An Investigation of Building Construction and Materials Issues in Northern Iraq for Residential Projects

Hasan Samih Kakamam Kalwry

Submitted to the
Institute of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Master of Science
in
Architecture

Eastern Mediterranean University
March 2017
Gazimağusa, North Cyprus

Approval of the Institute of Graduate Studies and Research

Prof. Dr. Mustafa Tümer
Director

I certify that this thesis satisfies the requirements as a thesis for the degree of Master of Science in Architecture.

Prof. Dr. Naciye Doratlı
Chair, Department of Architecture

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Architecture.

Assoc. Prof. Dr. Halil Z. Alibaba
Supervisor

Examining Committee

1. Assoc. Prof. Dr. Halil Z. Alibaba

2. Asst. Prof. Dr. Polat Hançer

3. Asst. Prof. Dr. Nazife Özay

ABSTRACT

Building construction and materials constitute one of the biggest sectors of the Northern Iraqi construction industry as housing construction is one of the largest sectors in Iraqi cities projects. At present, the construction industry is perceived to include high-risk factors. Considering its inherent characteristics, the riskiness of the industry becomes even more apparent. In the design phase, the selection of appropriate construction materials is essential for the success of the project as a whole. The main aim of this research is to determine the factors most influential for the successful construction of buildings and the selection of materials for residential projects in Northern Iraq. The methodology of this research is mixed, employing both qualitative and quantitative approaches in the form of observation, interviews, and an extensive questionnaire survey which was sent to 132 architects experienced in residential construction project with 60 architects responding. The collected data was analyzed using SPSS and Microsoft Excel. The study discovered an apparent inability amongst architects to translate their information and awareness into suitable design implementation in Northern Iraqi residential projects. According to the results, all the important factors were ranked based on their effects such as an unwillingness to change the conventional ways of construction. On the other hand, most of the problems encountered in the residential buildings relate to the lack of a foundation design, wall cracking, and roof moisture in Northern Iraqi projects.

Keywords: Residential Building, Construction Materials Selection, Architectural Experience, Construction Problems, and Northern Iraq.

ÖZ

İnşaat yapimi ve malzemeleri Kuzey Irak inşaat sektörünün en büyük sektörlerinden birini oluşturmaktadır ve konut inşaatı düşünüldüğünde, Irak şehir projeleri için en büyük sektörlerden biri olduğunu görülmektedir. Günümüzde inşaat endüstrisi, yüksek risk faktörlerini içerdiği bilinmektedir. Doğal özelliklerini düşündüğümüzde, bu endüstrinin riskliliği daha da belirgin hala geldiği görülmektedir. Tasarım aşamasında, uygun inşaat malzemeleri seçimi, projenin bir bütün olarak başarısı için büyük bit önem arz etmektedir. Bu araştırmanın temel amacı Kuzey Irak'taki konut projelerinde başarılı bina inşaatları ve malzemelerinin etkili faktörlerini belirleyip bulmaktır. Bu araştırmanın metodolojisi, hem niteliksel hem de niceliksel yaklaşımları, gözlem, mülakatlar ve kuzey Irak'taki mimarlara yönelik kapsamlı bir anket çalışması şeklinde kullanmaktadır. Hazırlanan bu kapsamlı anket, konut projelerinde uzman 132 mimara gönderilmiş olup, bunlardan 60 mimar anketleri doldurarak bize göndermiştir. Toplanan veriler SPSS ve Microsoft Excel kullanılarak analiz edilmiştir. Bu çalışma, mimarların bilgi ve farkındalıklarını Kuzey Irak konut projelerinin uygun tasarım uygulamalarına aktarma konusunda açık bir yetersizliklerinin olduğunu bulmuştur. Elde edilen sonuçlara göre, projenin başarısı adına geleneksel yol belirleme konusunda kı isteksizlikler gibi temel faktörler ele alınarak sıralanmıştır. Öte yandan, konutlardaki sorunların çoğu, Kuzey Irak projelerinde temel tasarımı, duvar çatlaması ve çatı nemi eksikliği olduğu anlaşılmıştır.

Anahtar Kelimeler: Konut İnşaatı, Yapı Malzemeleri Seçimi, Mimari Deneyim, İnşaat Sorunları ve Kuzey Irak

DEDICATION

This modest effort dedicated to the prophet of this world and its shining lights Muhammad (Peace be upon him), and the source of kindness my Mother, Father, Grandfather, sisters and brothers whose unconditional love and care is the source of my strength to accomplish this long.

ACKNOWLEDGMENT

"In the Name of God, Most Gracious and Most Merciful"

First of all, I am very grateful to God for helping me to achieve this work. The writing of this thesis work would not have been possible without the guidance and support of the following persons. I would like to express my thanks and appreciation to my supervisor Assoc. Prof. Dr. Halil Zafer Alibaba for the continuous and support of my thesis study, for his motivation and patience. Besides my advisor Assist. Prof. Dr. Nazife Özay, I would like to thank the thesis committee members. I am so thankful to sixty professional Architects who gave their valuable knowledge and time to participate in my lengthy questionnaire. This research would not have been completed without you. Thank you all. Very special thanks to my parents Dr.samih Kalwry, Kafia Kalwry, and my grandfather Haji Kakamam Kalwry who gently displayed me support and unconditional love throughout my life. I also thank my sisters, my brothers and Safen, Ahmed and Didar for their continuous encouragement. Lastly, I would like to express my appreciation to all those friends in North Cyprus and North Iraq, who supported and helped me, during all the study.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

Chapter 1

INTRODUCTION

In chapter one, a discussion on the background of building construction and materials for a residential project are presented. Following that, the research problem, as well as the main aims and objective of this research are provided. The chapter conclude with a clarification of the methodological approach and structure of the thesis.

1.1 Background of the Study

The methods used in modern construction differ greatly from those used when the early human began to erect shelters. The lack of machinery meant that the entire process was carried out using basic human labor, which acted in conjunction with the challenges that arose from insufficient design information. In the proceeding centuries, however, construction methods have improved in materials especially with the development of new technologies. Contemporary technological advancements have led to automation and prefabrication construction methods becoming prevalent in many countries. It is noteworthy however that, although the automation of the industry has led to a decreased level of human input, humans still play an important role in the industry, and as such, mistakes still do occasionally occur (Alwi et al., 2001).

Every architectural project has a unique character emerging as a result of the numerous components of which it is composed; building materials constitute one such component. A great number of architecture projects such as the works of Kengo Kuma,

Herzog, and Demeuron, serve as examples of how the selection of building materials determines what kind of structure can be built, as well as the character of the building.

At present, a growing diversity of materials is available for the construction of buildings as per the architect's design. Several criteria have to be taken into account in deciding between materials from criteria. As a general rule, every selection process must adhere to one simple requirement: finding the best materials for the particular project in question (Fernandez, 2006). Deciding what materials best suit the particular needs requires an understanding of the design preceding it. Furthermore, a productive selection process depends on the architects being presented with all relevant information to guide them in the decision-making process.

Performance requirements in construction refer to the expectations that people have from the building. The performance requirements of any given construction project may differ from client to client as none of them enjoy absolute primacy and some performance requirements are more salient than others. Regardless, there is consistency among architects regarding the importance of performance requirements (Yitmen and Alibaba, 2005).

The residential house is one of the most important parts of human's social life, and it is the very widely referenced example of a construction industry. While it might be portrayed as risky, time-consuming, costly, complex, etc., residential projects are also vibrant, stimulating innovative designs, attracting capital, and technological advancements. The housing sector in particular, in the world's developing economies, is one of the most prevalent sectors within the construction industry (Ahadzie et al., 2008).

1.2 Problem Statement

The use of new techniques and proper methods in residential buildings and materials in the construction industry still faces many challenges to execution in Northern Iraqi construction projects.

Various researchers have worked on topics concerning success in building construction and materials in different fields including construction technique, building problems, materials selection, etc., such as research conducted of, Didenko and Konovets (2009) “Success Factors in Construction Projects: A Study of Housing Projects in Ukraine”. AL-Shwani (2011) “Influence of Modernity versus Continuity of Architectural Identity on House Facade in Erbil City, Iraq (Doctoral Dissertation, Thesis. Universiti Sains Malaysia. Penang)” etc.; nevertheless, these are not sufficient.

In spite of the fact that different researchers have explored the various phases of building construction and materials issues, very few have done so in regards to residential building construction and materials. Furthermore, there is an apparent gap between conventional construction and materials evaluation techniques as well as the integration of more modern techniques into the decision-making process. Bridging this gap requires that current assessment methods should be thoroughly updated with construction development incorporated into the decision-making processes in residential projects in Northern Iraq.

1.3 Aim and Objectives

The major aim of this thesis is to investigate and identify a list of the main problems in construction projects and materials in residential projects in Northern Iraq, according to the occupants and the perceptions of architect's who work in building construction in Northern Iraq. The scope of this research is related to building construction and materials problems in the building components of Northern Iraqi residential projects, to which end the research focused on three main components: Foundation, Wall, and Roof.

The objectives of this thesis are:

a) To investigate the existing problems of building construction and materials in Northern Iraqi residential projects.
b) To investigate the reasons for said problems in residential building construction and materials in Northern Iraqi projects.
c) To recommend some solution to the problems faced by the professional architects, impeding success in residential projects in Northern Iraq.

In line with the objectives of the research, the questions the research aims to answer can be summarized as follows: What is the gap in building construction and materials for residential projects in Northern Iraq and how can it be improve? Moreover, what is the level of awareness in building construction and materials of Northern Iraqi architect and how does this affect decisions in design?

1.4 Research Methodology

The influence of the research methodology on the outcome of the research undertaken cannot be overemphasized. It is important to choose a research methodology suitable for the specific research objectives to ensure their attainment and the validity of research outcomes (Fellows and Liu, 2015).

According to Naoum (2012), the strategy of any research may be defined as the manner through which the objectives of the research may be realized. Qualitative and quantitative research methods constitute the two overarching strategies employed by researchers (Naoum, 2012) resulting in data in the form of either narrative information (qualitative) or numerical values (quantitative) (Polit and Beck, 2004). Objective in nature, quantitative research may be defined as an inquisition into reality by a hypothesis or theory made up of variables, represented by numbers, and manipulated using numerical, analytical procedures (Polit and Beck, 2004).

This research involves both qualitative and quantitative data, as it combines both research methodologies. Following an exploration of the relevant literature is a thorough review of previous research and current practices in the field of building construction and materials, and the impact of architects' design decisions as they relate to projects in Northern Iraq and architects' awareness.

1.4.1 Data Collection Techniques and Questionnaire Design

The collection of the data was divided into three parts. In the first part of data collection, a questionnaire was distributed to in local architects Northern Iraq and occupant to investigate the building construction and materials practices in residential buildings. The second part involved interviews with the same architects to discuss the

problems that faced them during the construction of a residential house in Northern Iraq. Likewise, the third part involved field observation of some residential projects in Northern Iraq in various stages and specifying and determining the problems faced in reality by taking photographs.

The questionnaire of this research was prepared on the basis of:

- A review of the literature.
- Interviews with 60 architects and 40 occupants to obtain various ideas.
- The experience and skill of the architects who practice and work in the field of building construction and materials in Northern Iraqi residential projects.

The questions in the questionnaire survey were divided into four sections as follows:

- Section one: General information on architects.
- Section two: Awareness in building construction and materials for a residential project in Northern Iraq.
- Section three: Building elements in residential building construction and materials for a residential project in Northern Iraq.
- Section four: Occupant questionnaire in residential building construction and materials.

The questionnaire was created in English and Kurdish versions to enable them to be easily understood by the architects. The duration of the data collection for this research, including the questionnaire, simultaneous interviews, and observations conducted on site, was between May and September, 2016.

1.4.2 Data Coding and Analysis

Using computers for data analysis necessitates the coding of responses into numerical figures before the data analysis can be carried out (Weisberg et al.,1996) to enable the researcher enter the data methodically and proficiently. The data collected for this research was recorded in the Statistical Package for Social Sciences (SPSS) and checked both manually and electronically to guarantee data purity.

The statistical analysis was carried out in SPSS by:

- Outlining and coding various variables.
- Aggregating the data in a raw data sheet.
- Inputting the data into the program.
- Cross-checking the data.

Following the steps mentioned above, descriptive statistics were used to paint a picture of what trends exist within the data (Naoum, 2012). In this research, frequency (F), percentage (%), mean (M), standard deviation (S.D.) and ranking were used to describe aspects of the data set. These methods were used because a large amount of data was gathered. Generally, it is beneficial to split the information into categories and define the percentage of every category; this is named "category frequency" (Weisberg et al., 1996). For this project, the data and subsequent results were presented in tables, bar, and pie charts.

1.4.3 Sample Size and Response Rate

Babbie (1990) notes that sampling is essential due to temporal and other limitations on obtaining population data. Achieving a depth of understanding regarding the specification process requires an enhanced understanding of the persons who exert considerable influence on the process of choosing between building and construction

materials. This study is concerned with two groups of decision makers involved in the building process: the architects and their respective occupants who are understood to be the traditional determinants (Emmitt and Yeomans, 2008).

The Directory of Architects Registration Board estimate that over 1163 architects are currently employed in Northern Iraq with about 60% working in small or medium-sized private practices. Majority of the remaining 40% tend to be employed by industrial organizations or commercial firms (e.g. manufacturing, finance, retail, local government, etc.). Due to the implausibility of collecting data from such a large population, a sample was necessary. To determine the appropriate sample size for this study, the formula provided by Czaja and Blair (1996) was adopted:

$$\text{S. S.} = \frac{z^2 * p\,(1-p)}{c^2}$$

Where:

s.s. = Sample Size.

z. = Standardized Variable (when 95% confidence level and z. = 1.96).

p. = picking choice percentage, which is 50 % (or 0.5).

c.= Confidence Interval (c. = ±8% for this research).

$$\text{S. S.} = \frac{1.96^2 * 0.05\,(1-0.05)}{0.08^2} = \frac{3.8416 * 0.25}{0.064} = 150 \text{ Architects}$$

Consequently, the sample size for this particular questionnaire should be 150 architects. However, this figure needs to be corrected for the finite population of architects in Northern Iraq. Using the formula contained in Czaja and Blair (1996):

$$\text{True S. S.} = \frac{ss * pop}{ss + pop - 1} = \frac{150 * 1136}{150 + 1136 - 1} = 132 \text{ Architects}$$

Where: Pop = Population (Architect)

Following Takim et al., (2004) who state that a conservative rate of response lies between 30% - 40%, the appropriate sample size for the survey was:

$$\text{Survey S. S.} = \frac{True\ S.S.}{respone\ rate} = \frac{132}{3.33(30\%)\text{ or }(40\%)} = \text{40-55 Architects}$$

Following these re-evaluations, the size of sampling remained approximately 40 to 55 architects. The Iraqi construction industry's response rate to questionnaires of surveys is also an average of 30 – 40% (Takim et al., 2004).

