil Works** | $17.140.704 | $18.042.846 | $19.305.845 |
| Wall Partitions | $1.861.956 | $1.959.954 | $2.097.151 |
| Slab Concrete Works | $290.938 | $306.250 | $327.688 |
| Floor Coverings | $1.176.601 | $1.238.527 | $1.325.224 |
| Wall Coverings | $1.249.427 | $1.315.186 | $1.407.249 |

| | | | |
|---|---|---|---|
| Ceiling Covering | $593.726 | $624.975 | $668.723 |
| Doors and Windows | $701.140 | $738.042 | $789.705 |
| Plastering & Painting | $918.847 | $967.208 | $1.034.912 |
| Facade Works | $1.790.526 | $1.884.764 | $2.016.698 |
| Thermal and Moisture Isolation | $603.993 | $635.782 | $680.287 |
| Steel Structure Works | $2.131.563 | $2.243.750 | $2.400.813 |
| Furniture and Special Technical Equipment Works | $2.893.514 | $3.045.804 | $3.259.010 |
| Installation of Accessories | $475.000 | $500.000 | $535.000 |
| Manufactured casework furnishing | $2.453.474 | $2.582.604 | $2.763.386 |
| **Mechanical Works** | $7.961.000 | $8.380.000 | $8.966.600 |
| Ventilation | $2.585.385 | $2.721.458 | $2.911.960 |
| Heating& Cooling | $3.866.896 | $4.070.417 | $4.355.346 |
| Sanitary | $549.219 | $578.125 | $618.594 |
| Fire Extinguishing | $292.917 | $308.333 | $329.917 |
| Otomation | $424.729 | $447.083 | $478.379 |
| Laundry Equipment | $14.646 | $15.417 | $16.496 |
| Kitchen Equipment | $197.917 | $208.333 | $222.917 |
| Cold-room equipment | $29.292 | $30.833 | $32.992 |
| **Medical Gas Works** | $483.313 | $508.750 | $544.363 |
| **Pneumatic Transfer Works** | $117.166 | $123.333 | $131.967 |
| **Electrical Works** | $6.152.760 | $6.476.589 | $6.929.951 |
| Medium Pressure Current System | $250.444 | $263.625 | $282.079 |
| Earthing Installation | $111.833 | $117.719 | $125.960 |
| Lighting Installation | $88.667 | $93.333 | $99.867 |
| Fire Alarm System | $140.908 | $148.324 | $158.707 |
| Sound System | $113.434 | $119.404 | $127.762 |
| Security and CCTV System | $141.085 | $148.510 | $158.906 |
| TV Distribution | $164.033 | $172.667 | $184.753 |
| Nurce Call | $92.557 | $97.428 | $104.248 |
| Data Distribution | $241.656 | $254.375 | $272.181 |
| Cable Conveying | $589.428 | $620.451 | $663.882 |
| Halogen free pipes | $235.771 | $248.180 | $265.553 |
| Busbar System | $219.747 | $231.313 | $247.504 |
| Power Systems | $3.741.229 | $3.938.136 | $4.213.805 |
| PC Based Operation Room Control System | $21.969 | $23.125 | $24.744 |
| Projection System | $0 | $0 | $0 |
| **Medical Equipment Works** | $28.500.000 | $30.000.000 | $32.100.000 |
| Medical Equipments | $28.500.000 | $30.000.000 | $32.100.000 |
| **Elevators** | $626.555 | $659.531 | $705.698 |
| Elevators | $626.555 | $659.531 | $705.698 |
| **Landscaping** | $633.333 | $666.667 | $713.333 |
| Lanscaping | $633.333 | $666.667 | $713.333 |

# REFERENCES


1. Chicken, J. C., *Managing Risks and Decisions in Major Projects*, Chapman & Hall, London, 1994.

2. Burke, R., *Project Management Planning and Control*, Wiley, West Sussex, 1999.

3. PMBOK, A *Guide to the Project Management Body of Knowledge,* Third edition, Project Management Institute, Pennsylvania, 2004.

4. Rosenau, M., *Successful Project Management,* New York, Wiley, 1998.

5. O'Reilly, M., *Risk*, *Construction Contracts and Construction Disputes*, CIRIA Publication, London, 1994.

6. Hayes, R. W., *Risk Management in Engineering Construction*, UMIST, 1987.

7. Ansell, J. and F. Wharton, *Risk Analysis, Assessment and Management*, John Wiley and Sons, Chichester, 1995.

8. Kerzner, H., *Project management: A systems Approach to Planning, Scheduling and Controlling*, John Wiley and Sons, 8th Edition, pp.449 – 458, New Jersey, 2003.

9. Galbraith J., *Designing Complex Organizations*, Addison-Wesley Publishing Company, 1977.

10. Chapman, C. and S. Ward, *Project Risk Management - Processes, Techniques and Insights*, John Wiley and Sons, Chichester, 1997.

11. Evans JR, Olson DL, *Introduction to Simulation and Risk Analysis*, Prentice-Hall, New Jersey, 1998.

12. MacCrimmon, K. R. and D.A. Wehrung, *Taking Risks - The Management of Uncertainty*, The Free Press, A Division of Macmillan Inc., New York, 1986.

13. Flanagan, R. and G. Norman, *Risk Management and Construction*, Blackwell Science, London, 1997.

14. Abdou, O. A. “Managing construction risks”, *Journal of Architectural Engineering*, No. 2(1), pp. 3 – 10, 1996.

15. Rydeen, F., *Managing costs*, American School and University, No.78 (7), pp.58, 2006.

16. Mulholland, B., and Christian, J., “Risk assessment in construction schedule”, *Journal of Construction Engineering and Management*, No.125 (1), pp. 8 – 15, 1999.

17. Öztaş, A., and Ökmen, Ö., “Judgmental Risk Analysis Process Development in Construction Projects”, *Building and Environment* , No.40, pp. 1244 – 1254, 2005.

18. Mbachu, J. I. C., and Vinasithamby, K., “Sources of Risks in Construction Development”, *Queensland University of Technology Research Week*, pp.5 – 8, 2005.

19. Klemetti, A., *Risk Management in Construction Project Networks*, M.S. Thesis, Helsinki University of Technology Laboratory of Industrial Management, 2006.

20. Institution of Civil Engineers, Faculty of Actuaries and Institute of Actuaries, *RAMP: Risk Analysis and Management for Projects*, Thomas Telford, London, 1998.

21. Vose, D., "Quantitative Risk Analysis", *A Guide to Monte Carlo Simulation Modelling*, John Wiley and Sons, Chichester, 1996.

22. Grey, S., *Practical Risk Assessment for Project Management*, John Wiley and Sons, Chichester, 1995.

23. Caltrans, *Project Risk Management Handbook*, Second edition, Office of Statewide Project management Improvement (OSPMI), Sacramento, 2007.

24. U.S. Department of Energy, *Project Management Practices Work Breakdown Structure*, Office of Management Budget and Evaluation, 2003.

25. Verschoor, Jason. "The Benefits of Monte-Carlo Schedule Analysis" *AACE International Transactions*, 2005.