Effects of Some Stakeholders on the Briefing Design Stage in Construction Projects

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ABSTRACT

In the construction industry, one of the risk areas is lack of planning and management on the project budget, project time, and the project scope in the briefing design stages of the construction project between the stakeholders.

The briefing stages of the design project is divided into three parts; identification of the project, aim and content of the project, and design and performance of the project. In these parts, determination of possible risks and problems between client and design team plays a very important role in achieving the construction project design.

This research focuses on the determination of the potential risks between design team members (who takes the lead on the construction project design e.g architects and engineers) and clients (any person for whom construction work is performed). Also this research provides an instructing expert system to increase both the safety of clients and achieving the design team activity by sticking to the problems early in the briefing design stage.

Keywords: Briefing design stage, Client, Design team, Construction project, Expert system

ÖZ

İnşaat sektöründe yer alan projelerin risk alanlarından biriside, projelerin tasarım aşamasında taraflar arasındaki bütçe, süre, planlama ve yönetim alanındaki eksikliklerinden kaynaklanmaktadır.

Projenin tasarım aşamaları; projenin tanımı, projenin amaç ve içeriği, projenin tasarım olmak üzere üçe ayrılır. Bu aşamalarda tasarım ekibi ve işveren arasında yaşanan ve yaşanabilecek sorunların önceden tespiti ve çözümüne yönelik geliştirilen yöntemler projelerin başarısında büyük rol oynar.

Bu çalışmada, tasarım ekibi (inşaat proje tasarımında ilgisi olan meslek grupları; mimarlar ve mühendisler) ve müşteri (inşaat projesi yaptırmak isteyen kişi) arasında proje tasarımın aşamasında oluşabilecek risk ve problemlerin tespiti ve bu problemlerin ortaya çıkmasına engel olabilecek, bu aşamada tasarım ekibini yönlendirici bir uzman sistemin geliştirilmesine yer verilmiştir.

Anahtar Kelimeler: Tasarım süreci, İşveren, İnşaat projesi, Tasarım ekibi, Uzman sistem

To Mom and Dad

Who always picked me up on time

and encouraged me to go on every adventure,

especially this one.

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INTRODUCTION

1.1 General Background

The Briefing stage is the process of analysing the objectives and needs of a construction project. The aim of the briefing stage is to prepare project summary, identify client's requirements, estimate project cost to obtain approvals from the client. In this stage, clients must clearly explain the objectives of the project in terms of building requirements, cost, time and budget to the design team.

The problems start to occur when the design team does not understand the client's requirements; in other words, the client cannot express the project requirements clearly to the design team. In order to explain the impact of this situation there is a folk poem in north Cyprus 'Sell the first house you built, rent the second one and live in the third one.' that shows the poor consultancy of the design team meeting needs of the client. Another main reason of the problems is the client's unawareness of the construction project design or inadequate orientation can be given to the client about the construction project design, by design team.

Existence of these general problems was proved by the three methodologies. Firstly, there is 'Performance standards in buildings - Check list for briefing - Contents of brief for building design (BS 7832:1995 ISO 9699:1994) which is prepared to use for preventing briefing design stage problems. Secondly, on this study a questionnaire is

developed to identify the problem types between design team and client on the construction project design process in north Cyprus. This questionnaire survey focus groups are clients and design team members. Lastly, the author of this thesis has had experience on construction project design for about 3 years and the author of this thesis has witnessed briefing design stage problems between design team members and clients.

To prevent these problems in the briefing design stage, an instruction method was developed by using 'expert system shell' on the computer platform. The Briefing Design Stage Instruction Expert System (BDSIES) represents a checklist for the construction briefing design stage. Through, design team members or design manager will be instructed by BDSIES during the briefing design stage correctly.

BDSIES has been validated with respect to a human expert supervisory and a novice person comments. The validation purposes are to be able to establish the knowledge on the BDSIES, to be able to establish the level of simplicity of the BDSIES for users and to be able to analyse in order of the instructions of the BDSIES.

1.2 Scope and Objectives

The scope of this research covers the identification of the faced problems between client and design team and developing a system to prevent these problems during the briefing construction project design stage in north Cyprus. Therefore, the main objectives of the research are;

1. Literature and interview, contacting pilot interviews with client and members of the design team to find out problems' resource.

2. Preparing a questionnaire to investigate the type of problems between client and design team member.
3. Creating a checklist to contribute satisfaction in briefing design stage between client and design team.
4. Improving the understanding of design team for the purposes and activities in the briefing design stage.

1.3 Methodology

This research consists of four phases;

1. Literature studying about the construction project management and expert system shell.
2. Pilot interviewing with the design team members and clients to understand the main reasons of the problems.
3. Surveying to identify the types of the problems between client and design team member.
4. Self-experience (the author of this thesis)
5. Expert system development

1.4 Achievements

The Briefing Design Stage Instruction Expert System (BDSIES) has been created to instruct the design team members in the briefing design stage for avoiding the occurrence of any problems. The expert system instructs the users (project managers, architects, engineers etc.) by asking questions about the client and project design requirements, the system functions as a checklist for the briefing design stage. The BDSIES has been validated with respect to a human expert supervisory and a novice person comments.

In this study:

1. Briefing design stage problems' resources was found out by pilot interviewing with design team members and client.
2. Briefing design stage problems' type between client and design team was investigated by preparing a questionnaire.
3. A checklist was developed to contribute satisfaction in briefing design stage between client and design team.
4. The understanding of design team for the purposes and activities in the briefing design stage was improved.

1.5 Guide of the Thesis

The guide of this thesis is as follows: Chapter 1 is the introduction part of the thesis and it includes the general background, the scope and objectives, methodology, and achievements. Chapter 2 covers an overview of the literature about construction management and briefing design stage. Chapter 3 contains expert system shells which introduce description of the system, the system components and designing methods. Chapter 4 includes the questionnaire and it consists of the, design and contents of the questionnaire and the data of the responders. Chapter 5 explains the results and discussion of the questionnaires. Chapter 6 is about the design and development of the expert system: BDSIES. Lastly, Chapter 7 comprises the conclusions and recommendations of the study.

Chapter 2

CONSTRUCTION PROJECT MANAGMENT

2.1 Introduction

This chapter discusses and describes the steps that consist in each stage of the construction project design in north Cyprus. The construction project design stage is divided into three parts; construction project identification, construction project planning and construction project design. Construction project identification includes conceptual plan of the construction design and preparation of the feasibility study including facility and needs analysis. Construction project planning contains planning studies, site studies and technical studies. The last part which is construction project design includes determining client's requirements, preparing detailed construction project plan and establishing the project budget.

In this chapter, construction project management is explained in order to identify the current role of the relevant parties in the development stage of construction projects. Project management is explained generally including; process of project management, knowledge areas of project management and life cycle of project management. Also construction management is reviewed including; stages of the construction project especially briefing stage, designing stage, tendering stage construction stage and commissioning stage of construction project. Additionally, during these construction project stages, project managers and the other stakeholders' roles are identified in respectively.

2.2 Construction Industry

Construction is an enormous, powerful and complex industry that plays an important role in countries' economy. Construction industry definition includes general building constructions and engineered constructions. General buildings include; residential, commercial, institutional and industrial buildings. Engineered construction projects are usually known by their functionality rather than aesthetics. There are two categories on the engineered construction; highway construction and heavy construction. Highway construction contains excavation, embankment construction, installation of bridges and drainage structures. Heavy construction projects include dams, tunnels, pipelines, marine structures, water and sewage treatment plans, railroads, airports, water lines and street paving. The industry also includes new constructions, repair, additions and the prefabricate buildings and also construction of an unnatural nature (Bennet, 2013).

The construction industry is an economic investment and its relationship with economic development is considered as adopted. Many studies have mentioned the importance of the construction industry to national economic development (Myers 2013). The industry's remarkable effect on the world economy can be indicated by reviewing a construction's magnitude of the total value of equipment and services, as well as the number of people employed in construction as a magnitude of the construction work force and the number of construction companies compared with the total businesses in all industries (Bennet, 2013). Furthermore, technological changes in the construction industry is growing fast, usage of environmentally friendly technologies are increasing noticeably. At this point, the sector needs skilful workers or training the workers to adapt to such changes. There is an important point

that should be focused on the role of the quality and size of the construction firms which carry out the construction work. Quality and output of the construction works take a lead on the growth of the sector. Figure 1 shows the list of countries with the largest construction output in 2015.

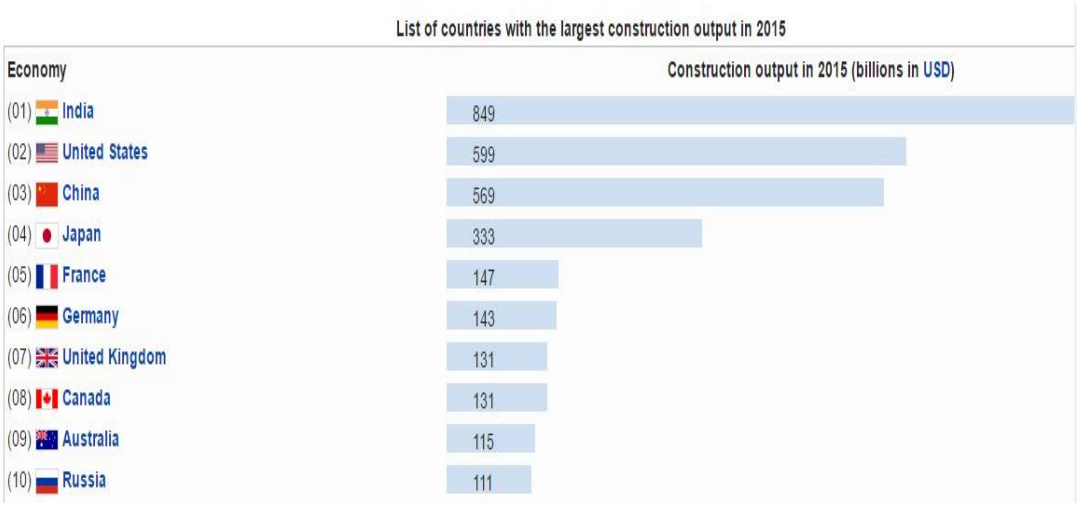

Figure 1: List of countries with the largest construction output in 2015
(Source: https://en.wikipedia.org/wiki/Construction)

2.2.1 Construction Industry in north Cyprus

North Cyprus is an island and it has small economy, it suffers from the isolations same as other small islands' economies. Its economic structure is not various and mostly service sector takes the lead of the economy. As Şafaklı (2011) clearly mentioned that more than 75% of employed people work in service sectors.

The construction boom accrued after the decision about the 'Cyprus Problem' by the UN Peace Plan with another word an 'Annan Plan' in the north Cyprus industry (Balkız & Therese, 2014). Description of the 'Annan plan' according to the Wikipedia is "a United Nations proposal to resolve the Cyprus dispute. The proposal

suggested restructuring the Republic of Cyprus as a United Republic of Cyprus, which would be a federation of two states".

From 2002 to 2007 the size of the economy in north Cyprus reached very high rates, as a consequence of positive influence of expectations on solution on Cyprus problem. Because of positive influence of expectations and raise in foreign demand, construction sector became backbone of north Cyprus' economy and construction sector starts to play an essential role in the socio economic development of the north Cyprus (Şafaklı, 2011).

Nevertheless, project management practice was inadequate and construction companies started to operate with weak quality projects and illegal construction projects to share the benefits of the construction explosion. This situation causes delays, high costs and poor quality on the construction works in north Cyprus (Yitmen, 2007).

Studies such as Şafaklı (2011) have shown that construction sector covers 7.6% of the economy in 2007. However, in 2009 the sector covers 6.5% of the economy. Figure 2 shows the sectoral distribution GDP in north Cyprus in 2009's economy.

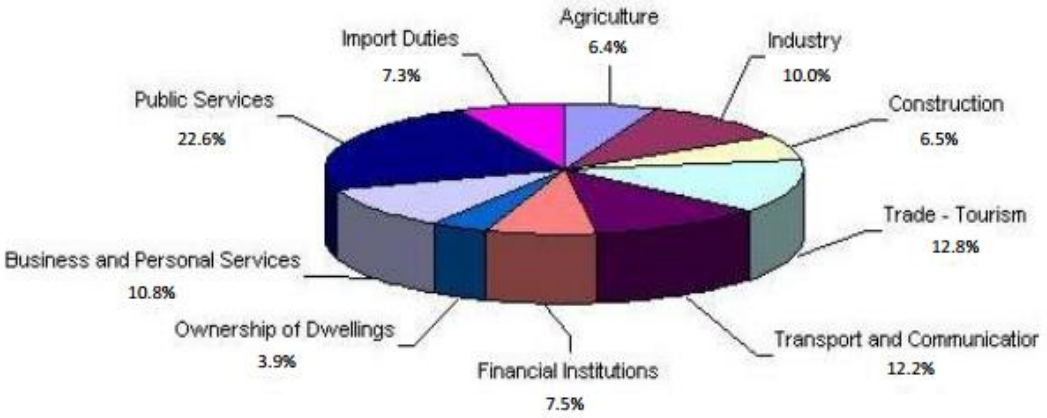

Figure 2: Sectoral distribution of Gross Domestic Product (GDP) in North Cyprus in 2009 (Şafaklı, 2011)

Also, Figure 3 shows the sectoral distribution of GDP in north Cyprus between 2008 and 2014. As it was mentioned on Figure 3 contributing construction industry is getting smaller in the economy of north Cyprus. This reduction on the construction sector can be explained by global economic recession, unresolved Cyprus problem and poor project management of the construction companies.

(Current Prices, %)

Sectors	2008	2009	2010	2011	2012	2013	2014
1. Agriculture	5.1	5.6	5.9	5.6	5.6	5.3	5.5
1.1. Crop Production	2.7	2.9	3.0	2.8	2.7	2.3	2.6
1.2. Livestock Production	2.1	2.4	2.4	2.4	2.4	2.6	2.5
1.3. Forestry	..	..	..	..	..	..	
1.4. Fishing	0.3	0.3	0.4	0.4	0.4	0.4	0.4
2. Industry	10.7	9.6	9.8	8.6	8.4	8.4	8.8
2.1. Quarrying	0.8	0.7	0.6	0.7	0.6	0.6	0.5
2.2. Manufacturing	4.0	3.2	2.3	2.5	2.8	2.9	3.1
2.3. Electricity - Water	5.9	5.8	6.9	5.3	5.1	4.8	5.1
3. Construction	7.1	6.5	5.6	6.3	4.8	4.9	4.2
4. Trade-Tourism	14.2	14.3	16.0	18.7	19.9	20.1	20.6
4.1. Wholesale and Retail Trade	9.7	9.0	10.7	11.1	11.4	11.2	12.3
4.2. Hotels and Restaurants	4.5	5.2	5.4	7.6	8.5	8.9	8.3
5. Transport-Communication	12.1	11.1	9.4	8.5	9.3	9.4	8.9
6. Financial Institutions	7.1	7.2	7.2	7.2	7.3	7.6	7.2
7. Ownership Of Dwellings	3.5	3.8	3.9	4.2	4.4	4.7	4.5
8. Business and Personal Services	10.3	11.3	11.6	11.2	11.5	11.7	11.6
9. Public Services	21.7	22.3	21.0	19.9	18.6	17.7	18.1
10. Import Duties	8.2	8.3	9.6	9.8	10.2	10.2	10.6
GDP	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: State Planning Organization

Figure 3: Sectoral distribution of Gross Domestic Product in north Cyprus (Source: TRNC State Planning Organization, http://www.devplan.org/GSMH/En/GNP-04.pdf)

2.3 Construction Types

In planning for diverse types of construction, the ways of procuring qualified services, assigning construction contracts' type, and financing the construction can be differed from each other. The general types of construction can be categorized into four groups; each group has its own characteristics;

i) Residential constructions

ii) Institutional and commercial building constructions

iii) Special-purpose building constructions

iv) Engineering constructions

Each group of the characteristic is specified below.

i) Residential Construction;

- Single and family houses, townhouses, high-rises houses and apartments.
- Operated by constructing companies
- The owners take charge for doing necessary required agreements for design and construction, the financing of structures and sale of the finished structures.
- The design is done by architects and engineers,
- The construction is produced by builders who work with subcontractors for the structural, mechanical and electrical works.

ii) Institutional and Commercial Building Constructions;

- Institutional buildings, social buildings, medical buildings, hotels, educational buildings, religious buildings.
- Generally private capital is used.

- Design is done by architects and engineers.

iii) Special-purpose Building constructions;

- Very large scale projects with a high degree of technological complexity, such as fabrics, steel mills, chemical processing plants and coal-fired or nuclear power plants (Elbeltagi, 2009).
- The owners are concerned with the development of the project, and they prefer to work with designers-builders until the completion of the project (Elbeltagi, 2009).
- Governmental regulations such as; environmental protection may affect the decisions on these project types (Elbeltagi, 2009).

iv) Engineering Constructions

- Functional properties are more important than aesthetic. Highways, tunnels, bridges, pipelines, drainage systems and sewage treatment plants, airports construction and bridges.
- Design is done by engineers.

2.4 Description of Project

"A project is any planned, temporary endeavour undertaken to create a unique product, service or other complete and definite outcome within a limited time scale and budget" (Steyn, 2008).

PMBOK defines a project as a "temporary endeavour undertaken to create a unique product or service."

2.4.1 Description of Project Management

The PMBOK Guide, 5th Edition defines a project management as the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements.

Project management is a set of principles, methods, tools and techniques for the effective management of objective-oriented work in the context of a specific and unique organizational operation. (Knutzon & Bitz, 1991)

2.4.2 Process of Project Management

The project management processes are the followings, as they are mentioned on the PMBOK Guide, 5th Edition.

- Initiating,
- Planning,
- Executing,
- Monitoring and Controlling, and
- Closing.

Figure 4 shows the project management processes and relationship between each order.