Architects from the Northern Iraqi Architects Registration Board were randomly selected to provide an amalgamated list comprised of at least 132 architects. 132 questionnaires were distributed according to the sample selected and a response rate ~45%, 60 questionnaires were returned. According to Takim et al. (2004); Akintoye (2000), a response rate of ~45.5% acceptable. They contend that the average response rate for postal questionnaires in the construction industry stands at 30-40%. Other researchers, such as Vidogah and Ndekugri (1998); Ofori (1990), also reported 45% response rates as reasonable.

1.5 Thesis Structure

This thesis is arranged into five chapters:

Chapter one is the thesis introduction. It concentrates on the background of the study, aim and objectives, as well as the methodological approach of this study. Chapter two is a literature review of building construction and materials. Chapter three provides an overview of the condition of the building construction and materials in Northern Iraq projects. Chapter four describes data collection as well as discussions and analysis of the results. Chapter five contains conclusions and recommendations for future research.

Chapter 2

BUILDING CONSTRUCTION AND MATERIALS

2.1 Construction Industry

The contemporary construction sector is relatively vast encompassing various stages including building design, renovations, and the production of construction materials. A combination of science and art, the industry is understood to be competitive as well as risky. Success in this industry is not dependent only on an understanding of the technical aspects of construction but also on the knowledge of the business and management aspects of the job. Furthermore, technological advancements and global competition in this sector have led to the accelerated development of construction techniques and material selection procedures (Nunnally, 2004).

Globally speaking, the construction industry, according to Pheng and Hongbin (2004) was one of the earliest economic sectors to be internationalized and can be traced back to over a 100 years ago. Similarly, Ngowi, et al., (2005), observed that construction in previous societies relied on resources from the environment such as land a climate. It was a communal endeavor in which all members were involved in creating a shelter which reflected their knowledge of the indigenous climatic setting and expertise of the capabilities of the available materials. Bernold and AbouRizk (2010) view the construction industry as a collection of various businesses engaged in interrelated activities. Nam and Tatum (1989) view construction as historically referring to all activities related to the production and restoration of stationary structures. In the same

view, Ling et al., (2007), describe construction as a process that involves the production of physical substructures, superstructures, and their associated facilities. The term construction can be understood to refer to the resources used in the process itself, the products of construction processes, and the economic as well as functional qualities of materials used in building and construction industries (Ofori, 1990).

The first human settlements were constructed using mud, stone, and other materials sourced and provided shelter from "the elements" (Ngowi, et al., 2005). These shelters were constructed using methods that were the product of numerous experiments, experience, and the accidents of generations of constructors whose work was either utilized or discarded.

The eighteenth-century industrial revolution ushered in a host of large scale developments. The construction industry however was not significantly affected in this era but did develop in the 19th century with great progress in the advancement of construction materials, especially cast iron, wrought iron, and later, steel which allowed for the construction of structures like bridges, railways, building frames, portland cement, reinforced concrete, glass used for large glazed envelopes, steel-framed buildings, and other construction activities products (Ofori, 1990).

2.2 Construction Materials

One major element of any construction project is the materials to be used in the construction process. The cost of the materials alone usually sits at about 50 % or more of the total cost of projects (Stukhart, 1995) despite the fact that factory costs constitute a minor 20-30%, or even less. The reason for this discrepancy is that the manufactured items are warehoused, transported, and restored before they are finally utilized at the

site construction. The total cost of the materials is comprised of the manufacturers selling cost, the cost of obtaining the materials (placing cost, processing, and payment of the materials, transportation, and physical distribution), and the costs site-handling (disposal, storing, dispensing and cost of unloading). Obtaining and handling materials efficiently plays a role in the completion of a project successfully.

2.2.1 Materials in Architecture

> Good architecture is not just about primary functions. You must also take into account secondary and tertiary functions, and even beyond that. Space is never about one thing. It is a place for many senses: sight, sound, touch, and the unaccountable things that happen in between. – Tadao Ando (cited in Auping et al., 2002).

The majority of materials perform more than one function. Selecting materials for a project goes beyond practical demands as the material's exterior appearance and sensory appeal also matter to the design process (Ashby and Johnson, 2013; Fernandez, 2006). When choosing a material, the architect also takes into consideration certain performance properties – durability, compression strength, etc. as well as aspects related to the sensory appeal and occupants experience e.g. color and visual consistency. Furthermore, the architect could also envision a specific ambiance that the materials need to emanate – like 'formal' in a lawyer's waiting room, or a 'trendy' feeling for a lounge bar. The swarm of materials options now available to designers and architects has made it necessary that the traditional categorization of materials be re-evaluated (Malnar and Vodvarka, 2004).

2.2.2 Importance of Materials

Material-related issues may be found in any organization. The effective regulation of materials is pivotal to every company's success as it relates to the completion of any project. Accounting for 50% – 55% of the total cost of the project (Stukhart, 1995),

materials is a big part of any project. They are critical to the operation of every industry as a lack of materials could halt operations. Additionally, the unavailability of materials could also adversely affect productivity and cause other problems. Conversely, an excess of materials could also create problems such as increasing the cost of storage; re-handling costs could also go up as well.

In the late 70's, companies in the construction industry experienced a decrease in productivity and a simultaneous increase in cost which was attributed to inflation and other economic issues. Upon further investigation, however, it was revealed that an inefficient use of resources was responsible for rising costs while poor management was the cause of decreased productivity (Stukhart, 1995).

2.2.3 Materials Information

Numerous handbooks and websites contain various lists outlining the properties of various materials. Many of the sources tend to concentrate on the materials' performance techniques with little attention being paid to the aesthetic and experimental aspects. Conventional selection materials in architecture seldom consider issues related to sensory experience and perception. Furthermore, most selection tools require that the architect is well acquainted with the technical aspects of the materials which somewhat limits the productive use of design aids (Alibaba, 1999).

The materials aspects of design are seen to be growing consistently (Ashby and Johnson, 2013; Fernandez, 2006). This interest does appear to be rather arbitrary and does not display a clear link between the actual materials and the way the architects consider or work on these materials. The individual architect's thought process is never actually made tangible, neither are the intangible properties of the materials themselves objectified.

In contrast to architecture, a substantial body of work has been carried out with a focus on the experience of the products materials, their nature and the different phenomena present in the industrial design field (Desmet and Hekkert, 2007; Schifferstein and Cleiren, 2005). Karana and Van Kesteren (2006) note that in addition to the outward properties of materials, individuals also take non-physical characteristics (e.g. sensorial appeal) into account.

2.2.3.1 Lack of Information

In addition to functionality, designers also consider the experience of the design. In architecture, the objects in an environment are also believed to shape occupants experience in that environment, and for this reason, materials' appearance and sensory appeal are taken into account in addition to technical compatibility (Fernandez, 2006; Ashby, and Johnson, 2013). Overall, the architect takes into account the functional and aesthetic characteristics of materials when deciding between them for a particular environment.

The process of selecting materials for a project involves, in addition to technical requirements, taking into account appearance and sensory appeal while designing (Ashby & Johnson, 2013; Fernandez, 2006). Although, the architect considers functional characteristics (e.g. durability and compression strength), he also considers properties that are related to the occupants' experience or sensory stimulation (e.g. color or texture).

Although current materials catalogs provide information on the technical properties of materials, little attention is paid to their intangible elements which are also important to the architects. Ashby and Johnson, (2013) introduce "aesthetic attributes" within a

list of materials' properties for architects in addition to other aspects such as transparency, softness or warmth.

2.2.3.2 Technological Problems

The use of materials and machinery in the construction industry has been considerably less than in manufacturing due to its labour-intensive nature. There has however been a recent trend towards the increased use of equipment in construction made essential by the growing demand for shorter construction times and the scale of contemporary projects. Furthermore, equipment tends to be minimal so as to realize maximum returns on the usually substantial investments (Gann and Salter, 2000).

2.2.3.3 Materials Selection Issue

Historically, the primary concern in the materials selection process has been minimizing cost. From the 1930's onwards, however, it became evident that materials choices should not be made purely based on cost considerations (Kishk et al., 2003). A poorly erected structure financially drains the client for the entirety of its existence, and while the architects have no vested interest in the structure and are not liable for its occupants related performance, the client has an interest in minimizing long-term costs (Sorrel, 2003).

For this reason, there is an increasing emphasis on whole life costs of structures in the public-sector regulation of construction procurement and best-practice texts (Sorrell, 2003). Established materials evaluation methods utilize Life Cycle Cost Analysis (LCCA) as the principal method of the decision-making process especially in public sector projects (Alibaba and Ozdeniz, 2016; Alibaba, 2016). LCCA is an evaluative method used in economics to assess the aggregate expense incurred on an asset over the entirety of its operational life. It includes the initial capital costs, maintenance and

operation costs, as well as the eventual cost of discarding said asset (Utne, 2009). It is a useful tool for deciding between alternative materials (Durairaj et al., 2002).

In conclusion, the successful functioning of the self-sustaining finance systems for building construction requires the convergence of three factors: income levels of the particular socio-economic category, real estate pricing that is affordable for the selected group of people, and available financing at affordable interest and maturity rates (Alibaba and Özdeniz, 2004).

2.3 Housing Construction

A construction project from its onset has specific properties and constraints regarding specifications, processes, and duration (Drewer, 2001). The construction industry is also composed of various stakeholders, a developed procurement system, and the end products are not necessary customized. These characteristics make it distinct from other industries and thus somewhat incomparable (Toor and Ogunlana, 2008). Giving its inherent uniqueness, it follows that specific factors should lead to success in construction projects. Moreover, Liu (1999) highlight that specific priorities for a given project, environmental conditions, etc. give each project a specific list of success factors which cannot be transposed to another project.

Similarly, Toor and Ogunlana, (2008) claim that the factors identified to be important for different projects might affect each project in a different way. While the construction industry is different from the production and service industries, some common features relevant to the other industries are also applicable to the construction industry as construction projects also deal with technical, financial, and human issues, as in other industries (Toor and Ogunlana, 2008).

2.3.1 Housing Typologies

Human settlements include the most suitable typologies which allow for several forms of tenure combined with a variety of building types (Trubka, and Glackin, 2016). The main types of housing are:

a. Detached House: (stand-alone building bordered by undeveloped land);
b. Semi-detached house (a house which is connected to another building on one of its sides);
c. Cluster housing: (a typology based on a technique in which detached houses are relatively close together with open spaces left as shared areas and common facilities are provided; this typology could result in high concentrations particularly suitable for urban areas);
d. Townhouse (house within a row of similar houses that are joined together on each side - except on the two ends of the row - with one or more floors; townhouses are suitable for medium to high-density neighborhoods, and for low-to mid-rise developments);
e. Apartment building: (a building comprising more than two floors with at least one housing unit on each and is used principally for residential purposes).

2.3.2 Housing Principles

The following minimum building principles shall be ensured in the design, engineering and construction of a building:

a. Structural stability;
b. Safety and disaster risk mitigation;
c. Accessibility, including for people with disabilities;
d. Efficient and effective use of resources;
e. Energy efficiency and renewable energies; and Environmental soundness;

f. Weather resistance and Rain and surface water harvesting;

g. Natural lighting and ventilation standards;

h. Hygiene and sanitation standards for all building categories;

i. Parking quantity and design standards;

j. Durability through maintenance.

2.4 Housing Policy

2.4.1 Policy Principles

General principles of housing policy are:

a. In the same vein as various international declarations such as the Istanbul Declaration of June 1996, the Millennium Development Goals, 2002, and the World Summit on Sustainable Development, 2002, the government considers housing to be a basic right for all its citizens. In line with this, it aims to provide basic infrastructural facilities for the populace as well as access to decent housing (NUHP 2008);

b. The Government commits to recognize all peoples, particularly women, children, handicapped people, people living in poverty, the vulnerable and any other disadvantaged groups, as well as their rights;

c. The Government acknowledges the necessity of dealing with housing in an all-inclusive manner and incorporating all social, economic and environmental elements equally, while guaranteeing access to basic infrastructure, social and environmental protection, avenues for individual/collective growth and development, and ensuring public health and safety;

d. The Government recognizes the need to provide forms of housing affordable to people of all income strata via a number of access schemes;

e. The Government acknowledges the importance of good management for the sustainability of human settlements. Such 'good management' shall also include encouraging forms of housing and settlement planning that undertake the planning and permitting cycles valid in the country;

f. The Government recognizes that the proper management of urbanization must involve the increased availability of housing options with respect to citizens' needs while underwriting their socio-economic development and at the same time easing any negative impact on the environment;

g. The Government stresses the significance of the rational management of land resources in any planning and decision-making venture;

h. The Government recognizes the importance of preserving a cultural identity within the development process and the larger framework of globalization; as such, it supports unique local architecture, space organization, and the use of local materials and technologies;

i. The Government stresses the need for a transition to cooperative development while moderating public expropriation for land development and ensuring the participation and integration of all individuals contributing resources to housing development;

j. The Government expects housing programs to stimulate local employment and entrepreneurship creation, the development of skills in the local construction sector, and wealth creation to the benefit of all citizens.

2.4.2 Policy Objectives

This policy has the following objectives:

a. To, through cooperation with the private sector, develop adequate available housing by addressing the issues of administration, affordability, efficiency,

availability, financing schemes, saving, neighborhood and settlement design and development as a means of creating adequate living spaces through supervised physical development such as those aimed towards meeting the service needs of the residents and upgrading informally established settlements (NUHP 2008);

b. To encourage the development of individual income generation and increased purchasing power by addressing off-farm employment, SME creation, employer incentives, labor-intensive programs, urban pull-factors and mixed use settlements, saving for housing, and the pooling of personal resources;

c. To ensure food security and support urban-rural linkages by addressing the efficient use of land, communal planning and cooperative development, suitability of housing typologies, urban agriculture for continued subsistence on transformed land, and protection of rural agricultural resources and the environment;

d. To increase social inclusion, dignity, empowerment, and wealth creation by addressing issue with youth employment, women empowerment, the inclusion of society's lowest segments, and social cohesion;

e. To increase knowledge and productivity by addressing regional competitiveness and in-country productivity, the quality of locally produced materials and construction, development of technology and research, and the advancement of skills across the country;

f. To use available resources conscientiously towards the continued wellbeing of future generations by addressing long-term environment-related issues with resource-efficiency always remaining a foremost consideration in development and all endeavors geared towards the protection of the environment through

the implementation of green growth and green building schemes and principles.

2.4.3 Local Construction Materials

This policy supports the use of local construction materials. Emphasis should be on an increase of the quantity of material, its quality, and on competitive costs of locally produced products (Aubin, et. al 2016).