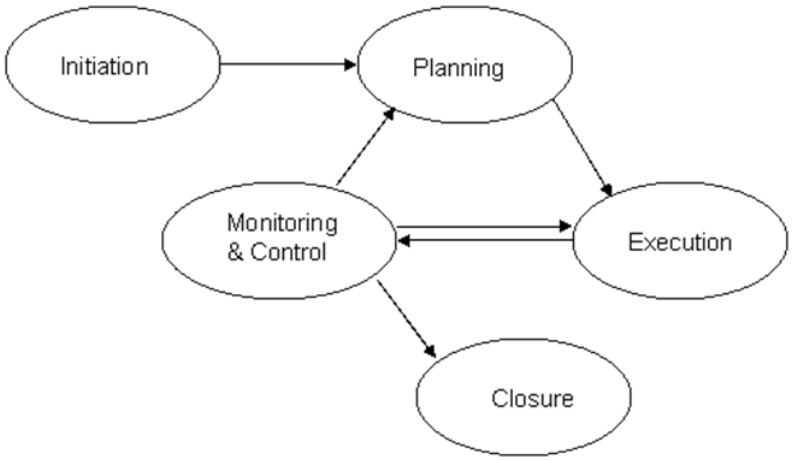

Figure 4: Link among process in a phase
(Source:http://www.moct.gov.sy/ICTSandards/en/27/4_Project_Management_Phases_Knowledge_Areas_and_Processes.htm)

- Initiating Process Group – Before starting a project, it is the process of obtaining authorization.
- Planning Process Group – On this process group, scope of the project should be defined with the objectives, and progress should be established to have and achievement on the project.
- Executing Process Group – On this process, the project management plan should be completed by adhering to the project specifications.
- Monitoring and Controlling – On this process watching, reviewing, and arranging the progress of the project should be done during all the process groups.
- Closing Process Group – On this process, all the activities in the project should be finalized to close the project or phase.

On the processes of project management, the monitoring and controlling process group is effective on all process groups, as shown in Figure 5.

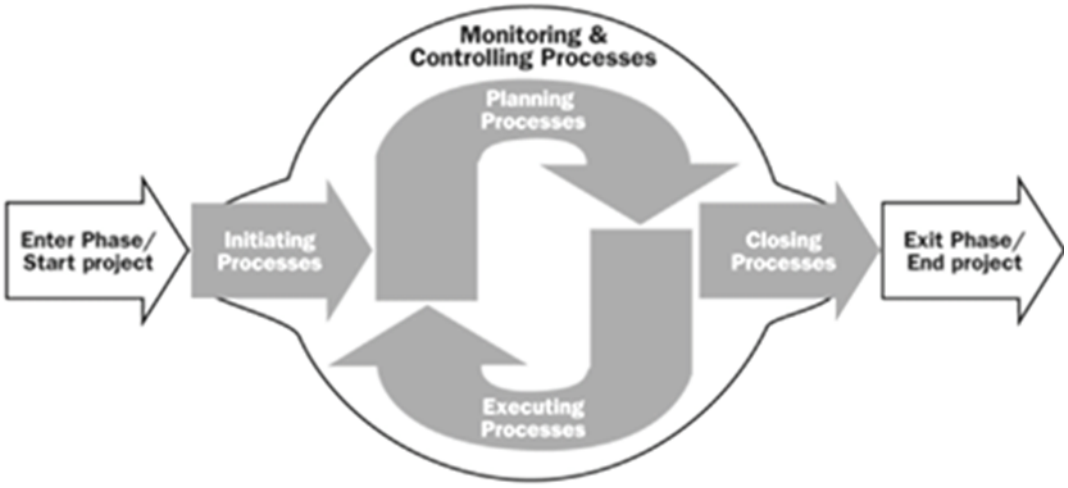

Figure 5: Project Management Process Group
(Source: A Guide to the Project Management Body of Knowledge, Fifth Edition 2013)

2.4.3 Knowledge Areas of Project Management

Project management has ten knowledge areas. The knowledge areas can be suitable for all project phases but there are situations that one or more than one knowledge areas are not suitable.

Integration management, scope management, time management, cost management, quality management, human resource management, communication management, risk management, stakeholder management and procurement management are nine knowledge areas of project management (Figure 6). The content of areas are explained in detail below.

Figure 6: Knowledge areas of the project management

Integration management is the process that covers integration of the elements of project management, which are determined, decided, connected, undivided and organized within the project management stages.

Scope management is the process that covers the whole work necessities to finish the project with success.

Time management is the process that covers the time arrangement of the project.

Cost management is the process that covers cost planning, cost assessment, accounting and examining the cost of the project until the completion of the project.

Quality management is the process that covers pleasure objectives on the project stages.

Human resource management is the process that covers organizing and managing issues within the project team member or with the relevant authorities.

Communications management is the process that covers contact issues, informing, and communication between project team members or with other relevant authorities.

Risk management is the process that covers risk assessment and risk handling on the project stages.

Stakeholder management is the process of managing, monitoring and maintaining expectations of anyone that has a concern in project stages or will be influenced by consequences of the project.

Procurement management is the process that covers purchase issues and contract management of the project.

2.5 Description of Construction Project Management

Construction project management includes of the construction project planning, project coordination, and project controlling from the beginning to the conclusion of the project.

Construction project management’s purpose is to meet a client's demand in order to produce a practically and financially usable project.

2.5.1 Stages of a Construction Project

The progress of finishing the design and construction of a building is separated into some stages. A construction project includes five stages and these are;

i) Briefing stage of construction project

ii) Designing stage of construction project

iii) Tendering stage of construction project

iv) Constructing stage of construction project

v) Commissioning stage of construction project (Celik, 2010)

By subdividing the project into smaller stages of work, the project manager can manage the scope of the project better. Also, constructions phases are very important in order to recognize the effect of the stakeholders on the construction project design stages clearly.

With these work the briefing stage and designing stage is explained in details to get better understanding of the mistakes, unnoticed or resolved problems and disputes between stakeholders in the briefing design stage of the project.

i. Briefing Stage of Construction Project

According to the BS 7832:1995 definition of briefing stage: "Working document which specifies at any point in time:

- the relevant needs and aims,
- resources of the client and user,
- the context of the project and
- any appropriate design requirements within which subsequent briefing (when needed) and designing can take place."

The aim of the briefing stage is to prepare project summary, determine client's requirements, estimate project cost to obtain approvals from the client.

During the designing stage of a construction project the following activities are undertaken.

- To create a work plan, assign the project designers and other experts
- To analyse client requirements, the project locations and site studies, planning designing, cost estimating, quality necessities.
- To prepare the project;

- Sketches as scale 1/100, 1/1000, 1/3500
- Cost estimating
- A plan for implementation
- The department data programme

Participants of the construction project in the briefing stage are specified as;

v) Architects: They are responsible for the preparation of the construction project design.

vi) Structural, electrical, mechanical engineers: They are responsible from performing calculations of the construction project design

vii) Client: The person that has ownership title and construction right.

viii) Users: The people who should execute and sustain the complexes which are procured.

ix) Project manager: A construction project execution is planned and controlled by the project manager.

x) Land surveyor: The people who investigate the land.

xi) Public Authorities and Agencies: The rights about health and safety of people who work or reside in a building are reserved by legal governance.

ii. Designing stages

The aim of the designing stage is to be able to finish design works by obtaining the required approvals from the client and from the necessary authorities, completing the project brief stage, deciding about the construction project layout, estimating project cost and arranging the tenders.

During the designing stage of construction project the activities aligned are below.

- Completing the project brief stage
- Obtaining technical studies
- Obtaining the client absolute approval
- Preparing

- A detailed design
- Preparation of the specifications
- Bill of quantities
- A final cost estimation
- Time-schedule

iii. Tendering stage of construction project

The aim of the tendering stage of the construction project is assigning a contractor or contractors to initiate the construction works separately.

During the tendering stage of construction project the activities aligned are below.

- To obtain tenders from contractors
- To select the contract.
- To prepare the contract document, to be signed by owner and contractor.

Pre-Qualification

To decrease the misunderstandings about the client's requirements, it is formal to offer some policy to establish the experience of the contractors to the client. This policy is called "pre-qualification". The policy includes examination of potential contractor's economical, directorial and other related resources with their experience on the similar projects and also consideration of the company's credibility.

Contract Documents

These documents should be prepared during the design stage to give the client. Construction contract documents include;

- The client-contractor agreement
- Performance bonds, payment bonds, and other bonds
- General conditions, supplementary conditions and other conditions
- Specifications
- Plans and drawings
- Additions
- Notice to proceed
- Work change directive(s)
- Change order(s)

Standard Forms of Contracts

The standard forms of contract are suggested to be use because:

- Their contents are well known and understood by the parties.
- The circumstances have already been tested in law,
- The arrangement of new forms of contract takes time and money.

Participants

Alan C. Twort and J. Gordon Rees (2004) stated that,

> A construction contract is made between two parties only 'the employer' and 'the contractor'. Their roles defined in the contract. However, because there is a need for day-to-day supervision of civil engineering construction, the two parties may agree that a third person should carry out such duties. This third person can have varying powers under the contract and this is reflected in his designation. He can be designated 'the engineer' under the contract; or he may be designated 'the project manager' or 'employer's representative' in both cases occupying a distinctly different position from the engineer (p.51).

iv. Constructing stage of project

The purpose of the constructing stage of a project is to construct the building within allowed limits of cost, time and specified quality.

In this stage the activities are production planning and site operations. Production planning includes:

- Time schedules,
- Site organization,
- Labour plan,
- An equipment plan,

- A materials delivery plan.

Production planning is important for the success of the project implementation. Failure on one of the activities can cause disruption on the whole production schedule.

Site operations include:

- Supplying all materials, furniture and equipment.
- Coordination of subcontractors,
- Execution of the work,
- General monitoring.

The main participants on this stage are the project management team members and contractor. The project manager and other team members should check the work to establish the construction requirements.

v. Commissioning stage of construction project

The aim of the commissioning stage of construction project is to ensure that the construction has been completed as specified in the contract documents and that all the facilities developed function accurately as considered in the design. Additionally, during the construction process, problems may occur which can cause changes on the project design. These changes should be recorded during the construction process in order to see them on the financial variations.

In this stage activities can be ordered;

- provide all steps on the construction records
- control the construction
- regulate, test and monitor all work
- provide performing direction guide
- manage the labours

The commissioning stage is the period between the construction and use of the building. In this period the participants are

- project management team members
- performing personnel
- designers and engineers
- client
- the contractor

2.6 Building Design Briefing Stages for Design team and Client

Dino Bouchalghem (1994) describes the briefing:

> Briefing is the process running throughout a construction project by which the requirements of the client and other relevant stakeholders are progressively captured, interpreted, confirmed and then communicated to the design and construction team.

The briefing stage is very important for the success of construction projects, but also it is known that developments are needed in this process in order to decrease the cost and increase the quality of constructions (Latham, 1994).

Identifying the briefing design stage critical success factors for the stakeholders has a significant impact on the success of the project. Different studies have identified

different critical success factors and the Table 1 shows the briefing design stage success factors for design team members and the client separately.

The briefing stage represents important activities which start with the project development process to the selection of the organizations that will arrange the different project elements in the construction. According to Royal Institute of British Architects (RIBA) outline plan of work, the briefing stage is identified on the Figure 7 as it is shown.

Table 1: Briefing Design Stage Critical Success Factors

	Critical Success Factors
Design team members	1. Skilled or experienced design team members (Alias, Zawawi,& Aris, 2014).
	2. Team member's motivations (Alias, Zawawi,& Aris, 2014)
	3. Quality of the communication (Babu, 2015)
	4. Quality of the project scope and project plan (Babu, 2015)
	5. Commitment of the members (Omran, Abdulbagei & Gebril,2012)
Client	1. Consultation of the client (Babu, 2015)
	2. Communication (Babu, 2015)
	3. Adequate budged (Alias, Zawawi,& Aris, 2014).
	4. Satisfaction (Alias, Zawawi,& Aris, 2014).

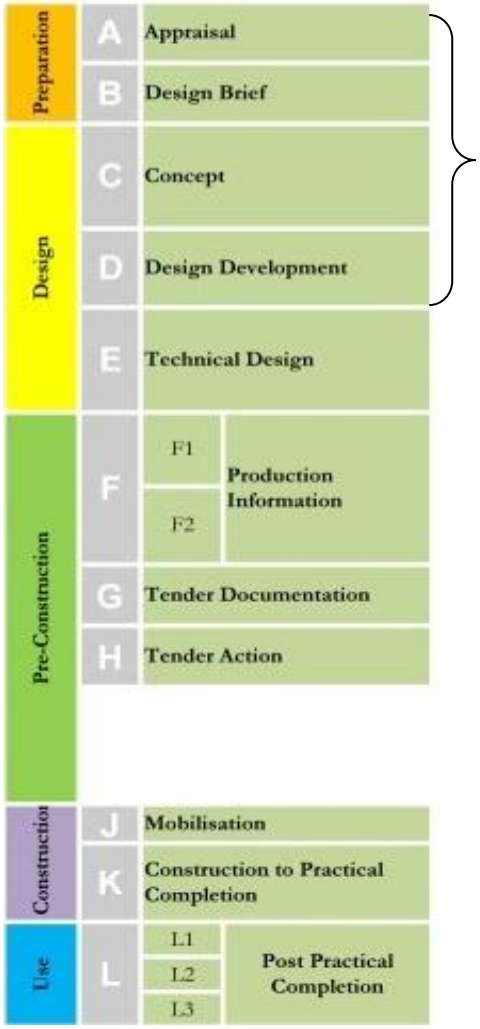

Figure 7: RIBA Plan of Work
(Source: https://www.ribaplanofwork.com/)

The briefing stages are separated into two phases. Firstly, the preparation stage consists of appraisal and strategic briefing which include feasibility study, land condition control and site study. Secondly, the design stage consists of concept design and design development which include preliminary design sketches, related project documents, project design calculations, size of structural members, location of these members, ground works, mechanical part and other designing staff should be completed.

- Appraisal and Strategic Briefing
    - Construction project identification
    - Construction project planning; planning studies, site studies, technical studies
- Concept Design and Design Development
    - Preliminarily construction design,
    - Design Development;
        - Complete the development of the project brief.
        - Preparation of detailed proposal.
        - Application for full development control approval

Additionally, on the contract document development stage, whole related documents should be prepared to join in the construction contract, including the detailed project drawings, technical reports and legal approvals should also be provided for the contract. When the planning and design phase is finished, the client or the client's representative should be ready for selection of the construction coordination. For all construction projects, the stages described in this section should all be executed. To decrease the problems during briefing stages, the given hints here must be followed by the client and the design team members.

2.6.1 Construction Project Identification

Construction projects start with an identification of the client's need by the design team. The team members must study about the construction project needs, according to the client redirections. The design team members start to a construction project with identification of the project scope, planning the project and designing the project.

2.6.1.1 Identity of the Construction Project

Briefing design stages start with resourcing the client to the construction design company for project design.

The identification of the construction project helps project managers not only understand the characteristics of the project, but also helps on predict the time of the project design. In order for client satisfaction to be achieved, there is one and effectual requirement that have to be carried out. This is getting client's constructional needs to be translated into a design which specifies technical components, performance principle and quality norms.

The identification of the lands' characteristic plays a big role on the selection of construction type and size. The identification of the land properties and location of the land should be considered first to identify the project and client's needs.

2.6.1.2 Purpose and Scope of the Construction Project

In this section the project manager assesses the main reason and main aim of the desired construction project with the client. Project scope should express the client's needs in the broadest terms. The manager gets the information about the desired building size, quality and superficially the planning of the project starts to get financial and time frame. While doing these activities, the manager should break the construction project into phases. Recognizing the project's aim and scope helps to identify the construction project steps. One of the first things for creating project phases is thinking about the scope of the project specifications. These specifications help to determine the task contents of the project.

Elbeltagi (2009) clearly point out that we can consider:

- Deliverables: These can be explained as some physical products, services, or outcomes that are produced during the project. There should be a task to reflect these deliverables components.
- Key Dates: According to the project completion date, the other projects should be considered with same way.
- Ending Criteria: How can a project's expiry date can be known? Is it possible to start a project without planning? Or is it imaginable to get expiry day of the project by experience? Recognizing the ending criteria allows the team members to have an aim for and helps them create the next stage of the project.
- Expectations: Recognizing the expectations of the design team members and management parameters may advice to classify project tasks. Expectation from the design team should start by keeping in touch, arranging meeting, submission of the process report and by communications with each other.
- Potential Problems: Determining potential problems may keep away from the effective damage. When the problem occurs, the problem can be balanced or minimized simply. That's why the potential problems should be identified on the task.

2.6.1.3 Identity of the Participants for the Construction Project

Client - Generally, the client is the person who has the ownership title, construction right or easement over the ground plot on which structural works are to be implemented.

Users – In some ways the users are the important participants on the construction project. They are the people who should execute and sustain the complexes which are procured. Although the same construction can be operating both client and user but also can be maintained individually.

General manager/administrator - A construction project execution is planned and controlled by the project manager. The project manager should have adequate authority to examine the responsibility of planning and operating a team to support the construction project. A construction project execution is planned and controlled by the project manager.

Designer - Designers are responsible for the preparation of the construction project design. They also carry out author's supervision for compliance of the structural works with the design. According to the Chambers of Architects, whose professional qualification have been recognized and also who have the right to practice as architects to develop construction design in the TRNC.

Structural engineer - Structural engineers are responsible from the structural design and also creating design drawings and specifications, perform calculations, review the work of other engineers, and write reports about construction projects.

Site surveyor - Site studies start investigation of the land. For construction projects, the site study include investigation of characteristics reports, right use of the land, relevant ways of right, formation of corners and boundaries, identification of building plot environment and slopes, position of current revisions and natural property of the land. For a pipeline or highway project, basic investigation method

layout can be harder than a construction building layout. This hardness consists of on the landscape, satellite-based overall location system methods that lead to lay out methods, different types of maps and coordination system databases handle in construction project planning. The surveyor experts can do their work in the construction phase; however, they are also as essential as part of the planning and design team (F. Lawrence Bennett, 2003).

Public Authorities and Agencies – For all construction types, the statutory requirements about construction standards and safety must be implemented during the construction process. For instance, for the roof design some parameters as snow and wind loadings must be considered. The rights about health and safety of people who work or reside in a building are reserved by legal governance.

Other related groups – In addition to the main participants there are related groups such as central government, local government, town planning/building authorities, financiers, neighbours and their consultants. It is important to inform the client about participants' roles and organizations.

2.6.2 Construction Project Planning

The selection of the designer is a big factor to success of construction project. After selecting the design team, the client should decide the construction project design criteria and project budged.

The project design criteria describe the construction project's purpose, architectural view, and additional requirements. The project manager and designers govern these criteria on the project design planning. During project planning, the project manager also determines the requirements for a project, identify the project's ranking in

importance relative to other projects, figure out budget requirements, and assesses whether to authorize the project for execution. The building project planning stages are explained meticulously.

2.6.2.1 Planning Studies

Planning starts by fleshing out what the project is to deliver and admitted the documents by client. The documents are;

- Determined border of land's map by land office
- Land registry document

The project manager considers which approach to takes, manages and carries out the works, implements the project, selects the project team, assesses the type and size of the project, and documents. Also it must be ensured that, client has an idea about the legal restrictions of the site and the roads around it or type of the buildings which can be designed.

Considering this information, client can estimate his/her desired project design.

The project manager provides project team members, and other stakeholders with a common understanding of what the project is all about, and is the authoritative reference document that defines the project. On the planning stage; according to the initial order of construction design, the project budget should be clarified.

2.6.2.2 Site Studies

Site studies should be done by project designers. Before design a construction, project designer assesses;

- The suitability of an existing site,

- The geological condition of the land,
- Type of previous use of the site,
- Population of the location
- Information about the near accommodation places with their numbers, functions, and characteristics.
- Spatial information such as day lighting, temperature ranges and wind directions.

Each matter should be assessed in relation to both the site and the surroundings.

2.6.2.3 Technical Studies

The project designer must have qualified technical professionals on the team to study on the project design and facilitate the technical evaluations. Technical evaluation of the project design includes;

- geotechnical investigations,
- zoning studies,
- potential hazard or threat requirements,
- required structural standards for the project design,
- comfort degree of the construction and
- life - span arrangement of the construction.

2.6.3 Construction Project Design

The design is an imaginative enterprise which is client's requirements; objectives are transpired on the 3D physical results.

For construction projects, design should not present a device to achieve the client's requirements; the other aim of the design is to satisfy the people aesthetically as a whole.

On the other hand, in the civil engineering projects design, usefulness and its budget is more important than in achieving the client's requirements. The projects' aesthetically effect on the landscape should be considered in the designing process.

Determining the client's requirements for a construction project can take long; but it is important to use the time and resources economically on this stage. On this point, minimal effort can save considerable costs. Additionally, when the project design is clearly prospered, the solution of the problems can be easily achieved. For attaining an optimal design result, the design procedure usually involves a sequence of repetitions.

After preparing a detailed project plan, the project design criteria govern the architect and engineer in their projects design to establish the final project budget. Upon the client's approval of the construction design, the designers seal the construction project design into plans.

Designers are typically engineers or architects and they are responsible through final completion of the construction project. The project design's success is related with the preparation of contract documents and the construction management's type. According to the client's decision, the charge of construction project design lead to an architect or an engineer. In general, if the project is a building, an architect takes the lead but if the project is functional–based such as roads or bridges a structural

engineer takes the lead. As a graphic representation (figure 8), the client appoints a project manager and the project manager establishes his/her own design team members including civil (structural), mechanical and electrical engineer. Additionally, the manager can choose to work with an interior designers and landscaping designer by recommendation of the client or client can work with them separately.

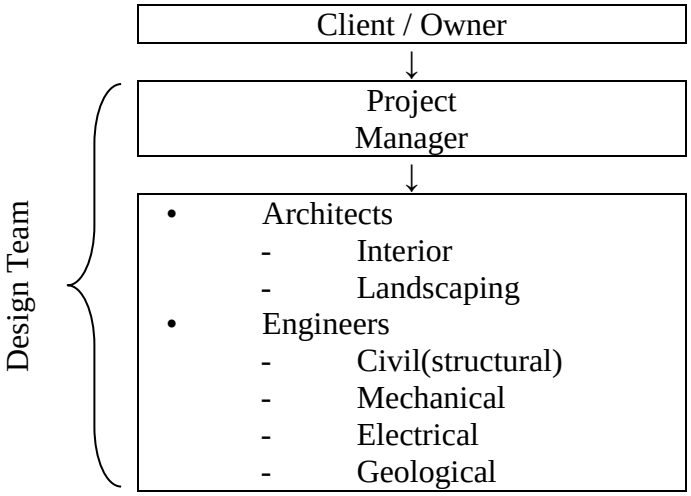

Figure 8: Project Design Diagram

According to north Cyprus construction industry procedure, construction project design stages are explained below.

2.6.3.1 Preliminarily Construction Project Design

The preliminary design stage cover, 20% of project design effort (Anderson, Huhn, Rivera & Susong, 2015). In this stage, the designer and client formalize and document the project necessities to move on to the development design stage. After obtaining site studies and necessary documents, which are explained on the planning studies; the land's map, land registry document and construction permit application are gathered by the client so that the architectural design can be started by the

designer. The project designer (architect) creates project design sketches taking into account of client's requirements, which includes an initial layout plan, initial floor plans, initial views of the construction, and initial sections of the construction.

Usually, on the schematic drawings, dimensions are used approximately. The architect conventionally develops these sketches to ensure the design parameters, such as height of building, number of storeys, area of the building, and architectural style of the building.

After completion of this stage, the architect presents the sketches to the client to examine and comment on preliminary design product. On the preliminary design stages, the communication between client and designer is a very important part for the understanding of the project design requirements. Additionally, to stick on the schedule, the design contract should be arranged clearly by the designer. The contract should include project design deadlines and project phases.

2.6.3.2 Construction Project Design Development

In the design development stage, the designer involves client in design review. The architect develops detailed layout plans, floor plans, building views and building sections.

The architect cooperates with the structural engineer, the electrical and the mechanical engineers on these drawings. If it is required, the architect cooperates with an interior designer and landscaping designer too. In addition, the architect develops the project design on the chosen materials and choice of the colour. The architect may even present a 3D model of the building on this stage.

Construction project design development stage, also include detailed design drawings and specification on the using materials and structural engineering requirements such as foundation size, column and beam locations, thickness of the floors. The specifications should be debated with the client in every detail. The specifications should refer the valid standards which a project designer should follow delicately.

As in the completion of the preliminary construction project design stage, the client reviews and comments again on the produced drawings during the construction project design development stage. Similarly, the contract is developed by designers. Completion time of the project and the project cost should be specified on the contract by the designers and the client.

At this stage, communication between design team members is very important to finish the work on time; also if necessary the design team should arrange the meeting date or alternate date to finish the work on time.

2.6.3.3 Construction Project Drawings

According to client's comments about the construction projects drawings, the designers then develop the final construction drawings and final specifications of the project design.

The architectural drawings include correct dimensioning layout plan, floor plans, sections plan and views plans for each storey. Also, detailed selection of materials should be attached to the drawings.

The structural drawings include detailed layout plan, foundation plan, column plans, floor plans and beam plans.

The mechanical engineering drawings include the location of the systems with the mechanical spaces, the type and size of the principal items of heating, ventilating, air conditioning, piping systems' equipment and fixture plans.

The electrical engineering drawings include the locations of electrical power equipment, types and sizes of electrical power equipment, power, lighting and signal distribution system plans.

The object of the construction project drawing stage is to develop drawings and project specifications to estimate the cost of the project and actual time of the project.

Upon the client's review and acceptance, the designers transpose the drawings in draft form to the final drawings form. Consequently, the designers produce the final construction drawings. These drawings are 100% drawings of the construction project.

The expression of the final construction drawings is not the end of designer's relation on the construction project. At least, the client can ask question or develop the content of the construction design, in other words the designer is responsible for the construction project design at all points.

2.6.3.4 Process of Construction Project Approval in north Cyprus

The process of project approval stage starts with the documents' and drawings' arrangement. The designers and client are officialised the construction project design

to move on to the construction stage. On these processes, the necessary file holder for the project design approval by the Chamber of Architect, which includes; drawings, contract, specifications document, map of the land and land registry document. Also need another file holder for the project's structural design approval by Chamber of Civil Engineer, which includes; drawings, static calculations' document, contract, specifications document, map of the land and land registry document. And other file holders for project's mechanical design approval by Chamber of Mechanical Engineer, which includes; heating system plans, ventilating system plans, piping systems fixtures plans. Also, other needed calculation documents. Finally, a file holder for project's electrical design approval by and Chamber of Electrical Engineer, which includes; lighting system plans, power system plans, signal system plans, underground work plans and necessary calculations documents.

The construction project file holders should be delivered to the related chambers to get the approvals of construction project. The file holders stay max seven days to be examined by the expert of chamber's members on the involving chambers. After the seven days the file holders are brought out from the chambers with the approval document of the construction project. Consequently, the designed construction project can be implemented legally.

Chapter 3

EXPERT SYSTEM SHELL

3.1 Introduction

Expert systems are developed to produce “expert quality” conduct for handling different problems (Ogu & Adekunle, 2013).

Expert systems are one of the most interesting applications of computers to develop in recent years. They give an appointee to the computer program for using expertise to assist in many types of problems, such as diagnosis, repair, instruction, interpretation, prediction, designing & planning, monitoring & controlling, classification & configuration.

In this chapter we focused on expert systems definition, historical backgrounds, working areas, contents, characteristics, advantages, disadvantages and developing process. We then focused at the process of designing and developing an expert system shell.

3.2 What is an Expert System?

According to Wikipedia description of the expert system; ‘An expert system is a computer system that emulates the decision-making ability of a human expert. Expert systems are designed to solve complex problems by reasoning about knowledge, represented primarily as if–then rules rather than through conventional procedural code’ (2016, Wikipedia).

Expert system is a judgement tool which is computer - based used for solving problems basing on an expert knowledge (Ogu & Adekunle, 2013).

Expert systems need an access to domain knowledge base and a tool to apply the knowledge to solve given problems. Expert systems will generally develop upon the opinion of knowledge representation, management rules and search (Bullinaria, 2015).

3.2.1 Historical Background of the Expert Systems

- Before 1960s

- Post 1943; If- Then rules system produced to solve problems (Leung, 1997).

- 1960s

- 1961 General Problem Solver (GPS) was developed by A. Newell and H. Simon (Wikipedia, 2016).
- 1969 Dendral (Feigenbaum, Buchanan, Lederberg) was a problem solving program that was developed to attempt to solve any problem in very large domain.

- 1970s

- Mycin was evolved in early 1970s at Stanford University by Edward Shortliffe by under the direction of Bruce G. Buchanan, Stanley N. Cohen and others (Wikipedia, 2016)
- After Mycin several expert systems had started to develop, the studies increased about development of knowledge representation theories

- 1980s

- 1982 First commercial applications were developed, such as: XCON & XSEL (at DEC) CATS-1 (at General Electric) by McDermott (Wikipedia, 2016).
- 1983 Some tools started to be commercially available such as LISP machine.
  - Now
- Expert systems are used in many areas

3.2.2 Component of Expert System

An expert system includes three components: the knowledge base, the user interface and inference engine, figure 4 shows the working system of the expert system contents.

The Knowledge Base – The knowledge base is the data storage place that programmers use to write the codes, problem - solving rules and procedures for the expert system (Maher & Fenves, 1984).

The User Interface - Where the expert system reached to the users. It is the place questions are asked, and problem results are produced. The problem results are represented as an output on the user interface. The user interface provides judgements or advice to the questions those are asked. Thus, users may develop their knowledge by taking such advice.

The user interface also helps to the programmer on the system to ensure whether the system works correctly, where the expert advice is represented on the system.

Inference Engine – The inference engine applied the rules to the knowledge base and analysed the new knowledge. This part is the 'unseen' part on the expert system, which is active during user start to run the program.

An expert system may use 2 different ways of inference; one of them is forward chaining and the other one is backward chaining.

A forward chaining begins with admitting the facts and defining new facts like a police collecting enough evidence on a crime scene. Forward chaining is generally used for diagnosis, instruct and arrangement in expert systems.

A backward chaining system begins with goals, and works to find what hypothesis must be asserted so that the conclusions can be achieved. Backward chaining is generally used for planning in expert systems. Figure 9 shows the components of the expert system with working order.

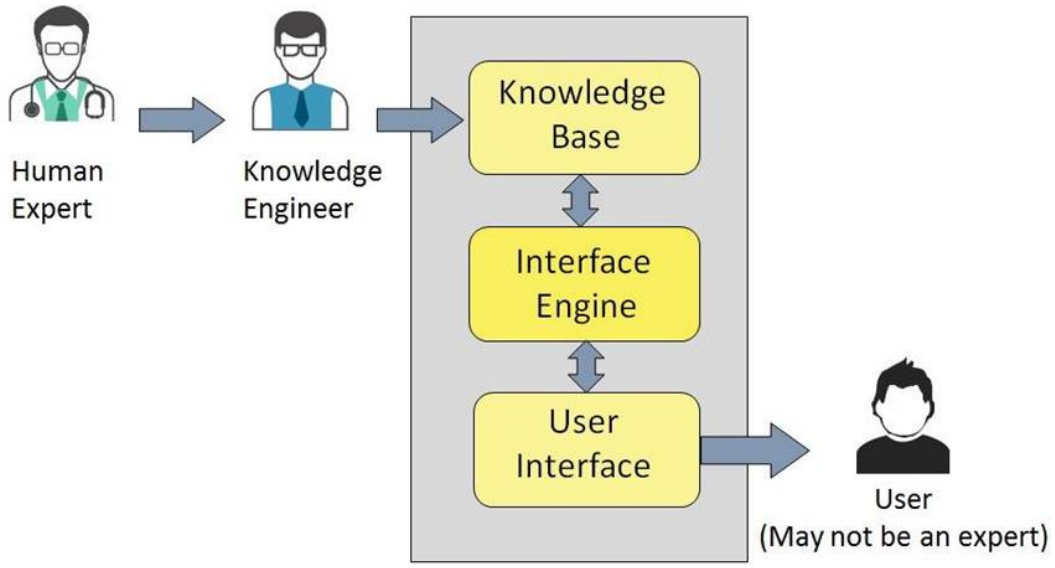

Figure 9: Components of the expert system
(Source:http://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_expert_systems.htm)

3.2.3 Using areas of the expert systems

Expert systems are used in many areas. For each area there are many type of expert system such as diagnosis, repair, instruction, interpretation, prediction, designing & planning, monitoring & controlling, classification & configuration. The fields are described on the following list.

1. Diagnosis - Diagnosis of multifunction types on the expert systems is used to identify human diseases or equipment (electronic, mechanical) faults.
2. Repair - Repair types on the expert systems are used to determine repair methods. Similar with the diagnosing method, the system offers a way for the repair of the element. The repair system includes planning framework and checking framework to approve the repair procedure. These kinds of systems are used on the automotive sector or similar sectors.
3. Instruction – Instructional types on the expert systems are used to categorize and classify the elements. Generally, this system is used on the directions of the students' fields.
4. Interpretation – These type expert systems have the intelligence to figure out knowledge to define its efficiency. These are often used for sonar data or geophysical measurement analysis.
5. Prediction – Prediction types on the expert systems are used for forecasting methods at the potential results. This is often used in weather forecast, exchange rates prediction and share prices.

6. Design and Planning – These types of systems help experts to evolve solutions to prevent time loss. These systems are often used for payment arrangements, building design planning, product ordering and magazine design.
7. Monitoring and Control – These kind of expert systems can be used monitoring or controlling the actions. Monitoring and controlling expert systems are often used for the nuclear energy industry, speed control of the vehicles, traffic control and the stock market.
8. Classification and Configuration - These systems allow to classify the data in the system by the description of various elements. These systems can be used for classification of various kinds of animals by zoologists, for configuring chemical compounds or classifying computer systems (Kaur, Rekhi and Nayyar, 2013).

3.2.3.1 Expert systems in Construction Industry

As Lawrence J. Kaetzel (1991) mentioned on his study:

> Expert systems are receiving greater attention from the construction industry to aid in the decision making process in areas such as diagnostics, design, and repair and rehabilitation.

Expert systems are generally using for the;

1. Construction project monitoring: Project monitoring is using on project management involving checking, regulating and controlling the performance and execution of a construction project. Monitoring includes cost control, scheduling and time control, purchasing and inventory control as well as quality control through the entire planning, design and construction process (McGartland, Martin R. & Hendrickson, Chris T. 2014).

For example; A expert system DCM (Digitalising the Construction Monitoring) is developed to integrate the information from construction drawings, digital images of construction site progress and planned schedule of work. (Ahmed, Z., Memon, M., Zaimi A.& Mustaffar, M., 2006)

2. Classification and configuration of the concrete: There are many expert systems applications about concrete. Following are some expert systems for the concrete's design, classification and configuration.

   BETVAL is a rule based expert system that provides suggestion on the choosing of ready mix concrete for the job site. The aim of the system is to assist construction site personnel in selection the type of fresh concrete ordered from the ready mix concrete plant (Abdullahi, 2008).

   COMIX is a rule and frame based expert system which provides suggestions on the design of normal weight concrete mixes (Kaetze, L. J.& Clifton, J. R., 1995).

3. Diagnosis of the problems in the structures: There are many type expert systems about the diagnosis of the structures' problems. The given examples show the some of the diagnosis expert system types.

   AMADEUS is a rule-based expert system that is developed for assisting building inspectors during emergency post earthquake damage assessment. The system records field inspection data and gives suggestions concerning

the safety of constructions that have been subjected to earthquake damage (Berrais, A. & Watson, A. , 1993).

RCDES is a rule-based system that is developed for diagnosing reinforced concrete structures' problems. It provides a broad view of diagnosis of reinforced concrete structures emulating the approach of human experts and uses a modular approach (Peter, 1996).

3.2.4 Characteristic of Expert System

Characteristics of the expert systems can be described by;

1. High performance - The acknowledgement at aptitude level equals to or better than a human expert.
2. Adequate response time – They respond in a reasonable amount of time, comparable to or better than a human expert's time. Time is an important issue on the real systems.
3. Good reliability – They must be reliable and must not crash. These features made the system more preferable.
4. Understandable - They have explanation ability. They should be able to define the steps on the working process. They should confirm its results in an equal way a human expert defends why he/she reached at that conclusion.
5. Flexibility – They also have an important efficiency structure where knowledge can be added, changed or deleted. (Robin, 2010)

3.2.5 Advantages of Expert System

1. Availability: Expert systems are accessible as mass production software. Expert systems are applicable on any computer hardware.
2. Cheaper: The cost of producing expert system is not expensive for per user.

3. Reduced danger: They can be used in any unsafe environments that may be risky for a human expert.
4. Permanence: The knowledge on the system will long endlessly.
5. Multiple expertise: They can be developed by more than one expert and knowledge will be multiple. Unlike the human experts, the expert systems can be available to work concurrently and constantly on a problem solving at any time of a day.
6. Explanation: They can explain the reasoning that lead to a conclusion in detail. A human expert might be exhausted or reluctant.
7. Fast response: They can response faster than a human expert and this response speed is the most important advantage of computers.
8. Unemotional and steady: Human experts may not operate at peak efficiency because of stress or dismay. Unlike human experts, they do not have stress, fatigue or dismay and work regularly during emergency situations or in real time.
9. Increased reliability: They increase confidence by producing another idea. Human experts may be tired or they made mistake under stress. Unlike human experts they do not any mistake.
10. Intelligent educator: They can be used by a student to run sample programs & explain the system's analysis.
11. Intelligent database: They can be used to access a database in an intelligent way.
12. Indirect advantages: The knowledge can be forgotten on the human expert's mind. Unlike human experts, knowledge is always in the system (Purwadi, 2010).