The following are some of the approaches employed in pursuit of these ends:

- To meet the required quality of materials, the institution responsible for materials standardization shall ensure construction-specific certification procedures for the performance and quality of materials;
- Competitive costs will be achieved through larger production and high efficiency in production, which will require investment support to local entrepreneurs, capacity building, and investment into research of materials life cycles the suitability of processed products. Given the demand for housing units, local supply will not only require primary construction materials, but also finishing materials, and equipment, such as equipment of sanitary rooms, for purposes of macroeconomic balances of imports versus in-country purchases;
- The production of construction materials will be environment-conscious in regards to any energy input required, carbon dioxide output reduction, and labor creation.

2.5 Main Elements of a Residential Building

All of the building elements are crucial to any structure and thus garner considerable attention in the design and construction phases in regards to their functions (Alibaba, 2003).

1: Foundation: is the most important part of any structure as faulty foundations tend to be the primary cause of felled buildings. The primary purpose of the foundation is to distribute the buildings projected weight safely to the soil below. Its basic functions are:

a. To distribute total load to the earth and prevent a building from every movement.
b. To distribute the weight of the structure evenly to prevention unequal settlement.
c. To counteract a lateral movement.
d. To provide a stable base to lay the brickwork and structure supporting.

2: Walls: the basic function of walls is the demarcation of spaces. A load-bearing wall as a structure in a building, however, should provide; Strength, Fire Resistance, Weather Resistance, Stability, Insulation (sound and heat), and Security and Privacy.

3: Basement, Ground, and Upper floors: the primary function of the floor is to carry the buildings human and materials elements. Due to spatial limitations, buildings are often divided into different floors (levels) to generate more space the floor should provide:

a. Stability and strength
b. Resistance of dampness and durability

c. Sound and heat insulation
d. Fire resistance

4: Doors and windows: the doors link the internal parts of the building and allow for unrestricted movement between the building and outer areas while windows allow for aeration and illumination of the building. They should serve the following functions:

a. Weather resistance
b. Audio and thermal insulation
c. Moisture and termite resistance
d. Resilience and fire resistance
e. Security and privacy

5: Roofs: it is the topmost part of a building and serves the functions of enclosing the building and protecting its interior from weather elements. A sturdy roof is as important as a sturdy foundation. A suitable roof provides.

a. Strength and stability –should be strong enough to withstand anticipated load.
b. Weather resistance –should be able to endure rain, snow, wind, etc.
c. Sound insulation –should provide sufficient isolation from external sound.
d. Heat insulation –should be provide adequate heat insulation.
e. Fire resistance –should be adequately resistant to fire.
f. Daylighting –should provide natural lighting to buildings with large floor areas through a window within the roof.

6: Stairs and Steps: a stair is a structure consisting of steps that lead from floor to another floor of the building. The primary stairs functions include:

1. Providing a means of moving between different floors.

2. Providing a means of escape in times of emergency.

To implement those functions, stairs need to have:

a. Stability and Strength– the stairs need to be steady sufficient to carry the load expected.
b. Fire resistance – materials used for the stairs should be resistant to fire damage so as to make them a viable means of escape in a fire emergency.
c. Sound insulation – if necessary, the stairs should be isolated from sound either using their design or by separating them from the main building.
d. Comfort and convenience – the suitable design of and appropriate placement of stairs in a building should offer the convenience of movement, natural lighting and ventilation, safety in an emergency, as well as a host of other advantages.

7: Finishes: various types of finishes may be applied on walls including paint, plaster, decorative color washing, etc. The primary functions of a finishing include:

a. Protecting the structure from the sun, rain, snow, etc.
b. Providing an aesthetically pleasing uniform surface for the structure.
c. Concealing flawed artistry.
d. Concealing the unattractive materials used in building structures.

Chapter 3

BUILDING CONSTRUCTION AND MATERIALS SITUATION IN NORTHERN IRAQ

3.1 The Historical Background of Northern Iraq

The Kurdistan region of Iraq is a large and mountainous plateau, located in the Middle East. It is distributed over four neighboring states, North-eastern Syria, South-eastern Turkey, Northern Iraq, and North-Western Iran. The official language, Kurdish, is spoken in Sorani, Badini, and Hawrami etc. and Islam is the dominant religion in the area (Nooraddin, 2012). Iraqi Kurdistan covers approximately 40,000 square kilometers of land, (KRG, 2013a). The Kurdistan region of Iraq has a rapidly increasing population, estimated at more than 5 million, by the Kurdistan Regional Government (KRG, 2013b). The Kurdistan region of Iraq consists of 3 cities where Kurds make up approximately 90% of the total population living in these urban centers. The region comprises three governorates: Erbil, Sulimaniah, and Duhok (KRG, 2013b). The region is experiencing an imbalance in the distribution of urban communities and according to the ministry of planning, 83.4% of Kurdish citizens live in cities (Ismael and Ngah, 2010). these three cities have has passed through rapid transformations after Iraq's liberation in 2003.

Figure 1: Maps of Northern Iraq
Source (http://www.freeworldmaps.net/asia/iraq/location.html-2016)

3.2 Climate of Northern Iraq

According to Köppen's climate classification system, Northern Iraq is situated in a 'transitional climate zone' between the Mediterranean climate (Csa) and the Arid climate (Bwh). This climatic zone is characterized by summers where temperatures range from relatively warm to really hot, with temperatures rising beyond 50^{o}C in the hottest part of the day during summer, and cold winters with low temperatures although sub-zero temperatures are rare in cities. The summers are extremely dry while the winters are fairly wet with Northern Iraq receiving an average of 300-400 millimeters of rain per annum during the months of October and April. The average annual relative humidity of Northern Iraq stands at 35% (Kurdistan's climate, 2010).

3.3 Construction Sector in Northern Iraq

The construction industry is very clearly vital to the economy of Northern Iraq. The region's fastest growing sector, private firms lie at the center of the construction industry in Northern Iraq. There are, however, issues that need to be tackled to simplify the construction process, draw investment and technological transfers, expand know-how, become more transparent, and ensure a competitive edge (KRG, 2013 a). Without the input of human capital and technology transfers, it is impossible for the

construction sector to flourish. The improvement of engineering and technological education, providing foreign experience for professionals, building state of the art construction laboratories, and improving health and welfare in the industry requires that considerable attention be directed towards these areas. Moreover, without competitive salaries, the loss of professionals will continue and the Kurdistan Region will be unable to sustain the growth in the construction sector.

An analysis of the construction industry in Northern Iraq would involve an inquiry into the magnitude of, and level of advancement of the industry in the region. Additionally, it would also look into the price, use, and properties of construction materials used in the industry; and the three segments of the industry: institutional/commercial (such as supplementary non-housing), housing, and social projects (e.g. roads, bridges, etc.). A variety of other aspects, such as the local labor market, land procurement practices, human capital investment, building codes, site development, building permits, and quality maintenance criteria, should be analyzed as well (KRG, 2013 b).

The Northern Iraqi government has faced some challenges in the building construction and materials sector including:

a. Inexperienced technicians, managers, and engineers;
b. No quality control measures being applied to the materials used by the industry;
c. An increased need for inexpensive housing attributed to population transfers via immigration and the return of displaced persons; and
d. The focus of contractors on upscale homes for the wealthy rather than an evenness of cheap housing disseminated across all income strata.

3.3.1 Size of the Construction Sector in the Northern Iraq

The construction sector is a major part of the Kurdistan Region's economy because of its size and its influence on other sectors. The construction sector is a consistent contributor to employment generation and the gross domestic product of the region. The fastest growing sector of the region, the construction sector is centred around private firms and is valued at approximately $2.8 billion, 65% of which is estimated to be controlled by Turkish companies (Heshmati, and Baban, 2014).

The Erbil Contractors Union (ECU), a part of the Kurdistan Contractors Union, reports that approximately 2,500 construction contractors currently operate within the Kurdistan Region: 533 in Dahuk, 835 in Sulaymaniyah, and 963 in Erbil. There are 169 foreign members, of whom 151 are Turkish and 18 are Iranian. The majority of Turkish firms establish partnerships with their Kurdish counterparts in the Region (Tas and Tanacan, 2008).

3.3.2 Growth of the Construction Sector in the Northern Iraq

The construction industry has experienced considerable growth in recent years due to general economic growth and the wave of migration of numerous Arab Iraqi professionals and their families to Northern Iraq. The internal migration from other provinces in Iraq since 2003 is estimated at 15,000 families to Erbil and 38,000 to Sulaymaniyah. Assuming that the average family consists of four people, the population increases stand at 4.5% in Erbil and 9.4% in Sulaymaniyah leading to subsequent increases in the demand for housing and other infrastructure (Heshmati, and Baban, 2014).

3.3.3 Productivity of the Construction Sector in the Northern Iraq

The construction industry of a country/region usually accounts for ~10 % of its gross domestic product; this percentage is usually lower in developed countries than in developing countries. In the majority of developing countries, there is a tendency to view the manufacturing industry as the primary driver of job creation; as a result, the construction industry receives substantial attention as a stimulator of economic development. Surprisingly, the technology employed in the construction industry has scarcely changed in decades putting the industry at a disadvantage in comparison to other industries where productivity has been improved by technological advancements. The productivity of the industry does not depend on individual activities but the industry as a whole as it is a diverse sector of the national economy involving an array of scarce resources (Heshmati, and Baban, 2014).

Some of the factors that exert an influence on productivity in the industry include: the superiority of the workforce; the administration systems in place; the intricacy of the projects; the quality of the final product; the enthusiasm of the workforce; the degree to which processes have been mechanized; the type of contractors employed; weather conditions during construction; buildability; and the forms of practices used in construction.

It is necessary that the needy segments of society, such as the poor, refugees, and internally displaced peoples, are the central focus of public sector housing generation activities as overall production by the public sector is expected to decrease. These trends are represented schematically in the following graphic.

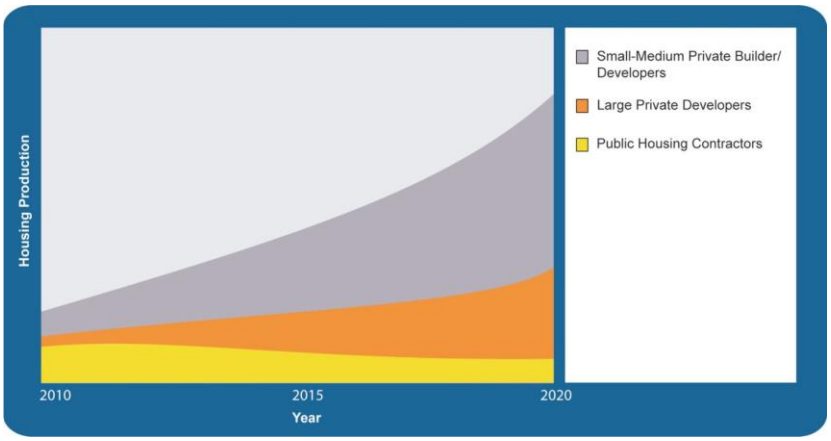

Figure 2: Evolution of Housing Production in Northern Iraq 2010-2020
Source: (MOCH, 2010)

Figure 2 makes the distinction between small-medium builder/developers and large developers because although the latter are under-represented in Northern Iraq today, they can make a much larger contribution to housing creation in the future. In fact, there is a continuum along builder/developer size. A new approach should be employed whereby private housing firms of all sizes are encouraged such that the involvement of larger developers, as well as medium-sized ones, is encouraged in an effort to make a range of various company sizes active in the Northern Iraqi housing.

3.4 Construction Materials in the Northern Iraq

Building costs in Iraq have risen considerably due to rising fuel, labor, and materials costs. Cement prices, for example, have increased to $125-$150 per long tonne from $25 in 2000 regardless of the fact that rebar steel has increased from $250 to $650 for one tonne. According to the Kurdistan Contractors' Union, construction industry costs have increased 10 - 500 % in the past decade. The market for building construction and materials in the area is estimated to $400 - $500 million based on "rule of thumb" calculations and total value estimates. Although cement, steel, and bricks constitute the majority of materials used in construction in the region, they are, in addition to other materials such as steel reinforcing bars, wiring, tiles, and fixtures, imported.

According to the Kurdistan Regional Government's (K.R.G.) Ministry of Industry, 204 firms supply materials to the region's construction industry, of which over 100 are Turkish firms (KRG, 2013a).

3.4.1 Cement

Total Iraqi cement consumption stands at approximately 10 million tonnes per annum with 25% – 40% of this figure being used by the construction industry in the Kurdistan Region. It is estimated that 7 million tonnes of cement were imported from Turkey, Jordan, and Iran yearly prior to the renovation and construction of new plants in 2006. Although cement production capacity has increased, it is still necessary to import cement into the Kurdistan Region in the short term to meet up with the demand created by increased construction activity. Of the 15 cement plants operating in all of Iraq, three are in Sulaymaniyah and one is in nearby Kirkuk.

3.4.2 Steel

Most of the steel used in the Kurdistan Region is imported from neighboring Turkey, Ukraine, and China. Little effort has been made to recycle scrap steel and iron in the region and at present, only one small steel production facility exists: Erbil Steel. Due to the fact that the iron ore in the region has a low ferric oxide (Fe_2O_3) content, scrap iron provides the best option and is used at the facility.

3.4.3 Bricks and Block

A modern brick factory, operated by the BG Group, is located in Zakho in the Dahuk Province while the Aso Brick Factory, operated by the Halabja Group, is located in the Takiya Subdistrict, 35 kilometers to the southeast of Sulaymaniyah. Equipment and machinery are in the process of being installed in a new brick factory established in the Koya area between Mosul and Erbil. This new factory will produce brick using the raw materials found in the neighboring Makhmour area. However, the majority of

concrete blocks and bricks used in the region are produced by relatively small independent manufacturers.

3.4.4 Materials Testing

One problem that exists for the construction industry is the lack of materials testing facilities with only two old and ill-equipped laboratories from the 60's and 70's present in the entire region. The Erbil materials laboratory requires as much as $1.5million in equipment to meet up with contemporary standards.

3.5 SWOT Analysis for Construction Industry

3.5.1 Strengths and Weakness

- The availability of domestically-sourced building materials such as sand, stone, blocks etc., lowers cost and the expenditure of foreign exchange
- There are shortages of building materials on the market
- The majority of artisans are trained in the use of local building materials such as blocks, stone, and sand.
- Dependence on the use of imported building materials adversely affects the domestic production of building materials.
- The performance of most of the artisans may be affected as most of the artisans receive their training through apprenticeships and consequently lack high levels of education.
- The quality of the building is very dependent on adequate on-site supervision.