3.2.6 Disadvantages of the Expert System

- Making decisions, there is not common sense on the expert systems.
- They are not creative comparing with a human expert
- They are not talented of explaining the idea and analysing an opinion.
- It is not simple to write complex processes on the system.
- They do not have capability and flexibility of changing environments or adapting to new environments.
- They cannot interpret the results when there is not an answer.

3.3 The Architecture of Expert Systems

The process of designing expert systems is generally called knowledge engineering. The typical architecture of the expert system is shown on Figure 10. The knowledge engineer is developed with all fundamentals of an expert system:

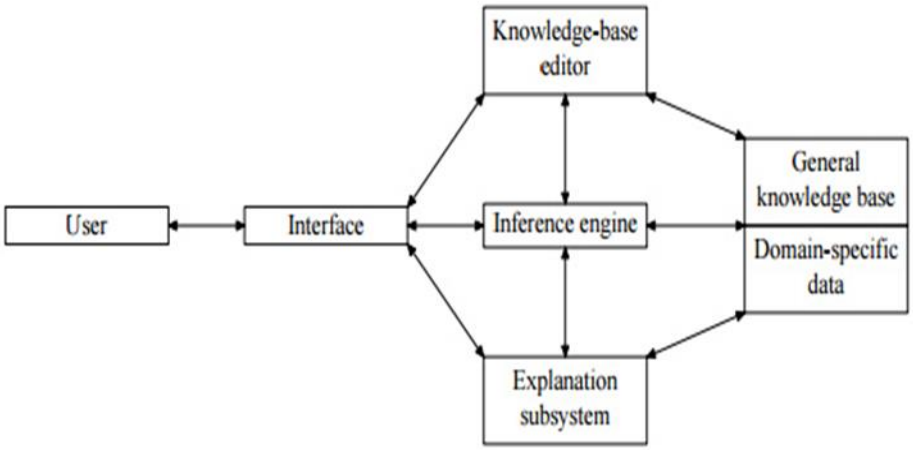

Figure 10: Typical Architecture of the Expert System
(Source: Luger, 2005)

Designing expert systems is a continual process. Their components and their networks will be built using codes by the knowledge engineers and the experts (Bullunaira, 2005).

The knowledge engineers work with human experts during designing process of the experts system. The four steps in the process are as follows.

1. Problem selection and Model construction: Firstly, the knowledge engineer may begin with interviews, asking questions about what can be done to, decide and narrow the problem, and assess the availability of an expert system.
2. Decide representation: Then knowledge engineer developed a knowledge representation scheme and the inference mechanism. The knowledge engineers require to choose an ontology: the vocabulary to take the knowledge and the definition of that vocabulary. After that knowledge engineer may implement the model, and produce assessment from experts.
3. Implementation: Knowledge engineers prepare on accurate plan. At the same time, another knowledge engineer develops the model and develops the inference and representation judgement.
4. Assessment: The model is tested to check if the system can pass itself off as an expert in the domain which show if the knowledge is correct or not.

3.4 Knowledge Acquisition

The knowledge acquisition component lets the expert to enter their knowledge or expertise into the expert system, and to clarify it later as and when needs (Bullunaira, 2005).

Knowledge acquisition contains the elicitation, collection, analysis, designing and acceptance of knowledge (Chakraborty, 2010).

The knowledge acquisition process contains three stages:

5. Knowledge elicitation is the coactions between the human expert and the knowledge engineer to bring out the expert knowledge in some systematic way.
6. The knowledge is obtained and stocked in a scheme of human friendly representation.
7. The representation of the knowledge is then compiled into a workable form that the inference engine can progress.

3.5 Knowledge Base

Expert system is developed for a basic knowledge module. Expert system includes an explicit representation of the data produced by human expert. This data might be in the shape of problem-solving rules. To organize this knowledge into the system, it is needed to make use of one or more representation manner.

Transferring information from the human expert to a computer system is the most difficult part of designing an expert system. The knowledge acquired from the human expert should be written in the exactly way with expert knowledge, and the data should be able to manipulated to a computer.

There have been three frequent methods for knowledge base developed over the years; if-then rules, semantic rules and frames.

3.5.1 If- Then Rules

Rules ‘if-then’ is the most common encoding knowledge method in expert systems. Its form is:

If a_1, a_2.....a_n

Then b_1, b_2...b_n

where each 'a_i' is condition or situation, and each 'bi' is an action or conclusion. For example;

If *pulse is absent* and *breathing is absent*

Then *the person is dead*

3.5.2 Semantic Rules

By this way knowledge is represented by language of objects and connections between objects.

The objects are connected using nodes on a graph. The most used form is semantic networks on this system. These networks are used to link the nodes to represent 'is-a and has' relationship between objects. Figure 11 shows an example for semantic rules.

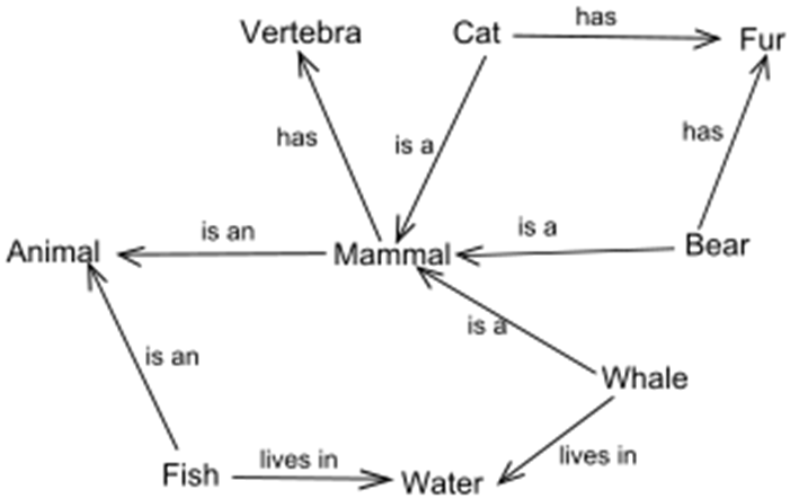

Figure 11: Example of a semantic network
(Source: https://en.wikipedia.org/wiki/Semantic_network)

3.5.3 Frames

In this method, knowledge is broken down into several modular parts named frames, which are established noted structures.

Knowledge frame includes envisions, situations quality of envisions, relationships between envisions, and ways to handle objects as well as aspect values.

3.6 Inference Engine

Inference engine works as a representation to come to the conclusion or an advice from an expert. It includes the system's problem-solving knowledge. The inference engine is responsible for determining the next using knowledge and scheduling results of conclusions or actions. The engine will take conclusions marked as needed by a part of knowledge which is found as the true result. In summary, the inference engine must be responsible for dealing with estimated and questionable information.

An inference engine separated into types, one of the main types of expert system knowledge is meta-knowledge. Meta-knowledge is the knowledge for the expert system. Meta-knowledge might consist parts of knowledge which are used on the first order, whether this part of knowledge should be implied or requested by the user or when the progress should be finished.

Inference engine works in two ways. One of it is data driven, also known as forward chaining and the other one which works is known as backward chaining. Forward chaining systems starts with same information and continue in the inference chain until it comes to a final object, action or conclusion. Backward chaining system is a

bottom-up procedure which starts with goals and queries the user about information which may satisfy the conditions contained in the rules.

3.7 Expert System shells

As Nii, H. Penny (1993) clearly describes:

> An expert system shell is a software development environment and includes the basic components of expert system. A shell is associated with a prescribed method for building applications by configuring and instantiating these components.

3.7.1 Approach of an Expert System Shell

Expert system shells are expert system development tools include the expert system substantially without the knowledge base, embodying the inference engine, working memory, and the user interface. Expert systems show reference or solve problems building a knowledge base which they are drowning by using IF/THEN rules (Sener, 1991).

The shell is processes the information inputted by a user; the information relates the concept which consists of a knowledge base; and produce a judgment or solution for the problems. Because of that, expert system shell produces a layer between the user interface and computer operating system to arrange the input and output of data (Boss, 1991).

The main aim of the knowledge base is to produce the content of the expert system the networks between theories, opinions, and statistical possibilities that allow developing of the potential problems (Boss, 1991).

3.7.2 Component of an Expert System Shell

1. Knowledge Base: This is a data store for heuristic knowledge. An expert system shell produces one or more than one knowledge representation plans for figuring knowledge about the function domain. There are some shells that include both frames and if-then rules in their knowledge base scheme. Although, in the beginning of the system the knowledge in the knowledge base is represented by logical descriptions.

2. Reasoning or Inference Engine: This expresses to the inference systems that are used for changing the computer language data and knowledge consist of the knowledge base in order to form an analysis procedure to the solution of a problem. The inference system may arrange the inputs backward or forward chaining by using if-then rules to more complicated case-based analysis.

3. Knowledge Acquisition Subsystem: This is a backup system that cooperates with the experts to design knowledge bases. It includes the knowledge representation encode. The procedure of assembling the related domain data required handling problems and designing the knowledge base goes on to present the most important barrier in designing expert systems.

4. Explanation Subsystem: This is a backup system that explains the system's conclusion by offering reasons why a present cause of conclusion was preferred by an expert system. The explanation may have an order from how the last or middle solutions were reached at to support the necessary added data.

5. User Interface: This system is a communication tool with the user. The user interface is not a general part of the expert system, and is not focused to involve expert systems. The users get their demand in system, and the expert system progress brings a result by using an inference rule to choose the suitable solution from a knowledge base.

6. Trace Facility: This is one of the components of an expert system shell and this component works to follow the inference process.

The shells have an important role in designing expert systems. A system can be designed to work on duty by programming the shell to include all the needed knowledge about duty domain.

The basic components of expert system shell are shown in Figure 12 by their working order.

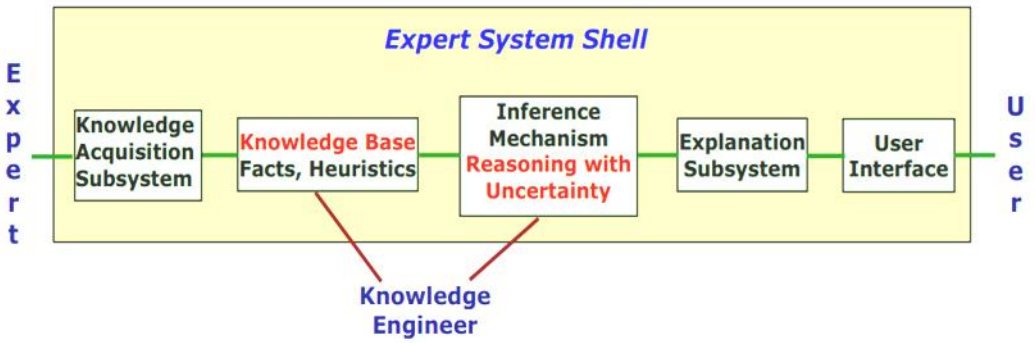

Figure 12: Basic Components of Expert System Shell
(Source: Nii, H. 1993. http://www.wtec.org/loyola/kb/c3_s2.htm)

Chapter 4

QUESTIONNAIRE

4.1 Introduction

Questionnaire is developed to identify the problem types between design team and the client on the construction project design process. Investigation of the problems between participants is important for handling the problem.

One of the focus group of this questionnaire survey is clients which want a construction project design; other focus group is the construction design team. This survey is very important in assessing the problems which will be useful on the problem handling process.

4.2 Questionnaire Design

Problems are identified according to the following categories: cost, time, design quality, technology, equipment, safety and environment. After identifying the problems, the questions were prepared to find source of preoccupations. On the survey, the questions were answered by yes, no and definitions. A questionnaire with 27 questions was prepared for the clients and for the design teams 31 questions were prepared (Appendix A).

4.3 Questionnaire Content

The questionnaire surveys included questions about,

a. cost factors,

b. time factors,

c. quality factors,

d. technology factor

e. equipment factor

f. safety factor

g. environment factor

4.4 Questionnaire Participants

Participants of the questionnaires are two groups. One of them is construction design team members and the other is clients.

4.4.1 Design team members

Design team is responsible for planning the construction's layout with suitable model, cost and quality according to the consumers with in due time. Their purposes are to stick by clients' decisions using the vocational knowledge and to ensure that the full project can applicable successfully on schedule and on budget at the construction site.

General questions were prepared to get information about encountering problems of the design team members during the construction project design process. 60 questionnaires were distributed to 60 responders for analysing the problems on the design stage of the construction projects. Therefore, 100 % response is obtained from the questionnaire.

4.4.1.1 Gender and age of the responders

63 % of participants were male and the rest of the participants, 37 % were female. The average age of the responders was identified as 54 % for 20 to 30, 37% for 30 to 40 and 9 % for 40 to 50 years old as shown on Figure 13 and country of the responders was North Cyprus and Turkey.

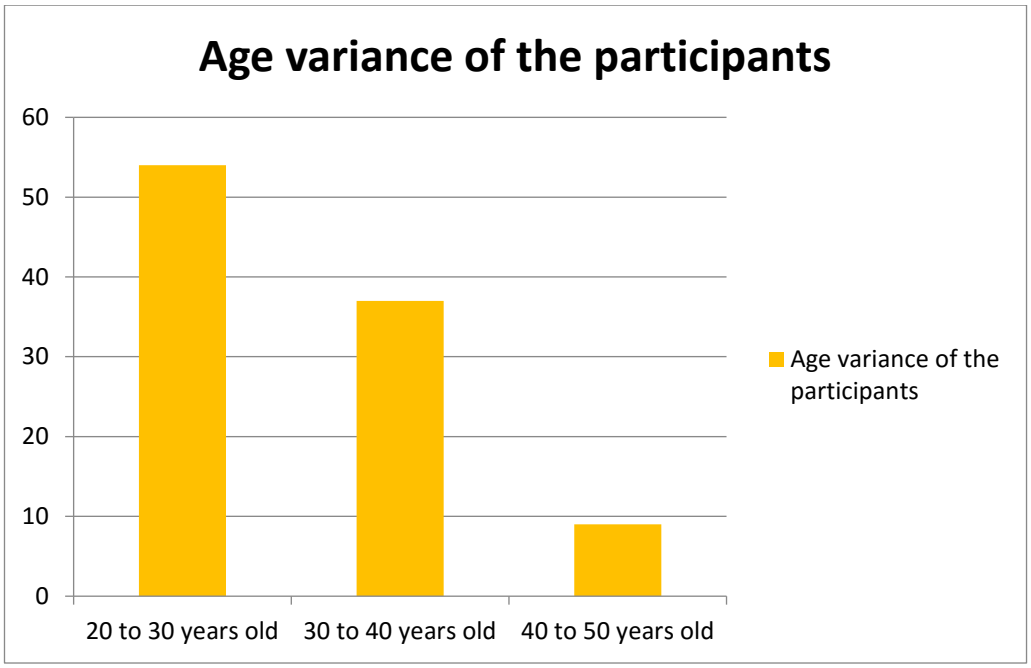

Figure 13: Age variance of the participants

4.4.1.2 Position of responders

The survey was responded by design team members including engineers and architects. Figure 14 shows that 57 % of the participants were architects, 23 % were civil engineers, 7 % were mechanical engineers, 7 % were technicians, 3 % were electric engineers and the rest of the participants 3 % were industrial engineers.

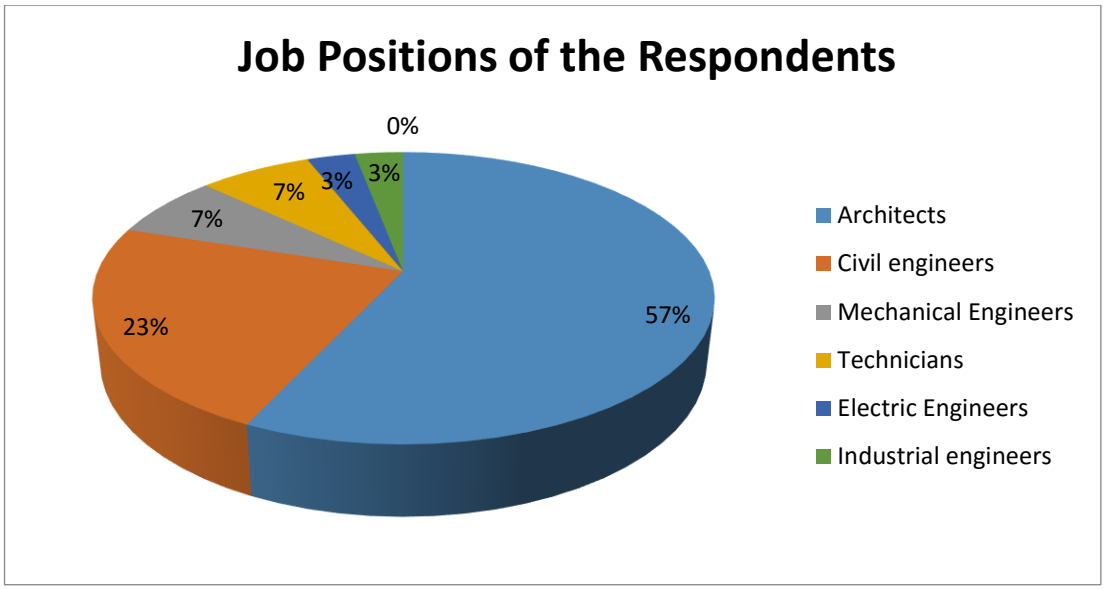

Figure 14: Job Positions of the Respondents

4.4.1.3 Experience of the responders

Experience of the responders was between 1 to 20 years on the sector.57 % of the participants have experience about 1 to 5 years, 23 % of them have 5 to 10 years and 20 % of them have 10 to 20 years' experiences on the construction sector. Figure 15 shows the percentages of the variance of the experiences.