3.5.2 Opportunities and Threats

- Ongoing research is being conducted into the utilization of alternative building materials.
- The government has displayed an eagerness to engage professionals and consultants in an effort to develop the construction industry.

- Households have the option of constructing their houses in phases.
- The majority of professionals are instructed in construction-related jobs either through formal or informal education.
- Information is seldom circulated.
- Plans to improve the standards of construction materials and the productivity of the industry have fallen victim to political interference.
- The prices of new local materials are high and beyond the means of the low-income households.

3.6 Housing Construction Sector in the Northern Iraq

The housing sector in Iraq is responsible for the provision of habitable living areas and has strong links to the region's economy both in terms of its overall productivity, as well as what it means for the quality of the surrounding environment and living conditions. The chairman of the regional board of investment, Herish Muharam Muhamad, recently announced that the construction of 40,000 housing units was underway in the Kurdistan region.

Several high-end projects are ongoing in the Kurdistan region under the auspices of private sector investors but even with the added 8,000 units at Tarin Hills, 2,000 units at the Ankawa American Village, and another 356 at the Erbil American Village, Kurdistan housing prices remain substantially low in comparison to those in other areas in the Middle East Figure 3. The high-end units presently under construction in the Kurdistan Region usually cost between $733 and $1,000 per square meter (Erbil Governorate 2012) while Beirut's average price is $1,237 per square meter and Tel Aviv's is the highest in the Middle East at $5,021 per square meter (Erbil Governorate 2012).

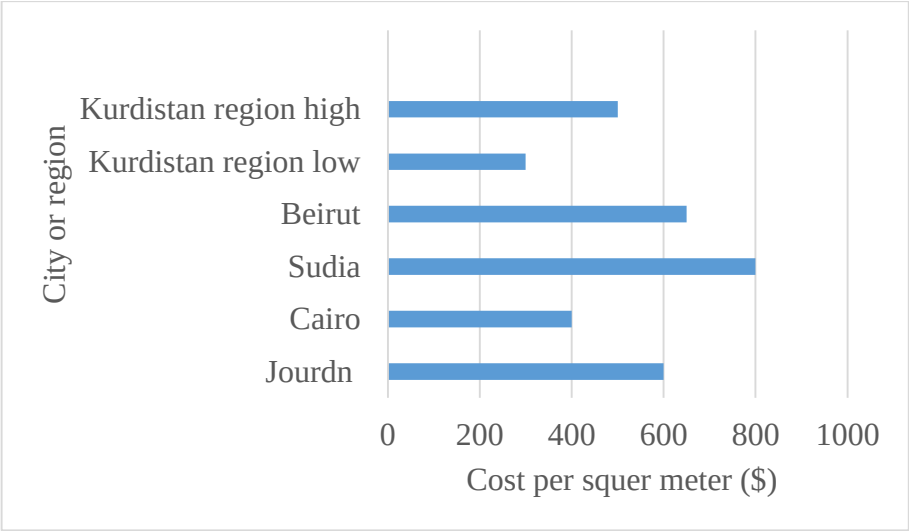

Figure 3: Cost of Housing in the Middle East
Source: (Erbil Governorate 2012)

The number of residential projects undertaken by members of the Erbil Contractors' Union increased from 30 in 2002 to 986 in 2007. Interestingly, there is an ongoing lack of small, inexpensive housing for the region's young people indicating a need for the development of housing units of varying prices and sizes that are accessible to people from all echelons of society. The challenges currently facing the Northern Iraqi government in the housing construction sector include:

a. A lack of affordable housing notwithstanding a thriving housing industry.
b. Insufficient information regarding the production, accessibility, and affordability of housing options.
c. Extortionate housing prices in relation to the salary of the average resident.
d. Increased demand for housing due to population growth.
e. Returnees' inability to return to their original areas as a result of the increased land prices.
f. A deficiency in the availability of small apartments and residences, particularly for the youth.

The Northern Iraq Commission asserts that investors have been increasingly interested in a number of sectors in the region. Most of this investment has been concentrated both in the housing market in general, and social housing development in particular.

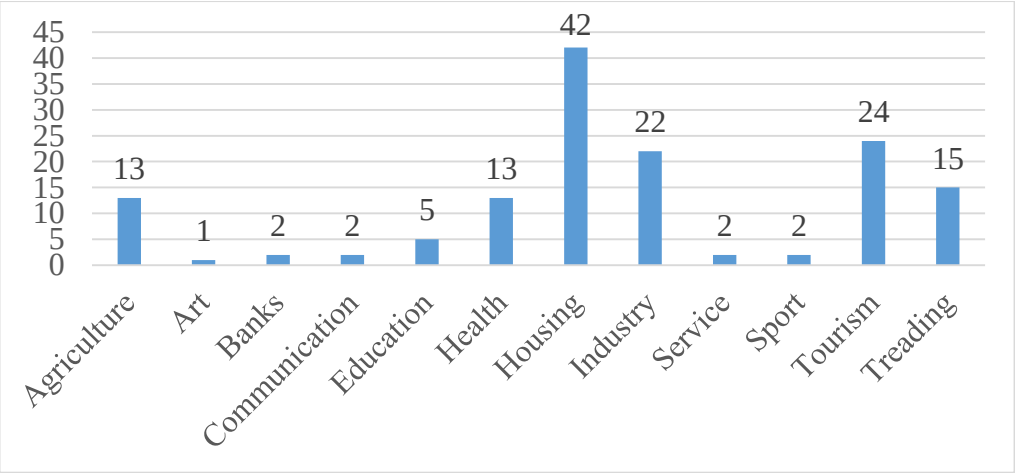

Figure 4: Number of Projects by Sector in Northern Iraq
Source: (Erbil Governorate 2012)

The graph presents the number of Licensed Projects by sector in Irbil (2010). The total number of projects is 143. The total number of projects for all three provinces, Duhok, Sulaimaniya, and Irbil was 258; 36.89% of these investments took place in Irbil. Compared to its two other KRG neighbors, Irbil had the largest share of investment since 2006. In 2009, it registered $2.774 billion investment, an increase from 2008 but slightly lower than 2007. Due to investor interest in the country's southern region, investment has significantly decreased, with only $799 million being committed to Irbil in 2010.

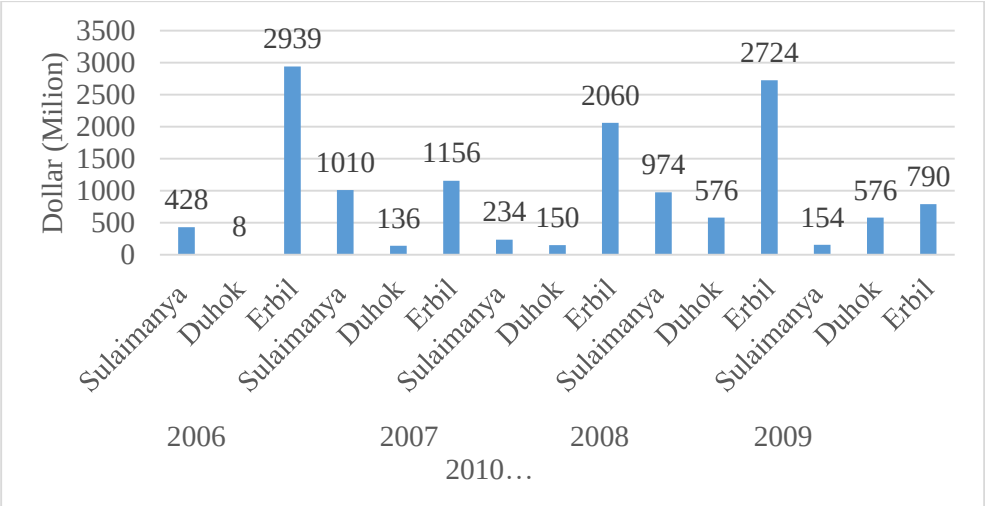

Figure 5: Total Investment by Kurdistan Regional Government
Source: (Erbil Governorate 2012)

3.7 Housing Materials Sector in the Northern Iraq

Although it has the possibility to satisfy its construction materials demands, Iraq's local materials industry is producing well under capacity. Manufacturers, public and private, are victims of outdated infrastructure, a lack of spare parts, problems with general neglect, electricity, and post-war looting resulting from years of sanctions against the country and war. These factors have adversely affected their operational efficiency and limited production resulting in an inordinate reliance on the import of some importance materials like cement, window frames, etc. and manufactured products e.g. windows. The high retail prices of such items, often the result of supply bottlenecks, also inhibit the production of affordable housing. The frequently cited problems among building materials producers include transportation challenges, simultaneous shortage of raw materials, high prices, frequent power cuts and poor input quality. The difficulties have affected the production of materials such as bricks, cement, concrete blocks, glass, gypsum, pipes, and tiles in Iraq. The majority of cement plants tend to be owned by the government while brick production is almost exclusively privately owned. The sort of operating environment in existence, where

energy deeds are subsidized and there are few rewards for performance results in few incentives for the public-sector producers to increase their output or efficiency. Additionally, because the materials in the building sector also serve non-residential buildings, the performance of this sector is not limited to housing; consequently, its shortcomings cannot be addressed exclusively within the national housing policy. The following proposals, however, are exclusively concerned with building materials for housing construction (Erbil Governorate, 2012).

The challenges faced in the housing materials sector by the Northern Iraqi government include:

a. A lack funding for building materials production companies to restore their old factories or develop new ones.
b. The relative inefficiency of building materials producers by present international standards and inability to utilize modern production technologies.
c. The high environmental costs incurred as a result of the majority of the materials frequently used in residential construction in Iraqi cities.
d. The low quality of some locally-produced building materials relative to comparable international products.

3.8 Housing Policy in the Northern Iraq

Despite a long and vibrant tradition of residential design and construction, a trend is underway in Northern Iraq whereby public companies and other key housing providers have been unable to meet present housing demands. This increasing gap between the demand for, and supply of housing requires that all housing providers are mobilized. Furthermore, the increasing demand for housing tends is varied in that while large firms with similarly large capital handle high-density, multi-story, and urban residences, the demand for low-rise and single-family housing could be handled by

any number of builders; because most of the residences in Northern Iraq are handled in small sizes, they involve handling individual clients who provide the design and financing for the house (MOCH, 2010).

Five key principles guide the formulation of the housing policy principles.

a. The role of the public sector must be clarified and focused. A clear and concise role for the Government in the housing sector is essential.
b. A sufficient pace of housing production will require contributions from a variety of actors.
c. A housing finance system must be rebuilt as a matter of urgency.
d. Decentralization from the national to local governments for land use and infrastructure planning is favored wherever possible.
e. New approaches to accelerate housing production.

The Housing Policy is intended to realize certain goals including:

a. Facilitating access to reasonable accommodations – understood to allow for sufficient space, access to government services and work areas, and protection from weather conditions – for all in Northern Iraq.
b. Increase the efficiency of housing production.
c. Expand the choices for Northern Iraqi's regarding type of housing, location, and tenure characteristics.
d. Improving the quality, energy conservation, and environmental footprint of the fresh housing.
e. Improving the capacity of the homeowner to expand and develop existing structures.

3.9 The Classification Periods of Residential Houses in Northern Iraq

One of the notable modifications of the visual scene in Northern Iraq has been the change in the housing style characteristic of it overtime. Political, economic and cultural alterations led the region to experience different changes; furthermore, there is also a movement towards modernization as well as the involvement of foreign architects in Northern Iraq (AL-Shwani, 2011).

Generally speaking, several factors affect the process of architectural classification, which are in turn affected directly or indirectly by the characteristics of the houses in Northern Iraq. These factors are:

a. Societal distribution and demography.
b. Developments in the economy.
c. The steady development of the city's sectors in terms of horizontal advancement.
d. The effects of political power on the city's evolution.

3.9.1 Traditional Period Before 1930 (Pre-Modern Period)

One of the oldest continuously inhabited urban settlements in the world is the ancient traditional Northern Iraqi city of Erbil (Gunter, 2004). The characteristic architectural landscape of the ancient city Figure 6 is an enormously complex network of buildings and tight streets surrounded by town walls. In this regard, the HCECR (2009) describes the citadel town of Erbil as being largely comprised of traditional courtyard houses reached through a maze of narrow.

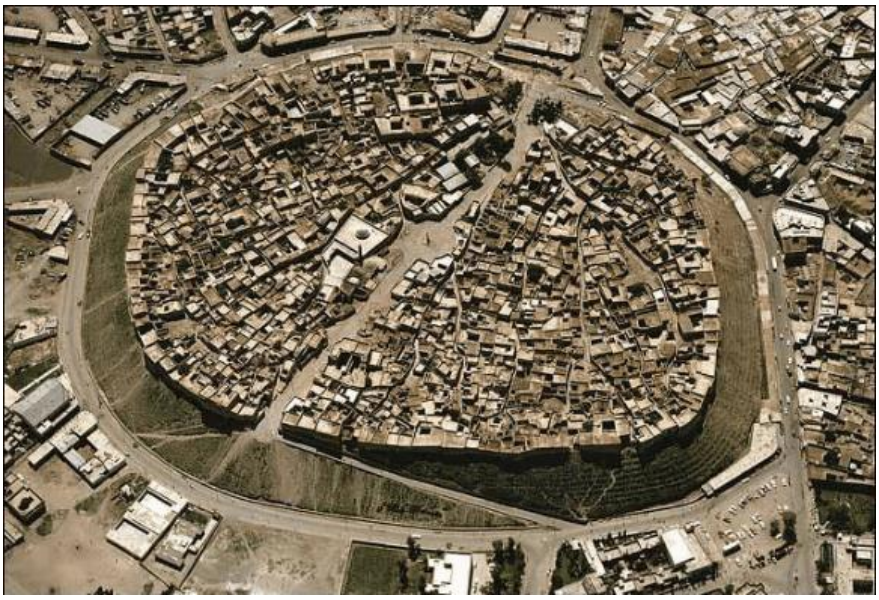

Figure 6: Housing in Erbil Castle - Northern Iraq
Source: iraq-businessnews.com/Erbil-citadel (2017)

Most of the houses in Erbil are one-story courtyard houses characterized by thick mud walls, small openings in the façade, mud roofing and short span timber roofs (Aljanabi, 1987). The majority of the houses are constructed using mud bricks and clay mortar. In spite of its limited width, the house in Figure 7 provides feelings of warmth, shelter, and comfort.

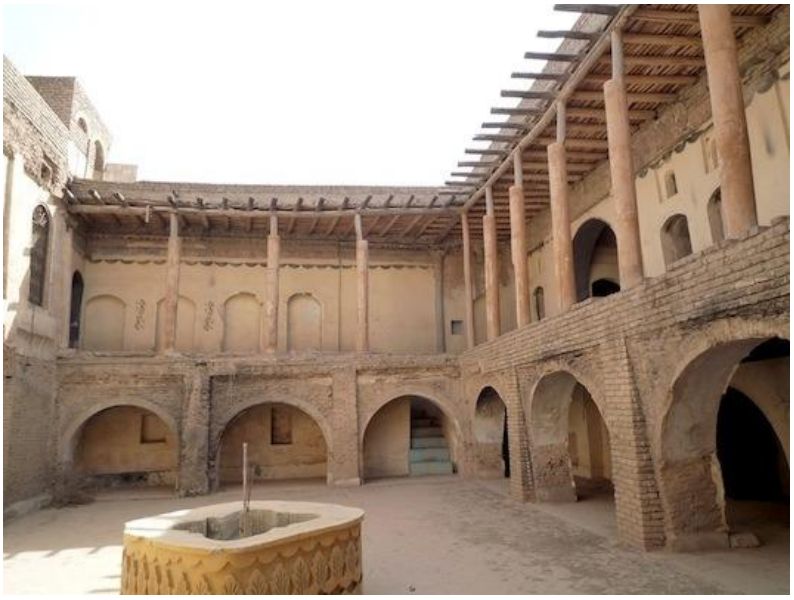

Figure 7: House Inside Erbil Citadel Before 1930
Source: http://www.tamirhane34.com/index.php?/arbil-citadel (2017)

3.9.2 Modification Period (Colonial Period) (1930-1980)

A modern city was introduced as a means of colonial control in the early twentieth century after Britain's occupation during World War I as the social and cultural effects of industrial capitalism provided a basis for perceptions of the modern (Gunter, 2004). Innovative houses became visible in the lower parts of town in a new and distinctive style indicating a major departure from tradition.

During this period, the city expanded in terms of space due to population growth, as shown in Table 1, and alterations in the prevalent political, social, cultural, and economic conditions of the city. The expansion of the city followed a circular course using the citadel as the center of the city and focal point. It is interesting to note that new roofing techniques were also adapted as an important structural change in housing construction (Aljanabi, 1987).

Table 1: Population Growth in Northern Iraq From 1947-1980

Census year	Rate of population growth	Immigrations – or +
1947	2 %	- 17517
1957	3.9 %	+ 5375
1965	10 %	+ 40132
1970	2.4 %	- 3947
1977	9.6 %	+ 65839
1980	3.5 %	+1102

Furthermore, these modern systems allowed for the use of large external windows, new paving tiles, doors, and plaster decorations although the classical internal courtyard continued to be used until its total disappearance in the 1950s (HCECR, 2009). The use of new construction materials such as concrete blocks, reinforced

concrete slabs, transparent windows, and color painting changed the distinctive feature of customary houses see Figure 8. The new styles of the house design signified a contrast between modernity and tradition (Al-Sanjary, 2008).

Figure 8: The Style of House in Modification Period (1930-1980)
Source: (AL-Shwani, 2011)

3.9.3 Transitional Period (1980-2003)

During this period, Iraq was subjected to years of sanctions, war, and destruction, and so ultimately, Iraq at the end of the last century was an impoverished country suffering from a devastating series of wars and foreign incursions (Stansfield, 2003). Consequently, the enormous rural-urban migration during this period led Erbil city to be influenced by the political conflicts in the region. The level of migration required that new urban residences were constructed to house the city's growing population leading migrant rural builders to take the situation into their own hands and construct residential buildings based on their own conception of urbanization. Accordingly, house facades, in Figure 9, filled with different hybrid elements emerged, altering the visual appearance of the city streetscapes. In contrast, the aesthetic value of house

facades in poor districts is neglected and facades in most cases are just used to cover the front sides of the houses without any visual considerations.

Figure 9: A House in Transitional Period (1980-2003)
Source: (AL-Shwani, 2011)

Since 1996, the revenues generated from the production and sale of oil have led Erbil city to be influenced by the resulting rapid economic developments. Moreover, the inhabitants were encouraged to build houses by the government banks' advance payments for housing projects and the government's provision of construction materials at lower costs. This condition led to an extreme polarization in the visual appearance of house facades in Erbil city. While on the one hand, it was reflected the need to construct thousands of housing units for low income inhabitants, on the other hand, it was affected by the historical background of Erbil city itself.

3.9.4 Advanced Modernity Period (after 2003)

Following Iraq's liberation in 2003, the architectural landscape of Erbil City went through a host of transformations due to the economic development that followed as a result of the lifting of some decades-old sanctions; peace, relative prosperity, and

democracy began to reign in the region (Gunter, 2004). This period was the crowning glory of the city's evolution as many development-geared projects were underway and the urbanization process reached its peak. The speedy advancement of the construction and housing sectors led to a situation whereby architectural forms came at odds with one another. Traditions fell victim to the appeal of more modern ideological orientations and most of the housing projects began to be more reflective of western concepts rather than local tradition. This phenomenon led to a state of confusion in architectural identity particularly in relation to the appearance of the facades and the speed of the developments also led to a new lifestyle and new functional requirements for residences, which impacted the available building areas of the projects.

Figure 10: Western-Style House in the Advanced Modernity Period (after 2003)
Source: (AL-Shwani, 2011)

The rising prices of real estate also affected the available building area of projects as subdivision came to be seen as a solution for low-income households. This also had implications for the façade in terms of proportion and the production of a new aesthetic feature for multi-layered units. Many local architects, as a reaction to the changes

underway, began to look to the lost architectural identity of Erbil city and produce architecture of admirable quality (AL-Shwani, 2011).

Figure 11: The Concept of Subdivision in Advanced Modernity Period
Source: (AL-Shwani, 2011)

3.10 Housing Profile

3.10.1 Housing Condition in Northern Iraq

The majority (over 90%) of households live in houses where the walls and roof have been constructed from durable materials. Where brick and cement blocks are primarily used in the construction of the walls, reinforced concrete and shilman are used for the roofs. Although bricks are more common in Central and Southern Iraq, cement blocks are the predominant building material for walls in Northern Iraq (Baker, 2006).

Table 2: Housing Conditions in Iraq

	In good condition	**In fair condition**; (nonstructural) rehabilitation needed	**In poor condition**; (structural) rehabilitation needed	**Not livable**, needs to be demolished and rebuilt	Total

South Iraq	54.0 %	38.0 %	6.0 %	2.0 %	100%
Central Iraq	29.6 %	49.2 %	19.3 %	1.8 %	100%
Northern Iraq	46.0 %	38.3 %	15.7 %	0.0 %	100%

Approximately one-third of the housing units surveyed in Central, Southern, and Northern Iraq were said to be in poor or unlivable conditions. The percentage is slightly higher in Central Iraq where 21.1% of the houses were said to be in terribly poor conditions or outright uninhabitable while the percentages for Northern and Southern Iraq were relatively even. The survey also revealed a tendency amongst lower income households to live in housing that is either relatively smaller, or in a terrible state.

Survey results indicate that the housing situation in the region remains relatively within expectations, however, in reality, it suffers from a host of problems. Sub-par housing construction and external interference have diminished the quantity and quality of houses countrywide. Housing provision schemes in Iraq have been performing well below expectation for decades, for the most part as a result of the sector's lack of access to financial, material, and human resources. Current housing production levels are not nearly sufficient to meet present demand.

3.10.2 Housing Materials in Northern Iraq

The primary building material used in the traditional period was locally sourced brick (sustainable local material). Generally, brick was the only material used in the construction of the vaults, arches, decorative ornaments, columns, floors, ad walls, Figure 12. Regardless of advancements in the field of construction materials during the second period (1930-1980), local materials such as hammered dressed stones and

bricks remained the preferred choice in construction. The volume of construction activities during the third period (1980-2003) led to the use of concrete blocks in 69.47% of cases leading to a situation whereby local and new construction materials were combined at an average ratio of 29.6%. In the final period (post-2003), and regardless of the appearance of new, foreign materials (such as timber roofing systems, aluminum composite panels, and prefabricated screen walls), the use of local stone for the finishing of house facades remained in 88.8% of cases in total (AL-Shwani, 2011).

Figure 12: Housing Materials in Different Periods in Northern Iraq
Source: (AL-Shwani, 2011)

3.10.3 Housing Sites, Codes, Quality Assurance and Control in Northern Iraq

Following the acquisition of the land, the investor must obtain a building permit from the municipal government that covers either the construction of a new structure or the renovation of an existing one. The legislation that governs activities related to sit

development includes stipulations specifically geared towards discouraging unregulated development (BSH3, 2016).

Although an air of confusion surrounds the issues of building codes and materials testing, the Ministry of Municipalities and Public Works is the government outfit responsible for building codes and permits. On contracting firm in particular claimed that Iraq used British building codes.

Furthermore, although the government does operate its own testing laboratories for materials, the equipment in these facilities is outdated and ineffective. Similarly, the dedication of the laboratory staff does not compensate for their lack of knowledge regarding modern methods and technologies.

The challenges in the housing sector include:

- A lack of building codes, inspections, and occupancy permits which creates potentially unsafe building environments.
- A lack of procedural guidelines leading to increased application times.
- An unclear and potentially intrusive municipal committee inspection process.
- Burdensome manual administration and processing activeties.
- A lack of specific rezoning procedures.
- The lack of a single facility for obtaining permits, and requesting utility hookups.

These challenges in the housing sector can be improved by:

- Introducing a “one-stop shop” permit-acquisition facility for each province or large municipality.

- Establishing a project development facility.
- Instituting and enforcing building codes.
- Enhancing the power of the municipal government to provide building permits.
- Developing information brochures and websites for the site development process.
- Ceasing municipal committee inspections.
- Refining permit issuance, permit tracking, inspector deployment, and final approval processes.

3.10.4 Housing Regulations for Residential Building in Northern Iraq

a. The plot (land area) should be at least 100m2
b. There must be a new permanent record and installed land border.
c. The architectural design must be approved by the design department.
d. The approval of the water, environment, and tax administrations should be secured.
e. The landowner should write a pledge promising to work according to directives.
f. A supervisory engineer should supervise the entire construction process.
g. After construction, tests for DPC, ground, first, second, and the last floor should be conducted.
h. The landowner must obtain a building license after finishing the structure.
i. If the land is divided into two or three parts, the front side should not be less than 5m for two and if divided by three, it should not be less than 6m for each house.
j. A set of Architectural design drawings must be included, containing:
    - The name and telephone number of the designer;

- All floor and Site plans;
- Front side section (plan and section) dimensions, heights, and line section in the plan should be discernible, and the ground floor's height should not exceed 3.5m from ground level;
- Room names and their respective dimensions;
- No stairs at the land setback from 2.5m; and
- An open space of no less than 20% on all floors (BSH3, 2016).

Chapter 4

DATA FINDINGS AND DISCUSSIONS

A questionnaire survey, interviews, and observation were used in this research for the collection of data on building construction and materials' in residential building design and construction. The data collection methods were applied to architects across Northern Iraq. Chapter one provides an explicit outline of the questionnaire's design, the study's research questions, and the sampling used in the study. The questionnaire's questions were a result of a literature review also presented in chapter two and three. This chapter outlines the study's results and delves into the individual questions and their relevant responses as they relate to the influence of building construction and materials' problems on design. The rest of this chapter covers these issues under these headings: (a) Evaluation of demographic figures (b) Building construction and materials awareness on design and construction practices for a residential project in Northern Iraq (c) Consideration of building construction and materials selection and techniques (d) Building materials selection – influence of stakeholders, information sources, energizers and hindrances, (e) Materials assessment methods and difficulties in their application (f) Building elements in residential building construction and materials, and (g) occupants current problem with building construction and materials.

4.1 Demographic Data Analysis

Data was collected on each of participants as professional architects and their respective organizations. The resulting data is presented in this section. The number of responses for each category is indicated in both raw numeric and percentage (%).

Work experience of respondents: Table 3 indicates that 33.3% of the architects have more than 15 years working experience in the building construction and materials sector 26.7% has experience in the industry ranging from 0 - 5 years, 23.3% have between 6-10 years experience, while 16.7% have 11-15 years experience with building construction and materials. Given the level of experience the respondents have amassed over the years of practice, the assessments gotten via the survey are believed to be significant and dependable. A large number of respondents have considerable experience with building construction and materials, and this buttresses the expectation that they could be reliable sources of information.

Type of organization relations work: Table 3 showed that 40% of the respondents were employed in architectural and design offices. On the other hand, 26.65% worked in the contractor sector, 16.65 % worked in the government sector, 10% worked in education and only 6.7% worked in another sector (e.g industry). Furthermore, 73.35% of respondents worked in the private sector, and more architects seem to be employed in the private sector than in the public sector which stands at 26.65%. Therefore, the opinions obtained through this survey tend to be more representative of architects working in the private sector.

For the architect's positions: Table 3 showed that most respondents worked as office and site architects with 53.3% working as office architect and 23.3% working as site architects. This is important for our results because it is investigation of the problems is within the context of actual practice. While 13.3% worked as project manager, and 6.7% worked in other positions, 3.3% had a company and worked as directors of their own firms.

A combination of valid responses regarding the architect's specialty in construction projects revealed that residential buildings 70% are the leading area of project specialization according to the respondents, with commercial 20%, institutional 5%, industrial 3.3% and other 1.7% accounting for other areas of specialization. The larger number of respondents who cited residential projects as their specialty supports the choice to place the focus of this research on residential buildings.

The question of how many projects they designed annually was asked to the architects and the results in Table 3 show that most of the architects 71.7% specified that they designed more than 30 projects annually and this sometimes creates problems for the architects as it is difficult to oversee such a large number of projects. 20% indicated an annual project turnover of around 16-30 projects and just 6.7% indicated an annual turnover of 6-15 projects with only one architect indicating that he worked on 0-5 projects yearly.

One of the objectives of this research is to investigate the skill of the architects in relation to their awareness and attitudes regarding the building construction and materials in residential projects. 75% of the responding architects indicated that they were extremely aware/moderately aware of the building construction and materials issues in residential projects and 23% indicated that they were somewhat aware with only 2% responding that they were slightly aware, but this percentage is relatively negligible and does not affect the results of this research.

Determining the most important elements in building construction, specifically for residential buildings is also one of the aims of this research to which the architects responded that the Foundation 7%, Floor 1%, Wall 10%, Roof 7%, Stair 0%. Majority

of respondents indicated that all the elements 70% are important for building construction; we take all building elements separatly to determine the spacing to each of them probles.

The important factors in construction are another element which makes the results more reliable for which the architects focused on quality, cost and time more than the environment and safety of the building in the projects. 32% of the architects indicated the quality of the building, 27% indicated cost, 18% indicated time, 12% environment, 8% safety, while 3% cited other factors as being important. These results indicate that the architects mostly focused on cost and time as opposed to safety and environmental concerns in residential projects and materials selection in Northern Iraqi projects.