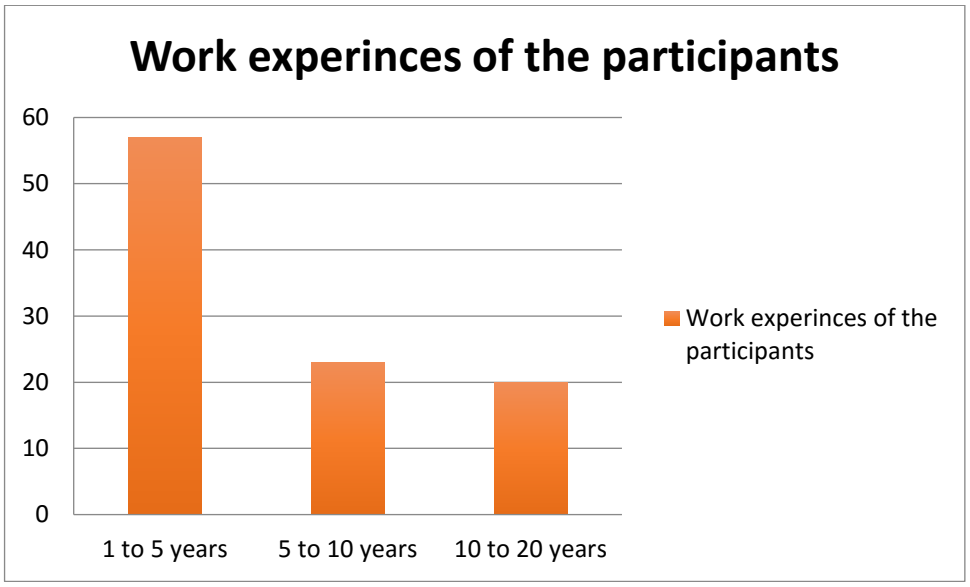

Figure 15: Work Experiences of the Participants

4.4.2 Clients

Clients generally expect the high performance and quality on the construction project design. The project's outcome should supply the market or the clients' necessities. Hence, clients should describe the performance or quality of the proposed projects based on their own and/or the market necessities. Expectation about design quality, time and cost some questions were prepared to identify the problems according to the client. 60 questionnaires were distributed to analyse the problems on the design stage of the construction projects.

4.4.2.1 Gender and age of the responders

64 % of participants were male and the rest of the participants 36 % were female. Country of the responders is North Cyprus and the ages of the responders were between 66 % is 20 to 35 years old, 20 % of the participants are 35 to 50 years old and 4 % of them are 50 to 65 years old. Figure 16 shows the percentages of the age's variance.

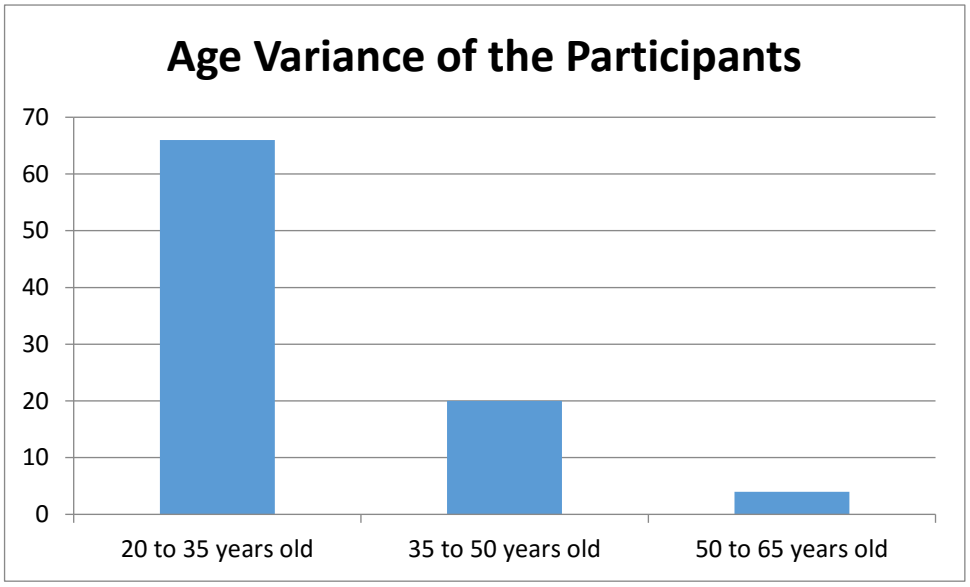

Figure 16: Age Variance of the Participants

4.4.2.2 Educational level and job of the responders

Responders' level of education is also has been identified. 87% of participants have bachelor degree, 13% have high school degree.

Questionnaire results show that 40% of the respondents are self-employment, the rest of them work as a teacher, police officer, lawyer, security, broker, carpenter, retired etc.

Chapter 5

RESULTS AND DISCUSSION

5.1 Introduction

This chapter include the results and discussion of the questionnaires and the problems which affect the cost, time and quality of the construction project design on the briefing and designing.

5.2 Identification and Analysing of the Problems from the Surveys Results

According to the surveys' questions content, the problems are verified clearly for both sides. The tables are prepared to show the results of the questions and to verify the faced problems during the construction project design process between the participants.

5.2.1 Identification of the problems from client perspectives

The questions asked to the clients and results are indicated in Table 2. The first column shows the statement of the problem the second column present the survey questions and the third column shows the percentage of the respondents' answers to the question.

Table 2: Identification of the Problems Client Perspectives

The problems	Questions	Questions' answers percentage (%)		
		Yes	No	Almost
1. Scanty knowledge about the design team members' professional functions.	Do you have any idea about the architect's professional function on designing of project?	**70**	**3.4**	**26.6**
	Do you have any idea about the civil engineer's professional functions on designing of project?	**63.4**	**6.6**	**30**
	Do you have any idea about the mechanical engineer's professional functions on designing of project?	**63.4**	**10**	**26.6**
	Do you have any idea about the electrical engineer's professional functions on designing of project?	**76.6**	**6.6**	**16.8**
2. Clients have a dilemma about the design of project and clients are without an opinion about the design of project and design teams' qualifications.	Have you investigated any similar project before?	**36.7**	**43.3**	**20**
	Have you investigated the design team, before starting the design of project?	**73.3**	**13.3**	**13.8**
	Are you aware of any designed project by that design team?	**73.3**	**20**	**6.7**
	Is that design team has any experience on your desired type of project?	**80**	**-**	**20**
	Have you appointed with this design team before on any other projects?	**43.3**	**46.7**	**10**
3. Clients have lack of information about the area survey.	Do you know building regulations about use of land?	**20**	**30**	**50**
	Do you have any idea about duration of legal proceedings for building plot?	**50**	**16.7**	**33.3**
4. The clients' awareness about the construction project design process and inaccurate approval or incomplete documents from the clients.	Have you provided all documents about project?	**63.3**	**20**	**16.7**
	Do you have any idea how long does a construction design process take?	**46.7**	**43.3**	**10**
	Do you have any opinion about the briefing design stages on a project?	**30**	**26.7**	**43.3**
	Do you know who is the responsible from the future variations on the project design?	**83.3**	**16.7**	**-**
	Do you have any idea about required process for infrastructure?	**33.3**	**36.7**	**30**
5. Client's budget problems.	Are you the main sponsor of the project?	**73.3**	**26.7**	**-**
	Have you discussed budget of project with your design team?	**66.7**	**20**	**13.3**
	Are you aware of the variation on the project budget (cost), how affect the	**50**	**13.3**	**36.7**

	projects design stages?			
	Do you know anything about cost estimation for type of projects?	**50**	**26.7**	**23.3**
6. Inopportune variation request on the project design	Are you aware of the variation on the project design (quality), how affect the project design stages?	**50**	**10**	**40**
7. Clients' requirement about immature technologies or unattainable materials using on the design.	Have you discussed the availability of using technologies on the design with the design team?	**46.7**	**23.3**	**30**
	Have you discussed the availability of using materials on the design with the design team?	**66.7**	**16.7**	**16.6**
	Have you discussed the availability of skilled labours on the design with the design team?	**60**	**23.3**	**16.7**
8. Lack of communication with client	Could you attend all the arranged meeting with designed team?	**66.7**	**16.7**	**16.6**
9. To dispute with design team	Is that design team recommended by someone to you?	**56.7**	**33.3**	**10**
	Do you want to work again with the same design team on another project?	**96.7**	**3.3**	**-**

5.2.1.1 Ranking of the clients' problems

To identify the types of the problems, the questions are arranged according to their contents. Ranking of the problems are found by considering the weight of answers.

$$R = \frac{(N_a + A_a) + (N_b + A_b) + \ldots (N_n + A_n)}{(n)}$$

Equation 1: Problem ranking formula

On this equation, R represent ranking the problems, N is respondent's negative answers, a,b ....n shows the related question numbers and A is the percentage of answer from participants such as almost, not sure etc. Lastly, n shows the related total amount of questions. On this study the questions interpreted as a detecting the problems during briefing and designing stage of the construction project design.

5.2.1.2 Analysis of the client's problems

Analysing the problem's ranking is made by the formula 1. For example, for the first problem; the answers of the questions from the respondents (the questions addressed according to the type of problem is shown on the table 2) negative responses are 3.4% (N1), 6.6% (N2), 10% (N3), 6.6% (N4) and almost responses are 26.6% (A1), 30% (A2), 26.6% (A3), 16.8% (A4). When the formula is used with respect to the values, R was found as 31.65 % and it is shown on the table 2. All problems were ranked by using this way and also caused factors are identified according to effect of project design to understand the effectiveness level on the construction project design stages.

As it is shown on the table 3, the problem number 3 'Clients have lack information about the survey area.' is the most important and common problem on the construction project design stage with 65% ranking and it can cause the cost problems on the construction project design stage. Client should be oriented about area survey, require documents etc. by the design team members to go to next step for the project design correctly.

Problem number 6 'Inopportune variation request on the project design.' is the second common problem on the construction project design stage with 50% ranking and table 2 shows the caused factor of the problem is the cost on the construction project design stage. Cost factor only concerns the client because of that client must be informed about the variation request affects by the design team members to prevent the problem occurring.

Problem number 4 ‘The clients’ awareness about the construction project design process and inaccurate approval or incomplete documents from the clients.’ is the secondly common problem on the construction project design stages with 48.65% ranking and problem 4 affects the time factor. On the handling of that problem, design team members must control the necessary documents before the start of the construction project design.

Problem number 7 ‘Clients’ requirement about immature technologies or unattainable materials using on the design.’ is ranked 42.2% and affects the cost factor of the construction project design. The results show that clients do not have any idea about the design details such as availability of the using material or technologies sufficiently. On this step client’s awareness must be increased by the design team members being clear about the design of the construction project.

Problem number 5 ‘Client’s budget problems.’ is ranked as a 40% and obviously has an effect on the construction project cost. Another way, if the design is not suitable for the client’s budget, the quality of the design should be arranged as stated in client’s budget. Also, construction project cost accounting must be expressed by the design team members or the design manager.

Problem number 2 ‘Clients have a dilemma about the design of project and clients are without an opinion about the design of project and design teams.’ qualifications.’ Is ranked 38.76% and this problem affects the time factor on the project design stage. Directing the client about his/her desire is one of the biggest roles on this problem handling. Design manager should eliminate unwanted parameters about the design of project step by step until to be sure regarding of the client’s opinion.

Problem number 8 ‘Lack of communication with client.’ is ranked 33.3% and affected factor is the project time firstly then it may affect the quality of the project. Success of the construction project design is directly connected with the communication. Communication quality is also important to identify complications on the construction project design stages.

Problem number 1 ‘Scanty knowledge about the design team members’ professional functions.’ is ranked as a 31.65% and affected factor is the project cost. As it is seen on the results of the questionnaire, this problem is not a prevalent on the construction project design stages but nevertheless to settle the problem, design team manager should orient the clients on required times.

Problem number 9 ‘To dispute with design team.’ is ranked 23.3% and affected factor is the cost as well as problem number 1. Also this problem is related with the communication between participants and related with handling way of the other mentioned problems.

Table 3: Ranking of the client’s problem

Problem Statement	**Ranking (%)**	**Factor**
3. Clients have lack information about the area survey.	65	Cost
6. Inopportune variation request on the project design	50	Cost
4. The clients’ awareness about the construction project design process and inaccurate approval or incomplete documents from the clients.	48.65	Time
7. Clients’ requirement about immature technologies or unattainable materials using on the design.	42.2	Cost

5. Client's budget problems	40	Cost
2. Clients have a dilemma about the design of project and clients are without an opinion about the design of project and design teams' qualifications.	38.76	Time
8. Lack of communication with client	33.3	Time
1. Scanty knowledge about the design team members' professional functions.	31.65	Cost
9. To dispute with design team	23.3	Time

5.2.2 Identification of the problems from design team member perspectives

The questions asked to the design team members and results are indicated in Table 4. The first column shows the statement of the problem the second column present the survey questions and the third column shows the average of the respondents' answers to the question.

Table 4: Identification of the Problems Design Team Perspectives

The problems	**Questions**	**Questions' answers percentage (%)**		
		Yes	**No**	**Almost**
1. Misinterpretation of client's requirements on the project design by design team.	Do you think you can manage the designing woks required by client?	**96.7**	**-**	**3.3**
	Do you respond to the client questions on the time?	**80**	**16.7**	**3.3**
2. Lack information on the contract.	Do you think that the contract signed by designing team has enough efficiency?	**60**	**23.3**	**16.7**
	Do you think that the contract signed by client has enough efficiency?	**76.7**	**16.7**	**66.6**

	Did you face with any problem on the contract at previous work?	**3.3**	**80**	**16.7**
3. Weak site study by design team. • Area survey • Ground survey • Legal access	Do you think that town planning is fair on every point of the project design? If it is not, please explain?	**20**	**30**	**50**
		Yes	**No**	**Some times**
	Do you require the geo-technical report before finalizing project design?	**43.3**	**13.3**	**43.4**
	Do you face with any problem about right of using building plot on the construction project design?	**13.3**	**66.7**	**30**
	Do you visit the project land as a project manager before the designing?	**76.7**	**13.3**	**10**
4. Uncoordinated design team members. • Effected to the project time • Effected to the project quality	How often do you do correction on the design project due to lack of communication between design team members?	**Mostly**	**rarely**	**Never**
		10	**60**	**30**
	How often do the design team members come together?	**53.3**	**30**	**16.7**
5. Lack communication with client	Do you arrange enough number of meeting for the project design requirements with client?	**66.7**	**33.3**	-
6. Insufficiency on the project design quality	How much important the user needs on the project designs?	**mostly**	**lightly**	**Normally**
		76.7	**20**	**3.3**
	Do you take site engineers opinion on the project designs?	**43.3**	**30**	**26.7**
7. Design team members' qualifications.	Do you face with any problem about inexperienced design team members?	**50**	**30**	**20**
8. To dispute with design team	Do you get any feedback from your clients?	**70**	**16.7**	**13.3**
	If it is yes, could you rate of the clients' pleasure?	**Highly**	**Normally**	**Almost**
		43.3	**56.7**	**-**
	How clients recourse to you? Please rate the methods according to their priority? (5-mostly, 1-rarely)	Recommendations of ex-client's relatives		**3**
		A project reputation made by that design team		**2**
		Recommendations of construction companies		**1**
		Success of the projects' design		**5**

		Success of the design team		**4**
9. Laxity on the legal procedures.	How often do you face with the problem about laxity in legal procedures?	**mostly**	**Rarely**	**never**
		3.3	**40**	**56.7**
10. Insufficient functional project design.	Do you consider parking places on the project design?	**66.7**	**30**	**3.3**
	Do you consider the location of project is suitable for public transportation?	**20**	**26.7**	**53.3**
	Do you consider the landscape on your project designs?	**66.7**	**16.7**	**16.6**
	Do you consider a special rubbish collecting place on your project designs?	**30**	**43.3**	**26.7**
	Do you do any attachment on the project design for handicapped people?	**83.3**	**16.7**	**-**
	If it is yes, could you rate the attachments according to their importance on the construction project? (7 – most important, 1- important)	Ramps		**7**
		Sufficient space for wheel chair		**6**
		Platform lifts		**1**
		Railings and Handrails		**4**
		Parking place		**2**
		Rest rooms		**3**
		Elevator		**5**
11. Health and safety problems		**Yes**		**No**
	Have you ever done any changes on the project design because of health and safety?	**50**		**50**
	Have you ever faced with health and safety problem on construction of the project design?	**16.7**		**83.3**

5.2.2.1 Ranking of the design team members' problems

To identify the problem types, the questions are arranged according to their contents as well as client's problems. Ranking of the problems are found considering the weight of answers by using same formula.

$$R = \frac{(N_a + A_a) + (N_b + A_b) + \ldots (N_n + A_n)}{(n)}$$

Equation 1: Problem Ranking Formula

On this equation, R represent ranking of the problems, N is respondent's negative answers, a,b ....n shows the related question numbers and A is the percentage of answer from participants such as almost, not sure etc. . Lastly, n shows the related total amount of questions. On this study the questions interpreted as detecting the problems during briefing and designing stage of the construction project design.

5.2.1.2 Analysis of the client's problems

Analysis of the problem ranking is made by the same formula. For instance, for the first problem of the design team members; the answers to the question from the respondents (the questions addressed according to the type of problem is shown on the table 5) for negative are 0% (N1), 16.7% (N2), and responses for almost are 3.3% (A1), 3.3% (A2). When the formula is used with respect to the values, R was found as 11.65 % and it is shown on the Table 5. All problems were ranked by using this way and also caused factor was mentioned to understand the level of influence on the construction project design stages.

As mentioned on the table 4, the problem with high rank 58.35 % is the problem number 4 'Uncoordinated design team members.' This problem may cause to failure on the design quality and project design timing and also it affects the budget of the client. To prevent the problem, design manager must keep the team members in his/her control.

Second common problem between design team members is the problem number 7 'Design team members' qualifications.' with 50 % rank. This problem may affect the construction project quality. As stated in the construction project size, project type and project complexity, the project manager should assign the team members by

considering their qualifications. At this point, the manager must clearly understand and be sure about the construction project' requirements.

The other problem with 50 % rank is the problem number 11 'Health and safety problems'. One of the most important considering points is the health and safety parameters on the construction project design. This topic concerns all the participants such as users, clients, project manager, labours, etc. To prevent that kind of problem all the possibilities should be considered at the beginning of the project design stage. Consideration of the possibilities requires being competent person on the work.

Problem number 2 'Lack of information on the contract.' is ranked as 47.80 %. Contracts must include all requirement information in it. There are standard forms of construction contracts in TRNC. However, if that kind of contract is not qualified for the current construction project then suitable specifications should be identified to arrange proper contract for the stakeholders.

Problem 10 'Insufficient functional project design.' is ranked about 46.66 % on table 4. According to this problem, 46.66 % of design team members do not consider some parameters on the construction project design. As mentioned on table 10, some questions are asked about project functionality such as parking places, public transportation locations, landscape design, rubbish collecting places and handicapped people. That kind of specifications should be considered on the construction project design to make the life easier for the users and also to estimate the actual cost of the project before doing any modification on the construction.

Problem number 9 is ‘Laxity on the legal procedures.’ and it is ranked 43.3% by participants on the questionnaire. Unfortunately, this problem cannot be totally prevented by the design team members or by the client. Only design team members’ experiment around construction projects gives some prediction skills to estimate the legal procedure’s delay time. Otherwise construction project design stage may extent.