Design pressure from stakeholder: Table 3 shows that majority 85% of respondents faced pressure from stakeholders and this negatively impacts the design process, construction and the selection of materials in the residential projects. 63% of respondents indicated that they received pressure from clients and the government, 22% said they received pressure from the community, colleagues, environmental and other sources while only 15% answered that they don’t face any pressure and this is a small percentage including that most architects can't do the things they envision to realize the success of a project and benefit from the new technologies in the world.

Building system used in construction and materials: Table 3 illustrate that majority 70% of respondents have a system in place for their work in building construction and materials and the most frequent methods used by the architects in their projects relate to their experience 31%, market reputation 24%, price 21%, recommendations 9% and

others 5%. However, 30% of the architects do not have any system to utilize, and this is terrible for the construction sector in Northern Iraq.

Table 3: Architect's Demographic Data

Variable	Options	No. of respondents	Percentage (%)
1- Work experience in the construction industry and materials?	a. 0 - 5 years	16	26.7
	b. 6 - 10 years	14	23.3
	c. 11 - 15 years	10	16.7
	d. more than 15 years	20	33.3
2- What type of organization do you work for?	a. Architecture office	24	40
	b. Contractor	16	26.65
	c. Government	10	16.65
	d. Education	6	10
	e. Other	4	6.7
3- What is your position in your firm?	a. Director/ CEO	2	3.3
	b. Project Manager	8	13.3
	c. Office Architect	32	53.3
	d. Site Architect	14	23.3
	e. Other	4	6.7
4- What kind of construction project you specialize in?	a. Residential	42	70
	b. Commercial	12	20
	c. Industrial	2	3.3
	d. Institutional	3	5
	e. Other	1	1.7
5- Approximately, the number of annual projects?	a. 0 - 5 Projects	1	1.7
	b. 6 - 15 Projects	4	6.7
	c. 16 - 30 Projects	12	20
	d. More than 30 Projects	43	71.7
6- Please indicate your level of skill in building construction and materials?	Extremely aware	11	18
	Moderately aware	34	57
	Somewhat aware	14	23
	Slightly aware	1	2
	Not aware	0	0
7- Select main importance part in the construction	a. Foundation	4	7
	b. Ground (Floor)	1	1
	c. Wall	6	10

industry of Northern Iraq.	d. Roof		4		7	
	e. Satire		0		0	
	f. All		42		70	
	g. Other		3		5	
8- What is the most important factor in the construction of a residential project in Northern Iraq?	a. Cost		16		27	
	b. Time		11		18	
	c. Quality		19		32	
	d. Safety		5		8	
	e. Environment		7		12	
	f. Others		2		3	
9- Does your design face any pressure from stakeholders?	Yes if yes please select!	a. Client	51	23	85	38
		b. Community		2		3
		c. Environmental		7		12
		d. Government		15		25
		e. Colleague		4		7
		f. Other		0		0
	No		9		15	
10- Do you have any system in building construction and materials?	Yes if yes please select!	a. Recommendation	42	8	70	19
		b. Price		9		21
		c. Experience		13		31
		d. Market reputation		10		24
		e. Others		2		5
	No		18		30	

4.2 Awareness Regarding Building Construction and Materials for Residential Projects in Northern Iraq

4.2.1 Effects of Architects Information on Building Construction and Materials in Residential Projects

The process of materials selection can be considered to be a problem-solving activity due to the speed with which a lot of new products with various properties are entering the market. The excess of options increases the workload on the decision-makers who have to decide between them which requires a fixed flow of information on materials

options. Selecting materials requires one to be apprised of the properties of the individual options. Moreover, and perhaps most importantly, do they satisfy the architect's environmental, technical and aesthetic needs. The adequate information allows the architect to decide between materials based on the needs of the particular project. Table 4 shows the overall ranking of various effects on the building construction and materials considerations where "Budget constraints" ranked first with Mean (4.0667) and Standard Deviation (1.02290), "Inadequate current construction techniques" ranked second, with Mean (3.9167) and Standard Deviation (1.12433) and the third rank is occupied by "Inadequate instructions about materials" with Mean (3.8333) and Standard Deviation (1.12245).

Table 4: Effects of Architects Information on Building Construction and Materials

Statements	Sample Size	Option	Frequency	Percentage %	Mean	Standard Deviation	Rank
a. Lack of access to current and relevant information	60	Lowest	2	3.3	3.7887	1.18417	4
		Low	9	15.0			
		Medium	11	18.3			
		High	17	28.3			
		Highest	21	35.0			
b. Inadequate instructions about materials	60	Lowest	1	1.7	3.8333	1.12245	3
		Low	8	13.3			
		Medium	13	21.7			
		High	16	26.7			
		Highest	22	36.7			
c. Lots of workforce and time in analyzing & selecting proper material	60	Lowest	4	6.7	3.5000	1.21432	7
		Low	8	13.3			
		Medium	18	30.0			
		High	14	23.3			
		Highest	16	26.7			
d. Consideration of sustainable materials	60	Lowest	3	5.0	3.5333	1.24147	6
		Low	11	18.3			
		Medium	15	25.0			
		High	13	21.7			
		Highest	18	30.0			

e. Budget constraints	60	Lowest	0	0	4.0667	1.02290	1
		Low	6	10.0			
		Medium	11	18.3			
		High	16	26.7			
		Highest	27	45.0			
f. The problem in determining priorities	60	Lowest	3	5.0	3.3667	1.22082	8
		Low	13	21.7			
		Medium	18	30.0			
		High	11	18.3			
		Highest	15	25.0			
g. Inadequate current construction techniques	60	Lowest	1	1.7	3.9167	1.12433	2
		Low	7	11.7			
		Medium	13	21.7			
		High	14	23.3			
		Highest	25	41.7			
h. Building regulation (codes & ordinances)	60	Lowest	2	3.3	3.7000	1.15421	5
		Low	7	11.7			
		Medium	18	30.0			
		High	13	21.7			
		Highest	20	33.3			
i. Others (……)	60	Lowest	5	8.3	3.2167	1.22255	9
		Low	13	21.7			
		Medium	17	28.3			
		High	14	23.3			
		Highest	11	18.3			

4.2.2 Project Objectives Before Starting Construction and Materials Selection for Residential Buildings

Table 5 shows a ranking of project objectives in starting a building construction project. In descending order, the objectives are ranked: cost, project deadline time, building regulation, environmental considerations, and quality. This ranking indicates the conventional primacy of cost considerations in projects is also present in Northern Iraq with considerations of the environment in the last place. Cost ranked first with Mean (4.2000) and Standard Deviation (0.98806) as the most important, although not unexpectedly so because, as the client's foremost financial obligation, it is of much concern within the design and construction of a project.

As a result, the cost must be controlled and monitored either by the client or the project manager as buildings tend to be expensive and clients do not have the luxury of limitless funds to put into them. Consequently, fixed budgets delineate concise limitations for the architect and adhering to those requirements is a top concern for every participant on the project team (Demkin, 2008).

Building regulations placed second with a Mean (4.0167) and Standard Deviation (1.09686). The design and construction of buildings are regulated by legal guidelines stipulated in building directives that are intended to ensure the health and safety of people in and around buildings by providing functional requirements for building design and construction. The elevated ranking of building regulations as a consideration is also hardly unexpected as both the design and construction stages have to adhere to guidelines stipulated by the government.

Satisfying client specifications ranked third with a Mean (3.8000) and Standard Deviation (1.14685) as the speedy completion of a building project, as well as its quality, are considered by stakeholders to be necessary to a project's success (Chinyio et al., 1998); and architects' reception ranked fourth with Mean (3.6000) and Standard Deviation (1.8178).

Table 5: Project Objectives Before Starting Construction and Materials Selection for Residential Building

Statements	Sample Size	Option	Frequency	Percentage %	Mean	Standard Deviation	Rank
a. Meet project deadline	60	Lowest	2	3.3	3.6000	1.18178	4
		Low	10	16.7			
		Medium	16	26.7			
		High	14	23.3			

		Highest	18	30.0			
b. Satisfy client specification	60	Lowest	1	1.7	3.8000	1.14685	3
		Low	9	15.0			
		Medium	13	21.7			
		High	15	25.0			
		Highest	22	36.7			
c. Minimize cost	60	Lowest	0	0	4.2000	0.98806	1
		Low	5	8.3			
		Medium	9	15			
		High	15	25			
		Highest	31	51.7			
d. Minimize project impact on the environment	60	Lowest	3	5.0	3.3333	1.14487	5
		Low	12	20.0			
		Medium	18	30.0			
		High	16	26.7			
		Highest	11	18.3			
e. Meet building regulations	60	Lowest	1	1.7	4.0167	1.09686	2
		Low	6	10.0			
		Medium	11	18.3			
		High	15	25.0			
		Highest	27	45.0			

4.2.3 Stakeholders Influence on Construction and Materials Selection for Residential Projects

The term ‘building process’ refers to all the activities that collectively result in a finished building, and materials selection contains stakeholders as a part of the building process. In addition to a trend towards increased participation in the materials selection process, there has been a trend towards the inclusion of a wider range of individuals with a stake in the building. A review of the extant literature revealed that stakeholders are indeed involved in the materials selection process.

In line with expectations, the results recorded in Table 6 reveal that architects have the highest degree of involvement with Mean (4.1833) and Standard Deviation (1.04948), ranking second is clients, with Mean (4.1167) and Standard Deviation (1.04300),

followed by site manager with Mean (3.9333), project manager with Mean (3.9333), contractors with Mean (3.8000), technical consultants with Mean (3.7667) and others with Mean (3.2833) in that order.

The Stakeholders participation is easily explained by the fact that the Stakeholders bears legal responsibility for the project and bears the risk of the cost(s) of the project. Furthermore, the Stakeholders influence the adoption of the innovative strategies in various ways (Ling et al., 2007). While some Stakeholders have a prior understanding of the program, financial obligations, and other specifics, others depend on the architect to help outline the project's objectives and design a building tailored to those objectives. In either case, a stable relationship between architect and Stakeholders is necessary for the production and implementation of decisions during the project's implementation. This shows the central role of the Stakeholders in shaping the Architects strategies for the environment.

Table 6: Stakeholders Influence on Construction and Materials Selection for Residential Project

Statements	Sample Size	Option	Frequency	Percentage %	Mean	Standard Deviation	Rank
a. Contractors	60	Lowest	1	1.7	3.8000	1.16153	5
		Low	10	16.7			
		Medium	11	18.3			
		High	16	26.7			
		Highest	22	36.7			
b. Site Managers	60	Lowest	0	0.0	3.9333	1.10264	3
		Low	8	13.3			
		Medium	14	23.3			
		High	12	20.0			
		Highest	26	43.3			
c. Project Managers	60	Lowest	0	0.0	3.9333	1.10264	4
		Low	10	16.7			

		Medium	8	13.3			
		High	18	30.0			
		Highest	24	40.0			
d. Architects	60	Lowest	0	0.0	4.1833	1.04948	1
		Low	6	10.0			
		Medium	10	16.7			
		High	11	18.3			
		Highest	33	55.0			
e. Client	60	Lowest	0	0.0	4.1167	1.04300	2
		Low	7	11.7			
		Medium	8	13.3			
		High	16	26.7			
		Highest	29	48.3			
f. Technical consultants	60	Lowest	0	0.0	3.7667	1.09493	6
		Low	12	20.0			
		Medium	8	13.3			
		High	22	36.7			
		Highest	18	30.0			
g. Others (……)	60	Lowest	3	5.0	3.2833	1.23634	7
		Low	16	26.7			
		Medium	16	26.7			
		High	11	18.3			
		Highest	14	23.3			

4.2.4 Obstacles to Design Decision Making in Construction and Materials Selection in Residential Projects

Taking into account the obstacles faced in building construction and materials in regards to design decisions, choosing between various building materials has been known to be one variable that can influence the overall performance of a building (Nassar et al., 2003). Architects play a definitive role in implementing new building project techniques focusing on materials selection. Exploiting their influence in this area would require them to recognize the opportunities and constraints related to the successful application of said techniques and the realistic methods of improvement.

The results outlined in Table 7 reveal that the greatest problem facing building construction and materials selection is an unwillingness to change the conventional practices with a Mean of (3.8167) and Standard Deviation (1.08130), this was followed closely by a lack of information on building construction materials with Mean (3.7833) and Standard Deviation (1.15115) with problems in evaluating information coming in third place with a Mean of (3.7000) and Standard Deviation (1.18322). Summary discussions of these top three problem areas follow below.

Firstly, although numerous evaluation and selection methods exist for building construction and materials, many are believed to either be in comprehensive, or impossible to manipulate. An inquiry into the methodology of such tools reveals a lack of inclusivity regarding the criteria and indicators that are taken into account. Furthermore, some researchers have criticized methods of evaluation as being riddled with problems of bias and subjectivity as some vital elements received insufficient attention and other important elements were out rightly ignored. The identification of a lack of information as a problem facing architects is particularly worrisome given the present abundance of documentation related to the materials selection process.

Secondly, architects have a duty to remain apprised of current codes, regulations, developments in materials and building practices (existing and novel materials). In practice, however, this requirement engenders some challenges as practitioners attempt to obtain information from a variety of sources. Consequently, a lack of access to information does indeed represent the reality on the ground which has a definitive effect on design choices.

Lastly, architects may not have sufficient information to decide which materials options would be more or less suitable. Additionally, the architect may also just be unaware of the various alternatives available or lack the skills for implementation, and where the information is insufficient, the architect usually opts for the "safety" solution. In situations where information regarding new construction techniques and materials are not readily available, the architects tend to rely on the conventional methods and materials. This challenge thus necessitates information be better disseminated so as to make projects more successful.

Table 7: Obstacles to Design Decision Making in Construction and Materials Selection in Residential Projects

Statements	Sample Size	Option	Frequency	Percentage %	Mean	Standard Deviation	Rank
a. Lack of tools and data to compare materials alternatives	60	Least Important	6	10.0	3.3500	1.2865	5
		Fairly Important	11	18.3			
		Important	12	20.0			
		Very Important	18	30.0			
		Extremely Important	13	21.7			
b. Lack of information on building construction materials	60	Least Important	1	1.7	3.7833	1.1511	2
		Fairly Important	10	16.7			
		Important	11	18.3			
		Very Important	17	28.3			
		Extremely Important	21	35.0			
c. Maintenance concern	60	Least Important	6	10.0	3.3167	1.2952	6
		Fairly Important	10	16.7			
		Important	18	30.0			
		Very Important	11	18.3			
		Extremely Important	15	25.0			
d. Limited availability & reliability of suppliers	60	Least Important	3	5.0	3.5167	1.1859	4
		Fairly Important	9	15.0			
		Important	18	30.0			
		Very Important	14	23.3			

		Extremely Important	16	26.7			
e. Unwillingness to change the conventional way of specifying	60	Least Important	1	1.7	3.8167	1.0813	1
		Fairly Important	8	13.3			
		Important	11	18.3			
		Very Important	22	35			
		Extremely Important	18	31.7			
f. Problem in Evaluating information	60	Least Important	3	5.0	3.7000	1.1832	3
		Fairly Important	7	11.7			
		Important	14	23.3			
		Very Important	17	28.3			
		Extremely Important	19	31.7			
g. Aesthetically less pleasing	60	Least Important	8	13.3	3.3000	1.4178	7
		Fairly Important	11	18.3			
		Important	15	23.3			
		Very Important	10	15.0			
		Extremely Important	16	30.0			

4.2.5 Significant of Materials Selection Criteria for Residential Project Design

Regarding the significant criteria in building construction and materials in residential projects, Table 8 illustrate that “Aesthetics” was ranked first with a Mean (3.8667) and S.D. (1.11183), "Ease of construction/buildability" ranked second with a Mean of (3.8500) and S.D. (1.02221); and ranking third "Materials availability" with Mean of (3.6333) and S.D. (1.13446); which was a general concern among architects. The research revealed that an air of uncertainty surrounds long-term aesthetics, construction, and materials availability. This is not surprising, however, given that buildings free from additional aesthetics are favored by clients given the maintenance costs incurred by such buildings. The “first cost” has, and likely will continually be one major point of concern for architects as have been conventional performance criteria; “ease of construction,” the duration of the construction process, is also closely linked to the time, cost, and performance of a building. It is noteworthy that

environmental concerns account for 39.2% on the aggregate 'importance' scale pointing to a trend that has elevated environmental concerns from the less important factor for materials selection in construction projects it once was. This is indicative of the importance of sustainability to building designers in evaluating materials and can be explained by a) the fact that building construction practices are a collaborative effort involving various departments and are easy manage while they endorsed by the best management and b) the necessary resources for successful building construction practices are easily available to those responsible for these practices. This indicates a need for simplicity and clarity in the development of materials estimate methods.

Table 8: Significant Materials Selection Criteria for Residential Projects Design

Statements	Sample Size	Option	Frequency	Percentage %	Mean	Standard Deviation	Rank
a. Maintainability	60	Least Important	5	8.3	3.333	1.2166	7
		Fairly Important	10	16.7			
		Important	17	28.3			
		Very Important	16	26.7			
		Extremely Important	12	20.0			
b. Life expectancy of materials (e.g. strength, durability, etc.)	60	Least Important	2	3.3	3.566	1.2537	4
		Fairly Important	13	21.7			
		Important	15	23.3			
		Very Important	11	18.3			
		Extremely Important	19	33.3			
c. Fire resistance	60	Least Important	4	6.7	3.266	1.2332	8
		Fairly Important	16	26.7			
		Important	11	18.3			
		Very Important	18	30.0			
		Extremely Important	11	18.3			
d. Sound insulation	60	Least Important	9	15	2.750	1.2571	12
		Fairly Important	22	36.7			
		Important	11	18.3			
		Very Important	11	18.3			

		Extremely Important	7	11.7			
e. Methods of extraction of raw materials	60	Least Important	6	10	3.050	1.2544	10
		Fairly Important	16	26.7			
		Important	18	30			
		Very Important	9	15			
		Extremely Important	11	18.3			
f. Energy saving and thermal insulation	60	Least Important	7	11.7	2.883	1.2363	11
		Fairly Important	20	33.3			
		Important	14	23.3			
		Very Important	11	18.3			
		Extremely Important	8	13.3			
g. Materials availability	60	Least Important	2	3.3	3.633	1.1344	3
		Fairly Important	10	16.7			
		Important	11	18.3			
		Very Important	22	36.7			
		Extremely Important	15	25.0			
h. Health and safety	60	Least Important	3	5.0	3.466	1.1712	6
		Fairly Important	10	16.7			
		Important	17	28.3			
		Very Important	16	26.7			
		Extremely Important	14	23.3			
i. Aesthetics	60	Least Important	1	1.7	3.866	1.1118	1
		Fairly Important	8	13.3			
		Important	11	18.3			
		Very Important	18	30.0			
		Extremely Important	22	36.7			
j. Life cycle cost (initial cost, maintenance cost, repair cost etc)	60	Least Important	2	3.3	3.550	1.1412	5
		Fairly Important	9	15.0			
		Important	19	31.7			
		Very Important	14	23.3			
		Extremely Important	16	26.7			
k. Use of local material	60	Least Important	5	8.3	3.250	1.2436	9
		Fairly Important	12	20			
		Important	19	31.7			
		Very Important	11	18.3			
		Extremely Important	13	21.7			
	60	Least Important	0	0	3.850	1.0222	2

l. Ease of construction / buildability		Fairly Important	6	10.0			
		Important	18	30.0			
		Very Important	15	25.0			
		Extremely Important	21	35.0			

4.3 Building Elements for Residential projects (Foundation, Wall and Roof)

The following subsections display the results of the third part of the questionnaire where respondents were asked to consider various statements made about the main problems encountered in building construction in residential projects in Northern Iraq. Descriptive analysis was used to categorize these inquiries into three listed areas that are: The Foundation, Wall, and Roof of residential projects in Northern Iraq. The descriptive findings produced the following results.

4.3.1 Main Problems Faced in the Foundation of Residential Buildings in Northern Iraq

Table 9 outlines the main problems cited by architects in the foundation during construction in residential projects Northern Iraq. Most of the respondents argued that a lack of design, settlement, soil study and construction with concrete blocks only were the main problems faced during the construction of the foundation. Architects also agree that problems with the foundation are very much related to the failure or success of the project. Where 23.3% believed that foundation problems are related to a lack of design in buildings, 16.6% believed that the lack of a soil study and settlement of the land caused problems for the foundation of buildings and 9.6% believed that construction with only concrete blocks created problems for buildings. These results shed light on the continuity and change of foundation issues in the residential projects.

Table 9: Main Problems Relating to Foundation Design and Suggested Solutions by Architects for the Foundation in Residential Building

No.	Existing Problems	Architect's suggestion
1.	Foundation is poorly constructed with concrete block only	Well designed and built properly to bear the weight of the building
2.	Wrong design	Soil test its important before foundation design
3.	No Problems	No Problems
4.	No design for steel bar	Consult from structure engineering
5.	Settlement	Compaction
6.	Foundations settlement	Using technique of strip foundation
7.	No Problems	No Problems
8.	Fall and declining	Design of Reinforced Concrete correctly
9.	Settlement	Soil control
10.	Settlement and crack	Mat foundation
11.	Foundation dimensions	Increase foundation dimensions
12.	Not create reinforced concrete foundations due to being expensive (Cost)	No Solution
13.	No foundation sometimes	No Solution
14.	Settlement in some place	Make soil test before creating foundation
15.	Settlement	Modify before creating foundation
16.	No design	Special design for all land
17.	Quality	Make foundations with specifications adequate
18.	Soil	Soil test
19.	Segregation	Using vibration
20.	Dirty land	Cutting the first face of land
21.	Poor Surface and poor soil	Surfaces needs to be Well-prepared
22.	Soil problems	Testing soil
23.	Soil problems	Cutting part of face from land
24.	Lake of soil study properly	A good study and analysis soil
25.	No design	Calculation for loads to making quite deep and length for foundation
26.	Cracks or decline	Raft foundation
27.	Soil problem	A good study for soil in different sectors
28.	Soil study	Create specific laboratory for testing soil
29.	Differences in levels and sometimes no foundation	Apply the regulations from the municipality more strictly
30.	Soil test	Test for soil before working
31.	Excavation without standard	Excavation with standard

32.	Soil, reinforced concrete and steel bars	Testing of soil, suitable reinforced concrete strength, and weight of steel bars
33.	Cracks, weakness and lack of foundation	Changing the type and materials of foundation
34.	No design	Must be client to make a design
35.	Testing soil and full by concert	Test for soil and create with slandered concrete ratio
36.	Cost	Should understand the advantages of foundation
37.	Settlement	Soil test before foundation
38.	Testing soil	Soil test before foundation
39.	Testing soil and design	Soil test and good design
40.	Lack of knowledge in design	Using cutting edge technology for the soil investigation
41.	Stability	Good surveying
42.	Soil of land	Cutting part of face from land
43.	Soil and settlement	Special design for all land
44.	Design, quality of material	Suitable design, good quality
45.	Design	Correct design
46.	Cracking	Good design
47.	Uneven or Sloping Floors and Crack	Modify surface of land
48.	Failure and Cracks + differential settlement	Backfilling and curing process + correct design.”
49.	No design	Arranging and building a plan to the building
50.	No design	Good design and good excavation
51.	They don’t so care about this part.”	Building and studying this party more scientifically
52.	Cracking	Crack reinforcement
53.	Poor Surface preparation	Well-prepared surfaces and uniformly compacted
54.	No design	Good design
55.	No design and no standard	Design by standard
56.	No design and sometimes no foundation	Make a suitable design
57.	Soil study	Good study and analysis to build a good quality construction
58.	No design	Good design
59.	Time	Technique
60.	Cracking	Changing the type of foundation

In addition to the problems with the foundation outlined by the architects and shown in Table 9, the architects also agreed that problems with the foundation could lead to

the failure of the building. During the field observation to capture the problems experienced in actual projects, Figure 13 illustrates the lack of a specific design for the foundation which was selected by the architects as well as an irregular foundation shape. Figure 14 shows the settlement and soil study of the foundation and also illustrates that the surface of the foundation has sloped and the wall constructed on the slanted foundation poses a problem for the block wall. Figure 15 shows construction with only concrete blocks without the use of any reinforcement concrete for the foundation of a residential building in Northern Iraq. These figures illustrate the problems faced with the selection of wrong foundation types in the erection of a building which could make the project a failure.

Figure 13: Lack of Foundation Design
(Taken by author, 2016)

Figure 14: Settlement and Soil Test for Land
(Taken by author, 2016)

Figure 15: Construction of Foundation Via Block Work
(Taken by author, 2016)

Figure 16: Residential Building in Northern Iraq
(Taken by author, 2016)

4.3.2 Main Problems Faced in the Wall of Residential Buildings in Northern Iraq

According to the results shown in Table 10, architects designated certain areas as the main problems faced in walls during the construction of residential projects in Northern Iraq. Most of the respondents argued that wall cracking, lack of insulation materials, poor quality of certain types of materials (such as block) were the main problems encountered during construction they also argued that the problems with the walls are related to the condition of the walls in buildings where 30.0% believed that wall problems were related to cracking walls in buildings, 21.6% cited a lack of insulation and 18.3% believed that poor quality blocks created problems for the walls in buildings. These results indicate that wall issues usually emerge when the wall is built with poor materials and finishing in the residential projects.

Table 10: Main Problems Relating to Wall Design and Suggested Solutions by Architects for the Wall in Residential Building

No.	Existing Problems	Architect's suggestion
1.	Built with concrete blocks which are not good for heat resistance	Changing it to Clay Bricks with insulation
2.	Wall cracking	Build wall in standard time
3.	Cracked wall	Need lighter materials for building construction
4.	No insulation materials	Use insulation materials on both sides
5.	Cracking	Build wall with good quality
6.	Crack	Monitoring bonding and materials during construction
7.	Built with concrete blocks	Changing the wall system to the non-load bearing wall and use insulation materials.
8.	Cracks	Utilizing of high-quality materials and avoiding to use concrete block units.
9.	Season problems	Thermal insulation
10.	Crack	Concentrating on the opening and build a wall in suitable time
11.	Block wall and no quality	We must use brick wall for weather conditions
12.	Environmental problem due to lack of insulation	Using better materials than hollow block and using layers as insulation

13.	Poor quality of block	Testing block before using in the building
14.	Crack	Create structure for beam and column
15.	Sloping of wall and dimensions of block	Concentrating on the opening and build wall in standard time
16.	Cracking	Changing the quality of materials
17.	Mostly they will not do good walls just putting blocks with small amount of mortar	Good quality of materials and also good insulation during working with walls.
18.	Moisture	No answer
19.	Walls not parallel	Using angles and equal dimensions
20.	Hot and cold problems	Using layers of insulation materials
21.	Lack of Insulation materials	Introducing more than a layer of the wall construction system, and using different materials like brick, wood, stone
22.	Bulking and shrinkage	No answer
23.	The only block use for wall	Using different materials like brick, stone
24.	Several types of cracks	A proper study for wall construction and study of the best solution for materials
25.	Most walls in block unit doesn’t look suitable for our environment	Using stone or brick wall suitable for environment
26.	Block wall	Bricks the best solution for Bearing Capacity, also for heat and sound solution
27.	Use of block for all land	Classify the wall materials according to the land and environments
28.	Lack of materials quality and insulation	Use insulation materials.
29.	Less insulation	Apply insulation materials
30.	Sound solution's and fire solution's	Using that materials it have that property
31.	Sloping of wall	Create wall materials according to the standard
32.	Cracking and materials quality like block	Dimensions of brick or block with good quality, have a good bond between blocks or bricks
33.	Lack of insulation	Using fiberglass or polystyrene insulation
34.	Changing in design during implementation	Employing an architect to control the work
35.	No insulation materials	Using sustainable materials

36.	Block, poor sound and thermal isolations	Introducing the advantages of other local building materials such as brick and stone
37.	Cracking and insulation	Make good foundation and use insulation materials
38.	Cracking and dimension of wall	Design for interior and exterior of wall
39.	Block and low quality of materials	Using a good quality of materials and using brick or stone than a block
40.	Insulation	Use of latest insulation materials
41.	Insulation	Appropriate materials
42.	Cracking	We must use materials for wall for cold and hot weather conditions
43.	Using wrong materials such as block	Using suitable materials with land location
44.	Design, quality of material	Suitable design, good quality
45.	Cracks	Chemical solution
46.	Block without insulation materials	Using materials with a good resistance for hot and cold condition
47.	A large crack in an exterior wall caused by soil contraction	We must use materials that have a large degree of thermal resistance and use insulation at the entire wall
48.	Quality, type of the materials	Using environmentally friendly materials like brick and wood
49.	Nonavailability of BRC for preventing cracks	Starting to build a new building code
50.	System of wall and sloping	Focus on the wall system and control
51.	In general using block in building	Using another materials like brick for more segregation
52.	Cracking	Epoxy repair
53.	Environmental problem due to lack of insulation	Using extra layers as insulation
54.	Most walls in block unit does not have a good thermal insulation	Using suitable insulation materials in wall
55.	Parallel to walls	Using angles and engineering ruler
56.	Insulation material	Using insulation materials on both sides of walls
57.	Quality of blocks wall	Good quality of materials
58.	Cracked wall	Need lighter materials for building construction
59.	Cracking	Materials rapier
60.	Wall system	Using a suitable system in the wall

Table 10 outlines the opinions held by the architects regarding the problems faced with the walls in residential projects in Northern Iraq. An observation in the field was

carried out to obtain photos of the problems in reality, Figure 16 shows wall cracking, Figure 17, a lack of Insulation materials, and Figure 18 shows the type of the materials such as blocks used for residential buildings in Northern Iraq. Material preferences are indeed different for each party depending on their individual concerns and interests, especially if they have to increase their awareness of wall techniques and materials option. During the observation carried out for this research, the focus was more on the block wall 20cm and some of the walls created by brick 24cm.