Problem number 3 is ‘Weak site study by design team.’ and its rank is 41.10 %. This problem should be exactly prevented by design team members. Before starting to a construction project, site study must be done. Site study includes; area survey, ground survey and legal access. Otherwise project design may fail and that affects the budget of the client unnecessarily.

Problem number 6 ‘Insufficiency on the project design quality.’ is ranked 40 %. Understanding the client needs and users’ requirements are the most important things for the success of the project design. Misunderstanding or dismissing some details on the design stage may cause to decrease in quality of the construction. On this point communication between client and design team members plays a huge role to realize the needs of the project.

Problem 5 is followed by problem number 6 ‘Lack communication with client.’ by 33.30 %. Once again, the main problem is the quality of communication between the design team and the client. There is only way to eliminate the problem which is being planned. Construction project manager must arrange enough number of meeting and also the client should be informed about developments of the project.

Problem number 8 ‘To dispute with design team.’ is ranked about 30 %. As seen on the ranking it is not a common problem or unsolved one, although disagreements between client and design team affect the quality of the construction project design directly.

The last problem which is number 1 ‘Misinterpretation of client’s requirements on the project design by design team.’ is ranked 11.65 %. As remarked on the problem number 6, communication quality between stakeholders is very essential for achieving of the construction project design. The only responsible person here is the project manager.

Table 5: Ranking of the design team member’s problems

Statement	**Ranking (%)**	**Factor**
4. Uncoordinated design team members.	58.35	Quality
7. Design team members’ qualifications.	50	Time
11. Health and safety problems	50	Cost
2. Lack information on the contract.	47.80	Quality
10. Insufficient functional project design.	46.66	Cost
9. Laxity on the legal procedures.	43.3	Time
3. Weak site study by design team. • Area survey • Ground survey • Legal access	41.10	Quality
6. Insufficiency on the project design quality	40	Cost
5. Lack of communication with client	33.30	Time

8. To dispute with design team	30	Time
1. Misinterpretation of client's requirements on the project design by design team.	11.65	Quality

5.3 Results of the Briefing Design Stage Problems

In this study, some questions were prepared to analyse problems on the briefing design stage of the construction project between stakeholders. To identify the problems, the questions are arranged for both side clients and design team members. The problems are ranked according to their weight on the questionnaire results. The inputs are separated according to their affective factor on the construction project design such as quality, time and cost.

5.3.1 Handling methods for the client problems

As stated in the questionnaire result analyse, the main reason of the problems is the client's unawareness concerning the construction project design. The design team member's experience and knowledge is a big factor on eliminating these types of problems.

Construction sector has so many areas as mentioned before; residential constructions, engineering constructions, special-purpose building construction and institutional-commercial building constructions. For each of these areas, experience carries an importance in design quality. Whenever experience is not enough then some instruction method should be generated to prevent the problems. The generated instruction tool can be used by design team member or design manager to orientate the client with the best way during the construction project design stage. In summary there are two ways of handling client problems;

1. with enough experience of design team members,

2. an instruction tool for the design team members or design managers.

5.3.2 Handling methods for the design team members' problems

According to the result of questionnaire analysis, design team members have some problems among communication with the client and orientation of the client during construction project design stages. Briefing design stage is an essential element of the success on the construction project design. Managing this stage requires attention and experiment for the design team members or design manager. Experiment can be provided by working on different types of projects; attention can be supplied by awareness. To increase the design team members' or design manager's awareness about the construction project design stage, some instruction methods can be developed.

5.3.3 Instruction tool method for the design team members

The study results show us general problems have occurred when design team does not understand the client's requirements, client is not orientated by design team members well or design team members has not enough experiment about the construction project design type. To get these kinds of problems under control during the briefing design stage, an instruction method was developed by using 'expert system shell' on the computer platform.

5.3.4 Preventing briefing design stage problems by using expert system shell

For controlling problems during the briefing design stage, an instruction method is improved by using the expert system shell. The problems can be prevented by using Briefing Design Stage Instruction Expert System (BDSIES). On the system, needs of the briefing design stage steps are added by mostly getting inspired from 'Performance standards in buildings - Check list for briefing - Contents of brief for building design (BS 7832:1995 ISO 9699:1994) '. The aim of the British standards

check lists is to provide a standard framework for the briefing design stage which can be adapted for use with all types of building projects. The checklist helps to prevent the problems on the design process and similar checklist is implemented to the expert system shell by taking into account the weight of identified problems on the briefing design stage. Design team members or design manager are instructed by this system easily. Thus, the clients are orientated by design team members/design manager without doing any overlook or any mistake on briefing design stage of the construction project.

Firstly, the data schema is prepared by using yes/no instructions. Then that data schema was inputted to the expert system shell.

Chapter 6

DESIGN AND DEVELOPMENT OF EXPERT SYSTEM SHELL: 'BDSIES'

6.1 Introduction

This chapter explains Briefing Design Stage Instruction Expert System's (BDSIES) purpose, design and development progress, language, working order, user interface development and in addition validation of the BDSIES was done by using case studies method. The case studies have been done by an expert supervisory and novice comments.

6.2 'BDSIES' System Design

The BDSIEs has been designed to instruct the design team members in the briefing design stage of the construction project design. To design and develop the knowledge based expert system, the special knowledge field should be collected. The knowledge field is to be managed so that the data can be implemented in the computer program for easy use. The field of briefing design stage instruction service is an effective method for:

i) checking the order of the steps on the briefing design stage

ii) preventing the potential problems between stakeholders

iii) instructing the users about the construction design process

The purpose of this study is to present a method for preventing, controlling or instructing briefing design stage before any problem occurs. BDSIES focuses on to requirements of construction design stage processes on the sides of client and design team. The requirements are determined by the analysis of questionnaire results. The content of the briefing design stage instruction system is prepared as a chart method (Appendix B) then this chart is implemented to an expert system. BDSIES is a rule-based expert system which has been developed using the expert system shell: Microsoft Visual Studio 2015 software version 14.0.23107.0 D14REL. Figure 17 shows the basic structure behind the software.

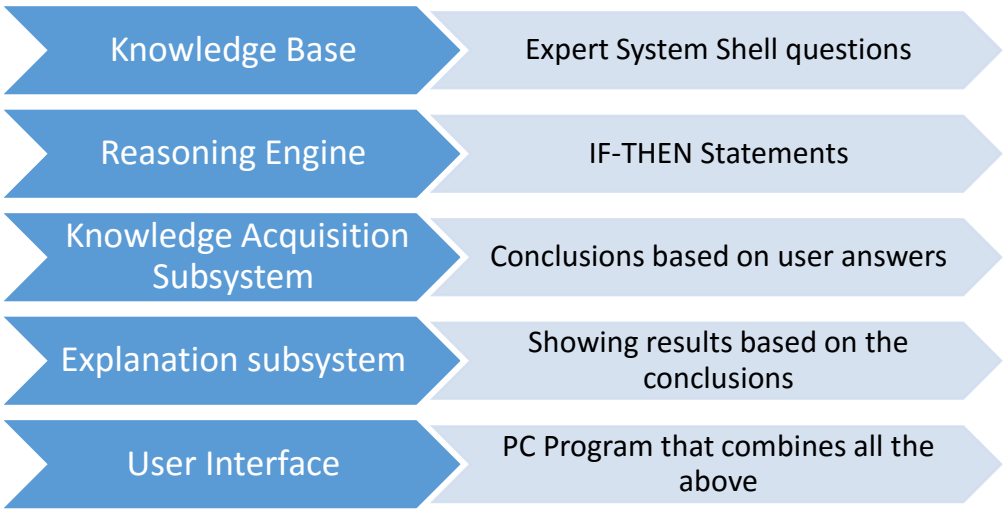

Figure 17: Expert System Shell – Software Skeleton

The software used in this study is designed specially to make use of the Expert Shell System in the construction management sector. It helps the user define the problem or the mistake in the project in easy and fast way by taking that experience into few steps/stages. Those are:

Knowledge Base

This is where the Expert System tools are located. Several questions that would lead the user to the final decision based on the given answers.

Reasoning Engine

A group of nested if-then statements that would recognize the answer of the user by simple yes and no and redirect it to the correct path.

Knowledge Acquisition Subsystem

This subsystem contains different conclusions for each answering sequence by the user. It takes the answers from the user as a whole and choose a pre-defined conclusion based on that.

Explanation Subsystem

This subsystem takes the conclusion from the previous analysing step and shows its contents to the user as a conclusion and guidance for the project to fix and set precautions for the defined problem by giving them some recommendations for that specific case.

User Interface

An interactive interface that gives the user a simple experience to read, answer, show and save the results of the system. It contains all the above stages working within its background and processing every single answer from the user based on some pre-set questions/conclusions (as shown in Appendix 2).

6.3 ‘BDIES’ System Development

The expert shell is written with that language, nested “IF … THEN” statements to choose which question goes next or which note to show. 48 IF-THEN statements were built in the BDSIES main module of the system. A brief description of these rules and their performing style are shown below.

Q1: Did you gather information about the location of the project from the client?

Yes / No

Q2: Did you request the land deed’s documents from the client?

Yes / No

Q3: Did you appoint the project’s category/type of use with the client?

Yes / No

Statement: Please, before starting to project design get the land registry documents from the client, then discuss about the category of construction. The system will work with this order;

IF: Q1 answer is Yes

THEN: go to Q3

Q1 answer is No

THEN: go to Q2

IF: Q2 answer is Yes

THEN: go to Q3

Q2 answer is No

THEN: show the Statement and STOP

IF: Q3 answer is Yes

THEN: go to Q4

Q3 answer is No

THEN: show the Statement and STOP

If answers to any of Q2 to Q3 are ‘no’ then the BDSIES module shows up the statement and stop running and lists movements that the user can see and check the answers one by one.

6.4 Integration of Modules and User Interface

In the design and development of the expert system shell: BDSIES, the system modules have been controlled to facilitate the system development and to validate the system. The user interface developed by using very simple theme (Figure 17). Also the theme of system has been designed in a way that anyone else can use it easily. There is not any complication on the interface. Answering question with ‘yes’ and ‘no’ will be enough to help the users on briefing design stage instruction.

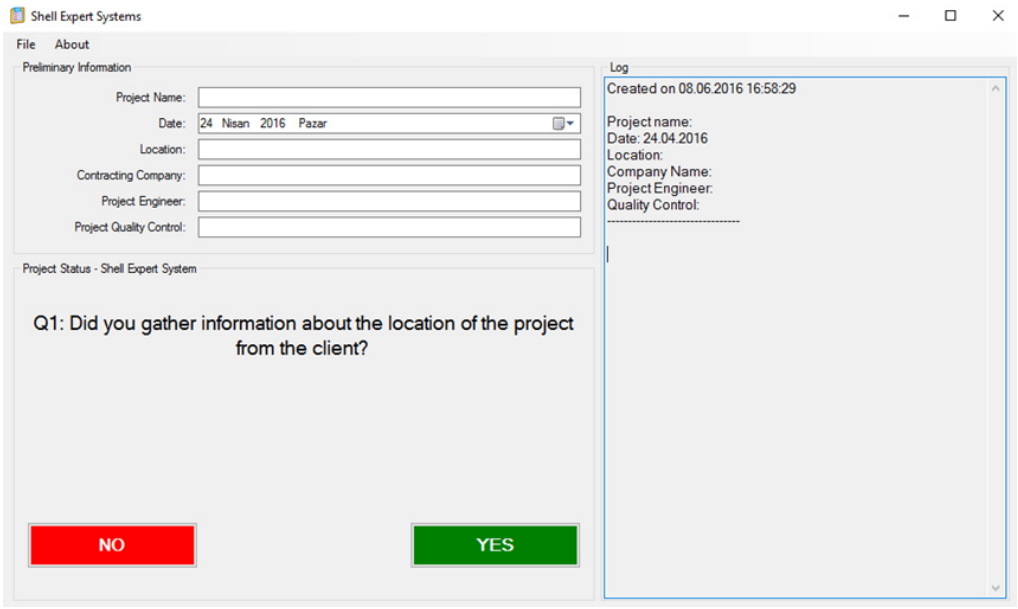

Figure 18: BDSIES user interface

6.5 Validation of BDSIES

Validation is a way to make decision for achievement of BDSIES and to be able to use it. If an expert system is not validated, this system's decisions can be weak or not enough. Validating the system makes the system more assurance and this affects the valuation of the BDSIES directly. Validation includes the following purposes:

(i) to establish the knowledge of BDSIES,

(ii) to establish the level of simplicity of the BDSIES for users

(iii) to analyse the instruction ability of BDSIES.

BDSIES has been validated with respect to case studies.

6.6 Case Studies

The case studies have indicated a valid result of BDSIES compared with assessment of a human expert and assessment of a novice user. On these processes the BDSIES has been checked if there is a problem with user interface and if BDSIES gives the best instruction on the any type of construction project design stages.

6.6.1 Case Study 1 – An Expert Supervisory

The BDSIES has been controlled by an expert who is a construction design company manager Arch. Cenk Basri. According to vocational knowledge of the expert, the questions contents and construction briefing design steps have been validated by giving some suggestions.

Briefing design stage check list has been controlled and on some point the instruction steps have been found inadequate by the expert. These points are generally about last stage of the construction design related with the payment of the construction project design cost. About this inadequate point some instruction questions were added to the BDSIES after the expert supervisory.

About BDSIES user interface, the theme has been found very simple and useable by the expert.

6.6.2 Case Study 2 – A Novice User Comments

Second case study has been done by taking a novice's comments on the BDSIES design and the system working manner. This control has been done by a student of architecture Ms. Hicret Efe from Eastern Mediterranean University.

The BDSIES has been run and controlled by checking answers of the questions one by one. According to her suggestion; for each project design case, answers should be saved as a file to see what is done and what is should be done on the next step. After taking her comment to the BDSIES a save tool was added. Except this point the BDSIES has been found very simple and useful for what is needed on briefing construction design stage.

After the case studies the instruction expert system BDSIES has been validated. The BDSIES can definitely be used by any construction design manager to check the construction design stage.

Chapter 7

CONCLUSION

7.1 Conclusions

This study aimed to ascertain the current briefing design stage problems between design team and client to develop a method for preventing the occurrence of the problems.

Briefing design stage problems were proved through analysing the questionnaire results. The problems are found out as;

1. Inopportune variation request on the project design by client,
2. Client's unawareness about the construction project design process,
3. Client's budget problems,
4. Client's confusion about the project design,
5. Lack of communication between stakeholders,
6. Misinterpretation of client's requirements by design team,
7. Insufficient functional project design by design team,
8. Inadequate qualifications of the design team members,
9. Laxity on the legal procedures,
10. Weak site study and
11. Dispute of the parties.

To get these types of problems under control during the briefing design stage, an instruction method is developed by using ‘expert system shell’ on the computer platform.

The expert system is named as a Briefing Design Stage Instruction Expert System ‘BDSIES’. The content of the briefing design stage instruction system is prepared as a chart method (Appendix B) then the chart has been implemented to an expert system. BDSIES is a rule-based expert system which has been developed using the expert system shell: Microsoft Visual Studio 2015 software version 14.0.23107.0 D14REL. The expert shell was written by using “IF … THEN” statements to select which question goes next or which note to show. 48 IF-THEN statements were built to instruct the design team in the main module of the BDSIES. The Briefing Design Stage Instruction Expert system is instructed the user by the questions. The system has been worked by following the questions with ‘yes’ and ‘no’ answers.

The system is validated to establish the knowledge of BDSIES, to establish the level of simplicity of the BDSIES for users and to analyse the instruction ability of BDSIES by direction of a human expert supervisory and a novice person comments.

The BDSIES user interface and its theme are designed with very simple and useable way to be able to use by any of construction design manager for checking the briefing construction design stage parameters. As a conclusion in this study;

- briefing design stage problems’ resources was found out,
- briefing design stage problem’s types was investigated,
- BDSIES (a checklist) was developed and

- The understanding of the purposes and activities in the briefing design stage was improved.

7.2 Recommendations

This study has demonstrated a useful as well as helpful checking system in the briefing design stage which can be quite powerful in preventing the common briefing design stage problems. For further researches with regards to this topic, suggestions are as follows:

1. Development of the BDSIES for different type of construction separately.
2. Development of the BDSIES for each of design team members separately.

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APPENDICES

Appendix A: Surveys

SURVEY FOR CLIENTS

Name and surname :	
Age :	
Gender :	
Education :	
Job :	

1. Do you have any idea about the architect's professional function on designing of project?

Yes		**No**		**Almost**	

2. Do you have any idea about the civil engineer's professional functions on designing of project?

Yes		**No**		**Almost**	

3. Do you have any idea about the mechanical engineer's professional functions on designing of project?

Yes		**No**		**Almost**	

4. Do you have any idea about the electrical engineer's professional functions on designing of project?

Yes		**No**		**Almost**	

5. Have you appointed with this design team before on any other projects?

Yes		**No**		**Almost**	

6. Do you know building regulations about use of land?

Yes		**No**		**Almost**	

7. Have you investigated any similar project before?

Yes		**No**		**Almost**	

8. Do you have any opinion about the briefing design stages on a project?

Yes		**No**		**Almost**	

9. Have you investigated the design team, before starting the design of project?

Yes		**No**		**Almost**	

10. Is that design team recommended by someone to you?

Yes		**No**		**Almost**	

11. Are you aware of any designed project by that design team?

Yes		**No**		**Almost**	

12. Are you the main sponsor of the project?

Yes		**No**	

13. Is that design team have any experience on your desired type of project?

Yes		**No**		**Almost**	

14. Are you aware of the variation on the project budget (cost), how affect the projects design stages?

Yes		**No**		**Almost**	

15. Are you aware of the variation on the project design (quality), how affect the project design stages?

Yes		**No**		**Almost**	

16. Do you know anything about cost estimation for type of projects?

Yes		**No**		**Almost**	

17. Have you discussed budget of project with your design team?

Yes		**No**		**Almost**	

18. Have you discussed the availability of using technologies on the design with the design team?

Yes		**No**		**Almost**	

19. Have you discussed the availability of using materials on the design with the design team?

Yes		**No**		**Almost**	

20. Have you discussed the availability of skilled labours on the design with the design team?

Yes		**No**		**Almost**	

21. Have you provided all documents about project?

Yes		**No**		**Almost**	

22. Do you have any idea about duration of legal proceedings for building plot?

Yes		**No**		**Almost**	

23. Do you have any idea about required process for infrastructure?

Yes		**No**		**Almost**	

24. How long does a construction design process take?

2 weeks		**4 weeks**		**6 weeks**		**8 weeks**		**12 weeks**	

25. Could you attend all the arranged meeting with designed team?

Yes		**No**		**Almost**	

26. Do you want to work again with the same design team on another project?

Yes		**No**	

27. Who is the responsible from the future variations on the project design?

Any design team	

The project design team	

SURVEY FOR DESIGN TEAM MEMBERS

Name and surname :	
Age :	
Gender :	
His/her job :	
His/her position in the work :	
His/her experience on the work :	
Name of design company :	

1. Do you think you can manage the designing works required by client?

Yes		**No**		**Almost**	

2. How quickly you respond to the client questions?

immediately	

on my free times	

when it comes to my mind	

3. Do you visit the project land as a project manager before the designing?

Yes		**No**		**Sometimes**	

4. Do you require the geo-technical report before finalizing project design?

Yes		**No**		**Almost**	

5. Do you think that town planning is fair on every point of the project design? If it is not, please explain?

Yes		**No**		**Almost**	

6. Do you think is that there is applicability of rules about parking places on the project design?

Yes		**No**		**Almost**	

7. Do you consider the location of project is suitable for public transportation?

Yes		**No**		**Almost**	

8. Do you consider pollution regulations on your project designs?

Yes		**No**		**Almost**	

9. Do you consider the landscape on your project designs?

Yes		**No**		**Almost**	

10. Do you consider a special rubbish collecting place on your project designs?

Yes		**No**		**Almost**	

11. Have you ever done any changes on the project design because of health and safety?

Yes		**No**	

12. Have you ever faced with health and safety problem on construction of the project design?

Yes		**No**	

13. Do you do any attachment on the project design for handicapped people?

Yes		**No**	

14. If it is yes, could you rate the attachments according to their importance on the construction project? (7 – most important, 1- important)

Ramps **Sufficient space for wheel chair** **Platform lifts**
Elevator **Parking place** **Railings and Handrails**
Rest rooms

15. How much important the user needs on the project designs?

Mostly		**Normally**		**Lightly**	

16. Do you face with any problem about right of using building plot on the construction project design?

Yes		**No**		**Almost**	

17. If it is yes, please explain the type of problem?

18. Do you think that the contract signed by designing team has enough efficiency?

Yes		**No**		**Almost**	

19. Do you think that the contract signed by client has enough efficiency?

Yes		**No**		**Almost**	

20. Did you face with any problem on the contract at previous work?

Yes		**No**		**Almost**	

21. If it is yes, please explain problems.

22. How many meetings do you arrange for the project design requirements with client?

2 times		**5 times**		**To many**	

23. Do you get any feedback from your clients?

Yes		**No**		**Almost**	

24. If it is yes, could you rate of the clients' pleasure?

Highly		**Normally**		**Almost**	

25. How clients recourse to you? Please rate the methods according to their priority?
(5-mostly, 1-rarely)

Recommendations of ex-client's relatives
A project reputation made by that design team
Recommendations of construction companies
Success of the projects' design
Success of the design team

26. How often do you do correction on the project design due to lack of communication between design team members?

Mostly		**Rarely**		**Never**	

27. How often do the design team members come together?

At 1month more than 6times		**At 1 month 4times**		**At 1 month 2times**	

28. What kind of problem brings about by inexperienced design team members? Please explain the problems.

29. Do you take site engineers opinion on the project designs?

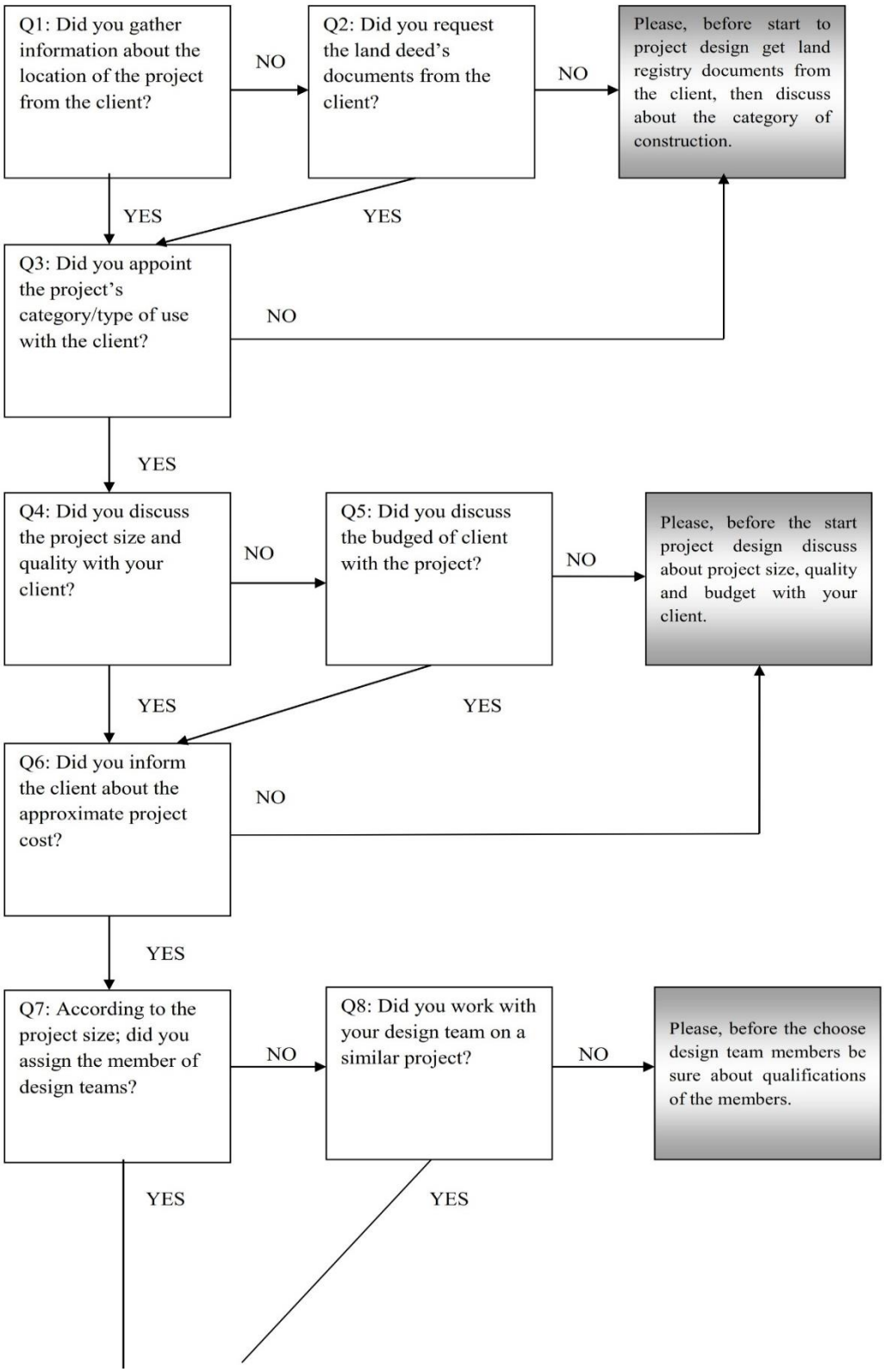
Yes		**No**		**Almost**	

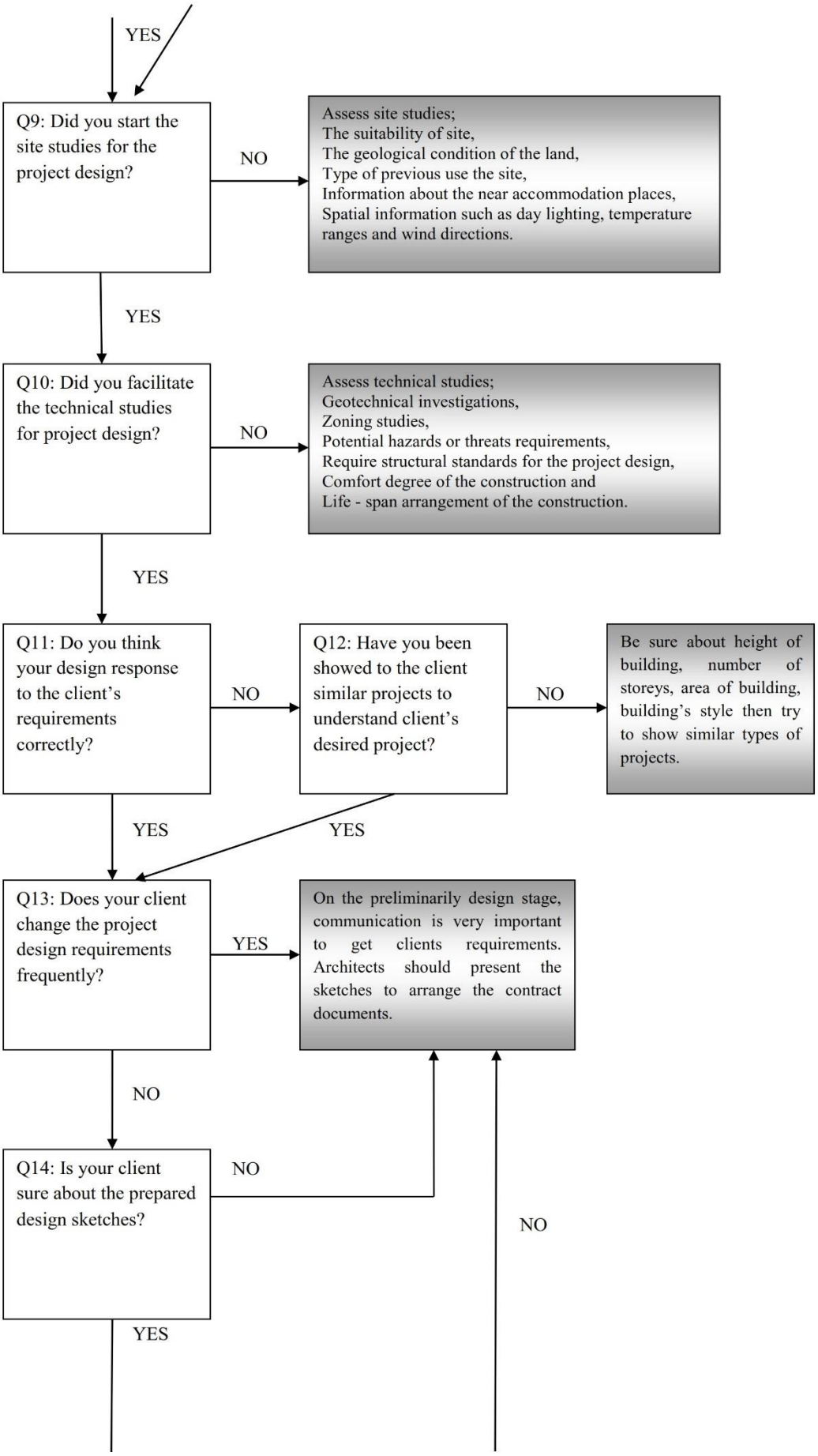
30. If it is yes, after taking their opinion, what kind of modification doing on project design please explain.

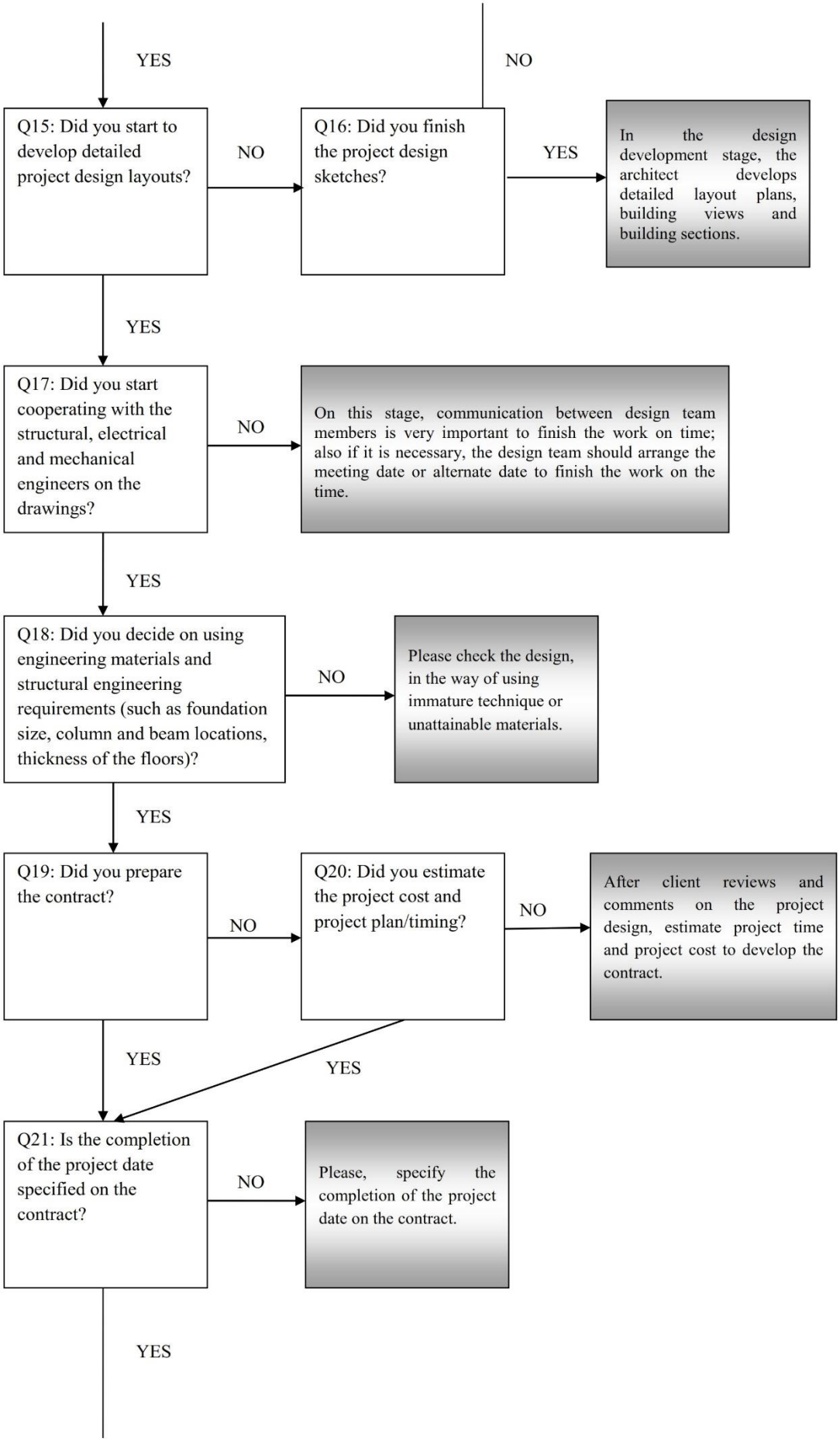
31. How often do you faced with the problem about laxity in legal procedures?

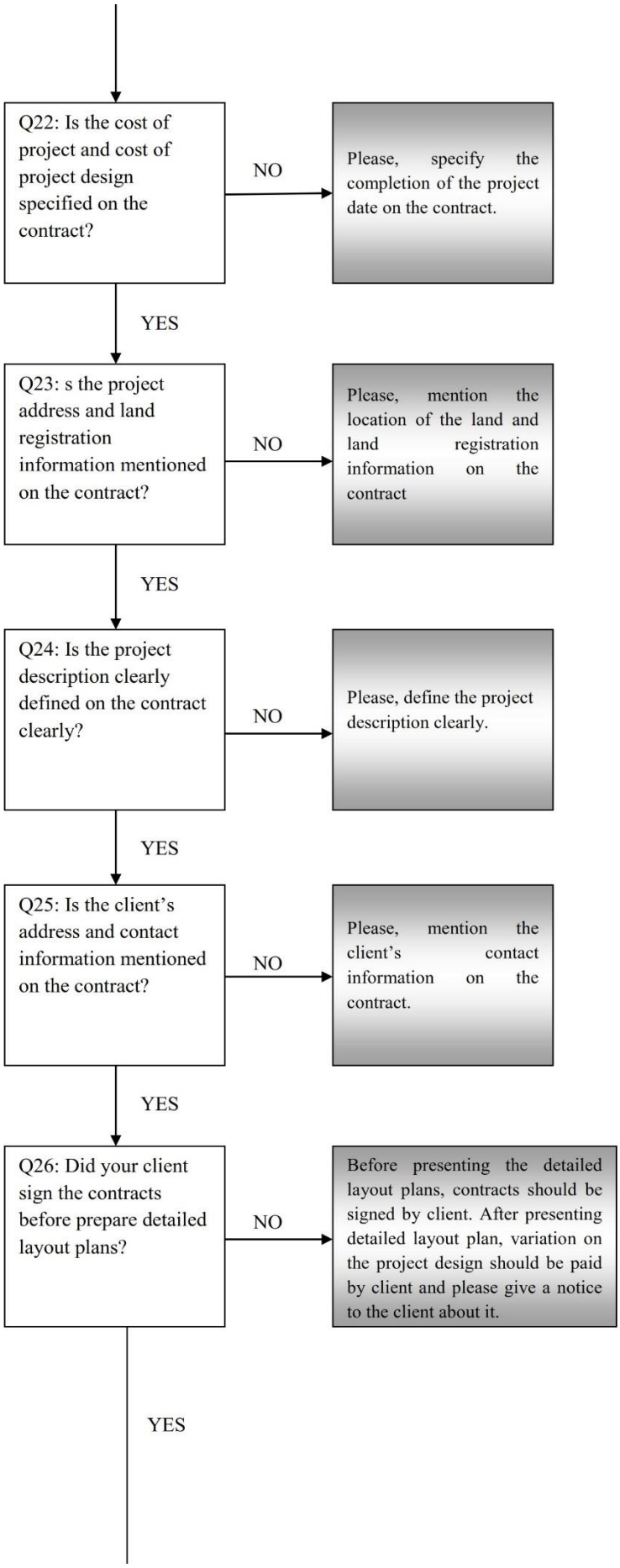
Mostly		**Rarely**		**Never**	

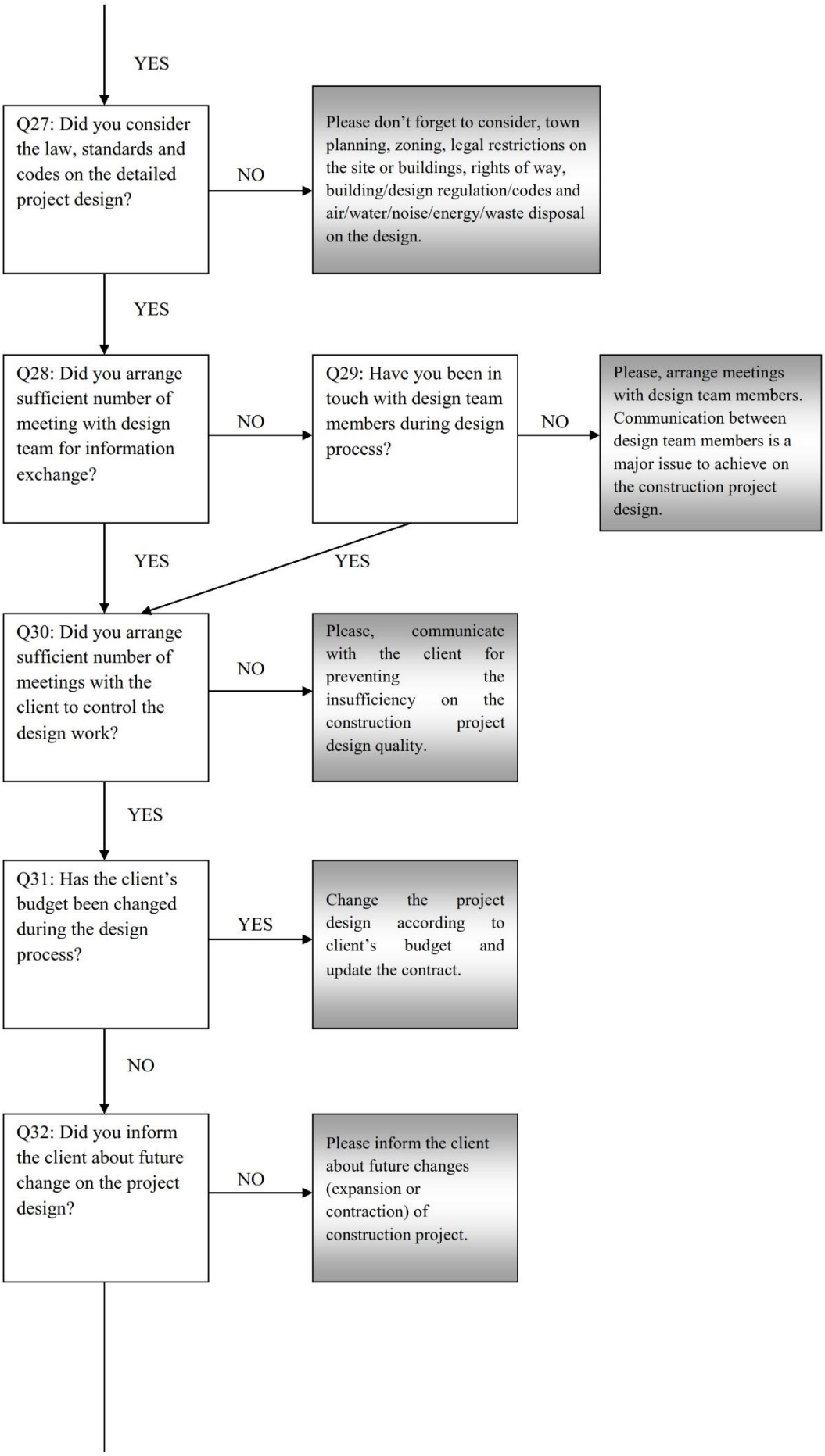
Appendix B: Expert System Shell Questions

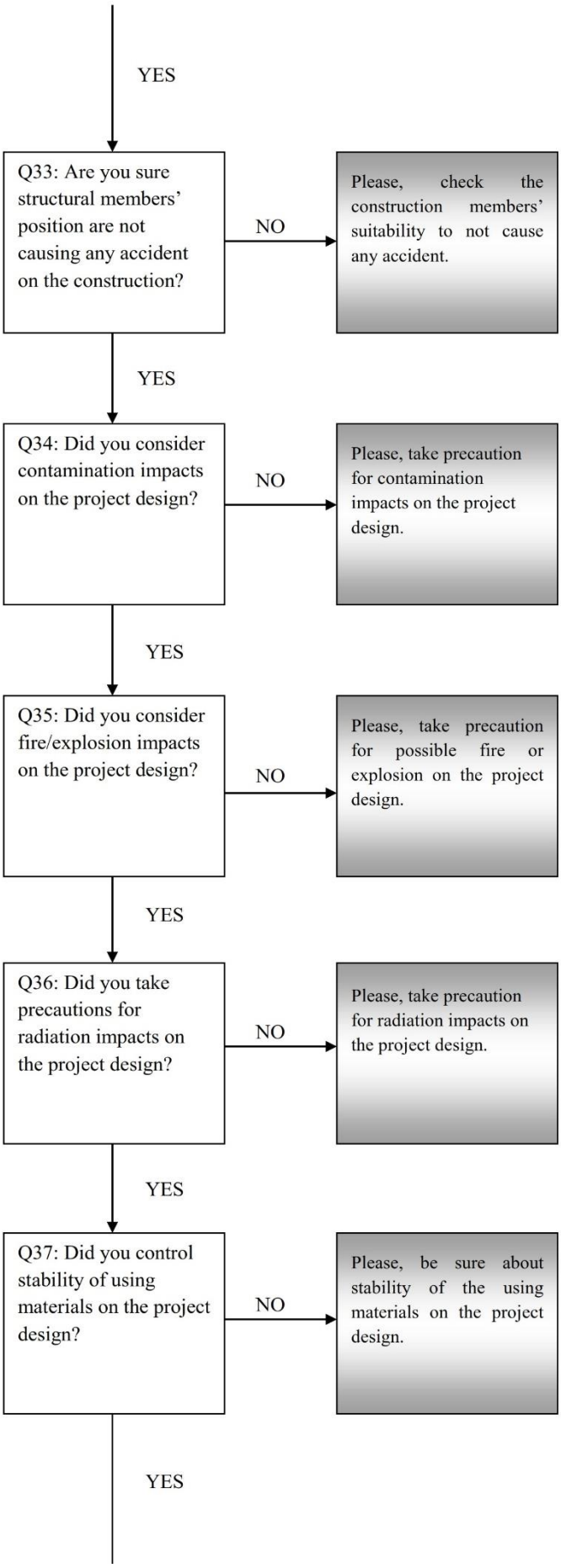


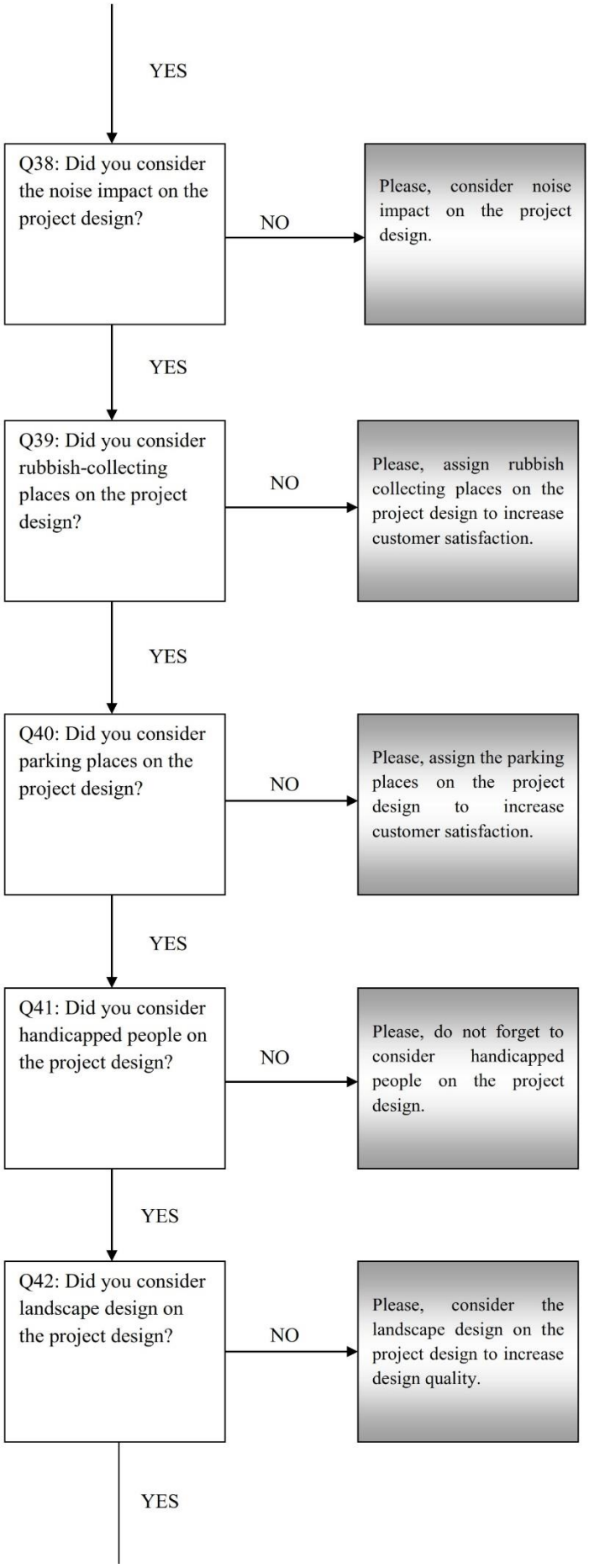

YES
Q9: Did you start the site studies for the project design?
NO
Assess site studies;
The suitability of site,
The geological condition of the land,
Type of previous use the site,
Information about the near accommodation places,
Spatial information such as day lighting, temperature ranges and wind directions.
YES
Q10: Did you facilitate the technical studies for project design?
NO
Assess technical studies;
Geotechnical investigations,
Zoning studies,
Potential hazards or threats requirements,
Require structural standards for the project design,
Comfort degree of the construction and
Life - span arrangement of the construction.
YES
Q11: Do you think your design response to the client's requirements correctly?
NO
Q12: Have you been showed to the client similar projects to understand client's desired project?
NO
Be sure about height of building, number of storeys, area of building, building's style then try to show similar types of projects.
YES
YES
Q13: Does your client change the project design requirements frequently?
YES
On the preliminarily design stage, communication is very important to get clients requirements. Architects should present the sketches to arrange the contract documents.
NO
Q14: Is your client sure about the prepared design sketches?
NO
NO
YES

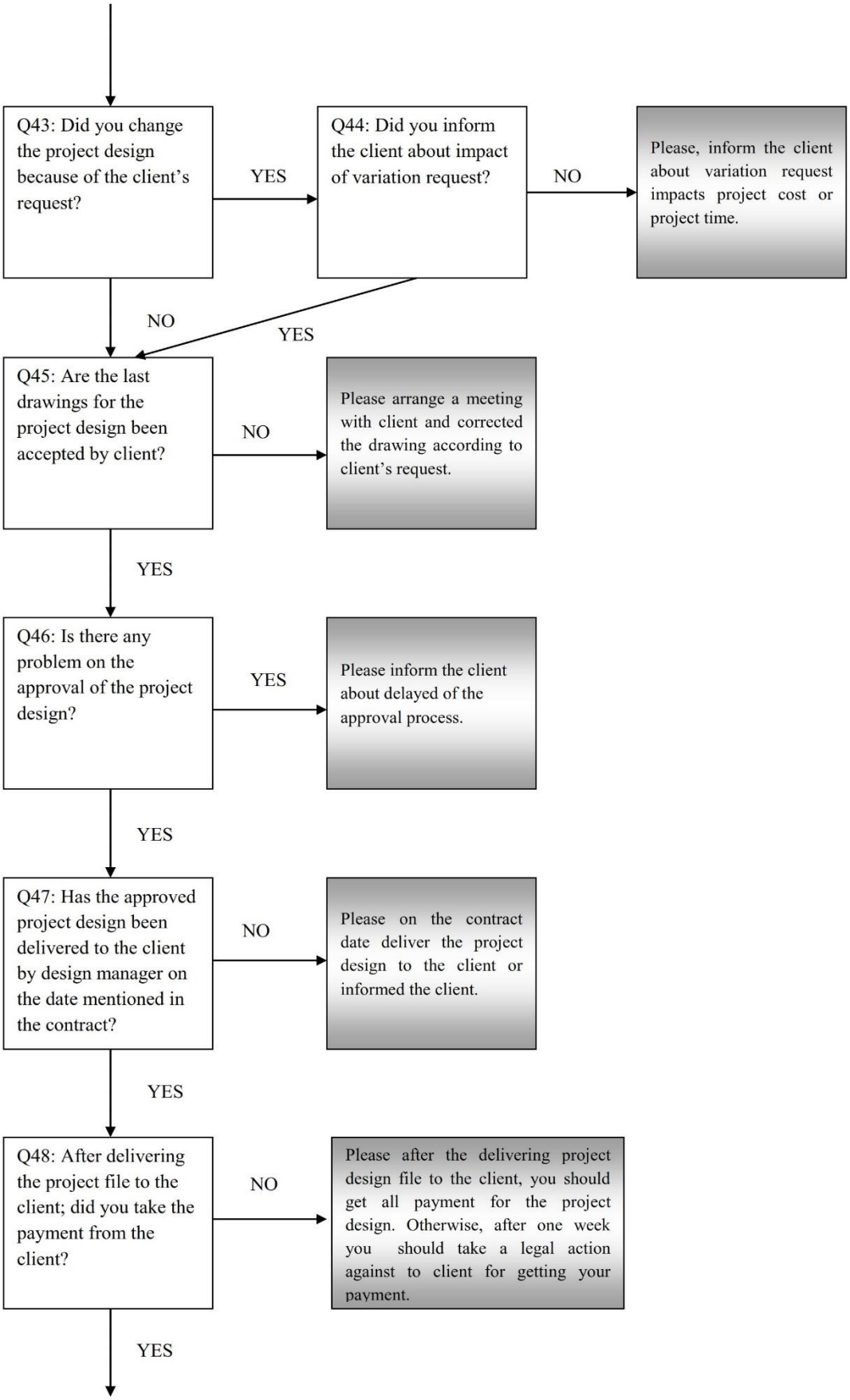

YES
NO
Q15: Did you start to develop detailed project design layouts?
NO
Q16: Did you finish the project design sketches?
YES
In the design development stage, the architect develops detailed layout plans, building views and building sections.
YES
Q17: Did you start cooperating with the structural, electrical and mechanical engineers on the drawings?
NO
On this stage, communication between design team members is very important to finish the work on time; also if it is necessary, the design team should arrange the meeting date or alternate date to finish the work on the time.
YES
Q18: Did you decide on using engineering materials and structural engineering requirements (such as foundation size, column and beam locations, thickness of the floors)?
NO
Please check the design, in the way of using immature technique or unattainable materials.
YES
Q19: Did you prepare the contract?
NO
Q20: Did you estimate the project cost and project plan/timing?
NO
After client reviews and comments on the project design, estimate project time and project cost to develop the contract.
YES
YES
Q21: Is the completion of the project date specified on the contract?
NO
Please, specify the completion of the project date on the contract.
YES


Q22: Is the cost of project and cost of project design specified on the contract?
NO
Please, specify the completion of the project date on the contract.
YES
Q23: s the project address and land registration information mentioned on the contract?
NO
Please, mention the location of the land and land registration information on the contract
YES
Q24: Is the project description clearly defined on the contract clearly?
NO
Please, define the project description clearly.
YES
Q25: Is the client's address and contact information mentioned on the contract?
NO
Please, mention the client's contact information on the contract.
YES
Q26: Did your client sign the contracts before prepare detailed layout plans?
NO
Before presenting the detailed layout plans, contracts should be signed by client. After presenting detailed layout plan, variation on the project design should be paid by client and please give a notice to the client about it.
YES


YES
Q27: Did you consider the law, standards and codes on the detailed project design?
NO
Please don't forget to consider, town planning, zoning, legal restrictions on the site or buildings, rights of way, building/design regulation/codes and air/water/noise/energy/waste disposal on the design.
YES
Q28: Did you arrange sufficient number of meeting with design team for information exchange?
NO
Q29: Have you been in touch with design team members during design process?
NO
Please, arrange meetings with design team members. Communication between design team members is a major issue to achieve on the construction project design.
YES
YES
Q30: Did you arrange sufficient number of meetings with the client to control the design work?
NO
Please, communicate with the client for preventing the insufficiency on the construction project design quality.
YES
Q31: Has the client's budget been changed during the design process?
YES
Change the project design according to client's budget and update the contract.
NO
Q32: Did you inform the client about future change on the project design?
NO
Please inform the client about future changes (expansion or contraction) of construction project.


YES
Q33: Are you sure structural members' position are not causing any accident on the construction?
NO
Please, check the construction members' suitability to not cause any accident.
YES
Q34: Did you consider contamination impacts on the project design?
NO
Please, take precaution for contamination impacts on the project design.
YES
Q35: Did you consider fire/explosion impacts on the project design?
NO
Please, take precaution for possible fire or explosion on the project design.
YES
Q36: Did you take precautions for radiation impacts on the project design?
NO
Please, take precaution for radiation impacts on the project design.
YES
Q37: Did you control stability of using materials on the project design?
NO
Please, be sure about stability of the using materials on the project design.
YES


YES
Q38: Did you consider the noise impact on the project design?
NO
Please, consider noise impact on the project design.
YES
Q39: Did you consider rubbish-collecting places on the project design?
NO
Please, assign rubbish collecting places on the project design to increase customer satisfaction.
YES
Q40: Did you consider parking places on the project design?
NO
Please, assign the parking places on the project design to increase customer satisfaction.
YES
Q41: Did you consider handicapped people on the project design?
NO
Please, do not forget to consider handicapped people on the project design.
YES
Q42: Did you consider landscape design on the project design?
NO
Please, consider the landscape design on the project design to increase design quality.
YES


Q43: Did you change the project design because of the client's request?
YES
Q44: Did you inform the client about impact of variation request?
NO
Please, inform the client about variation request impacts project cost or project time.
NO
YES
Q45: Are the last drawings for the project design been accepted by client?
NO
Please arrange a meeting with client and corrected the drawing according to client's request.
YES
Q46: Is there any problem on the approval of the project design?
YES
Please inform the client about delayed of the approval process.
YES
Q47: Has the approved project design been delivered to the client by design manager on the date mentioned in the contract?
NO
Please on the contract date deliver the project design to the client or informed the client.
YES
Q48: After delivering the project file to the client; did you take the payment from the client?
NO
Please after the delivering project design file to the client, you should get all payment for the project design. Otherwise, after one week you should take a legal action against to client for getting your payment.
YES

Please, be sure about pleasure of the client and keep in contact with the client during implementation of the construction project design