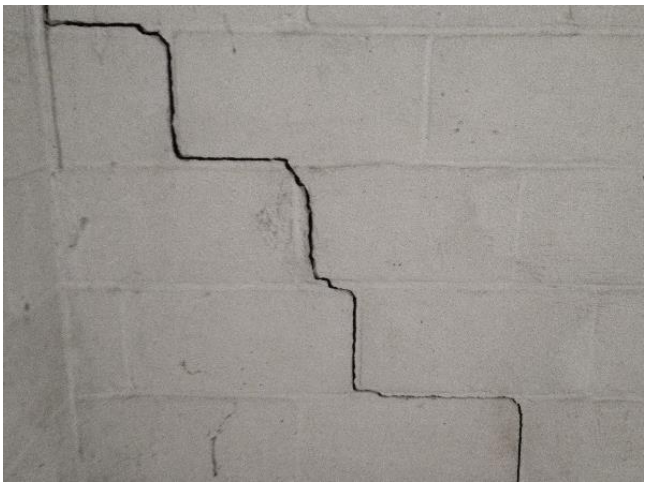

Figure 17: Wall Cracking
(Taken by author, 2016)

Figure 18: Lack of Thermal Insulation for the Wall
(Taken by author, 2016)

Figure 19: Poor Quality and Type of Materials Used for the Wall
(Taken by author, 2016)


Figure 20: Residential Building in Northern Iraq
(Taken by author, 2016)

4.3.3 Main Problems Faced in the Roof of Residential Buildings in Northern Iraq

The results outlined in Table 11 represent what architects selected as the main problems faced in the roof during the construction of residential projects in Northern Iraq. The vast majority of respondents argued that moisture or inadequate waterproofing, cracks or segregation and no insulation materials were the main problems encountered during the construction of the roof. Where 20% believed that roof problems tend to more frequently relate to moisture in the roof of the building,

18.3% believed that cracks or segregation created more problems for the roofs of buildings and 13.3% believed that a lack of insulation materials caused problems for buildings. The results show that the roof is, according to the architect responsible for making buildings comfortable but they seldom attempted to add an insulation layer to the roof during construction in the residential projects.

Table 11: Main Problems Relating to Roof Design and Suggested Solutions by Architects for the Roof in Residential Building

No.	Existing Problems	Architect's suggestion
1.	Constructed with reinforced concrete without any layer of thermal insulation or waterproofing insulation	Adding thermal and waterproofing insulation
2.	Roof thickness is less or more than standard	Should be designed roof rather than randomly
3.	Leaks	Insulation sheets
4.	No insulation materials	Using insulation material
5.	Moisture	Using waterproofing insulation
6.	Crack and water leakage	Using suitable materials and using for isogam surface
7.	Constructed with untendered reinforced concrete	Protect roof with thermal and waterproofing insulation
8.	Transpiration or leakage and moisture	Use of clean materials
9.	Moisture, thermal & sound	Waterproofing, sound and thermal insulation materials
10.	Small crack and no design for steel	Using a good cement and design for the steel
11.	Hot and cold	Use materials for weather conditions
12.	Cracks, leak of water	Using developed detail of roof
13.	Less of roof thickness sometimes 10 to 12 cm	Design for the roof from a professional engineering
14.	Moisture and crack	No answer
15.	Small crack because of water sloop	Level of the roof
16.	Cracks	Design for roof and use standard materials
17.	Cracking and liking and bad quality of materials	Using good materials waterproof materials and aware of humidity of area
18.	Moisture between the building	Make separate building (Detached)
19.	Segregation	Using vibration
20.	Hot and cold	Use insulation material

21.	No insulation and cracks and then resulted in leaks	I think providing multi-layer, and well-insulated roofs could fix this issue
22.	Deflection and shear punching	Setup steel at mid-span at bottom and the top near support
23.	Span of the roof	Design a suitable for roof separately
24.	Cracks and water dropping	A good academic study
25.	Thermal insulation	Making roofs with thermal solution because we have cold winter and hot summer
26.	reinforced concrete ready-coefficient and the quality of the steel	Casting site the best solution
27.	No design	Use a roof type according to the location
28.	Insulation	Use insulation material
29.	Leaking	Re-evaluate the ratios and qualities of the mixtures
30.	No design	Calculation the life load
31.	Thermal insulation	Use insulation material
32.	Thickness, Steel type, and span	Use suitable thickness, using suitable steel bars means no more and no less and determine allowable span.
33.	Water penetration, or cracks	Using find earth or asphalt insulations.
34.	Thickness of the slab	Employ a professional architect in the site
35.	Lack of insulation	Use insulation material
36.	No consideration to roof insulation	Constructing the roof with thermal insulation
37.	Insulation	Use insulation material
38.	Roof thickness	Build with the standard
39.	Cracks and design	Using suitable materials
40.	Insulation and green roof	Use of latest insulation materials that enable setting up green roofs
41.	Layers, water-proof	Follow the standardization
42.	Cracking and liking	Working in a good condition day
43.	Cracks	Using a standard and insulation material
44.	Design, quality of material	Suitable design, good quality
45.	Plaster (insulation)	Chemical solution
46.	Sound and thermal isolations	Using a good insulation material
47.	Weak structure and improper roof slope	Use a suitable structure of the roof according to the location
48.	Quality, type of the materials and design	Using environmentally friendly materials like wood
49.	No design	Making a plan for all the issues
50.	Segregation	Test for the correct which use in the roof
51.	Lack the layer type of materials	Using more than one layer for more segregation
52.	Leak and moisture	Waterproof and foam spray

53.	Segregation	Using vibrate
54.	Sound and thermal isolations	Using a good insulation material
55.	No Insulation	Using a suitable insulation
56.	Cracks and design of steel	Test for the cement before use to the roof
57.	Mostly cracking, leaking and bad quality of materials a	Using good materials waterproof materials
58.	Leaks	Insulation sheets
59.	Water flowing	Systematic slope
60.	Moisture	Waterproof

According to the results in Table 11, architects appeared to encounter some problems in regards to the roofs of residential buildings in Northern Iraq. During the field observation, as Figure 19 shows moisture and inadequate waterproofing in the roof was discovered, Figure 20 shows, cracks or segregation of the roof, and Figure 21 shows a lack of insulation materials in the roof of residential buildings in Northern Iraq. The observation period of this research tended to focus more on roofs produced by reinforced concrete with a thickness of 18cm.

Figure 21: Lack of Waterproofing in the Roof
(Taken by author, 2016)

Figure 22: Cracks and Segregation at Roof Level
(Taken by author, 2016)

Figure 23: Lack of Thermal Insulation for the Roof
(Taken by author, 2016)

Figure 24: Residential Building in Northern Iraq
(Taken by author, 2016)

4.3.4 Techniques Used in Foundation, Wall and Roof for Residential Building

According to the results, most of the architects responded that they didn't use any new techniques during the construction of the foundation and this creates a big problem for the success of the projects. Similarly, some of the architects used reinforced concrete (40x40), and this process is repeated for 32.1% of the residential projects which also creates problems during construction. These results show that the issue of using new techniques in the foundation in residential projects remains a convoluted issue.

According to the results, the majority of architects responded that they used a particular technique during the construction of the wall but this is not sufficient as results also showed the architects used a load-bearing wall constructed with block or brick materials; this is not a new technique in wall construction and it does not satisfy all requirements for the wall element to be successful in the buildings. These results show that new techniques for use in walls in residential projects need to be developed and made more suitable for the environments of the land area.

According to the results, architects responded that they mostly used the reinforced concrete technique during the construction of the roof. This points to the fact that architects are not aware of the new types of roofing materials to use in building construction, implying that the issue of using new techniques in the roofs of residential buildings is a complicated issue. Overall, the results indicate that architects are not mindful of the new types of roofing materials used in building construction.

4.3.5 Thermal Insulation Materials Used in the Foundation, Walls and Roof of Residential Buildings

The respondents' use of insulation materials outlined in Figure 22 shows that 70 % of the respondents don't use any insulation materials in the foundation in residential

projects in Northern Iraq and this has a negative impact on the building. While 20% of respondents said that they sometimes used insulation materials during foundation construction, only 10% responded that they generally used insulation materials for the foundation during construction in residential projects and the impact of this minute number on the total number projects in Northern Iraq is arguably negligible. The findings of this section show that most of the architects are not concerned with the use of insulation materials in the foundation of residential buildings.

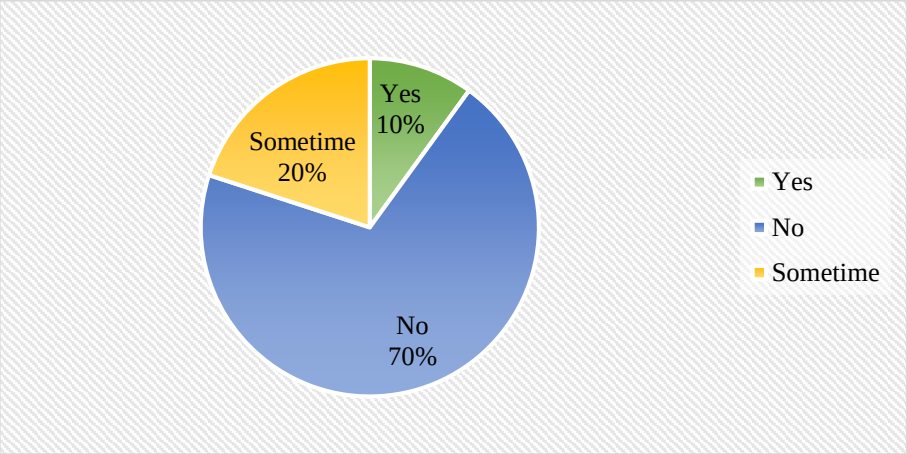

Figure 25: Percentage Use of Thermal Insulation Materials in the Foundation

Regarding the use of insulation materials in the wall of buildings, Figure 23 shows that more than a third 77% of the respondents revealed that they don't use any insulation layers in the walls of residential projects in Northern Iraq and this has a negative impact on the buildings. Where 15% of respondents said they occasionally used insulation materials during wall construction, only 8% responded that they used insulation materials in the wall during construction in residential projects and there is no significant implication considering the large number of the projects in Northern Iraq. The findings of this section buttress the notion that most of the architects are not

concerned with the insulation materials issues in the wall element which is one of the most important elements of the residential buildings.

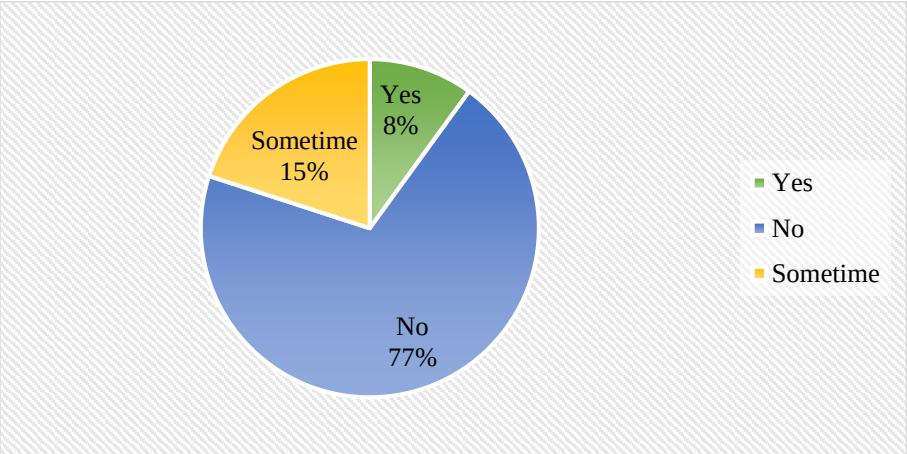

Figure 26: Percentage Use of Thermal Insulation Materials in the Wall

Figure 24 shows that 43% of respondents don't use any insulation materials in the roofs of residential projects in Northern Iraq and it has a negative impact on the performance of the building but less than in the cases of the foundation and the walls. 35% of respondents claimed that they occasionally used insulation materials on the roof of buildings while only 22% responded that they frequently used insulation materials during construction of residential projects in Northern Iraq. The findings of this section reveal that the architects are more interested in the use of insulation materials on the roof than in the foundations and walls of residential buildings.

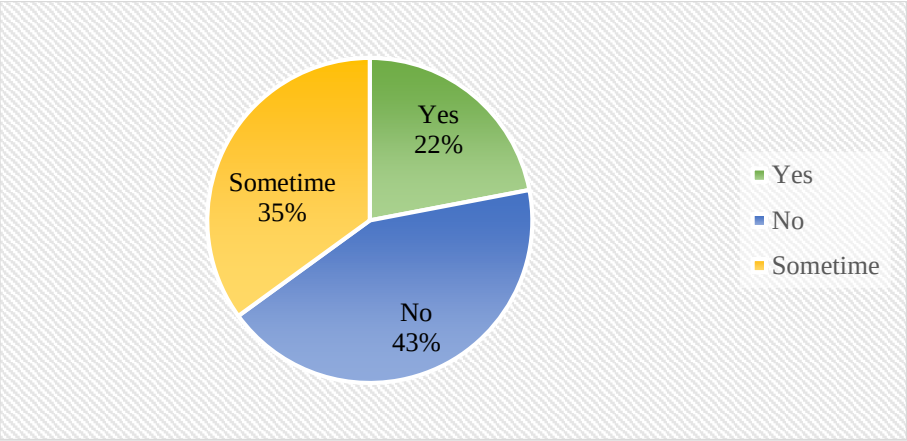

Figure 27: Percentage Use of Thermal Insulation Materials in the Roof

4.3.6 Type of Foundation, Wall and Roof in Residential Building

The best type of foundation for a residential building is shown in Figure 25; 70% of the respondents believe that raft or mat are the best types of foundation to use in residential buildings in Northern Iraq. 15% of them established that excavation foundation was also good to use in residential projects, 10% of respondents chose footing, while 5% selected other types of foundation. Based on the above results, the raft or mat appears to be the most suitable foundation for residential buildings in Northern Iraq. During the observation for this study, the researcher looked more at the foundations produced using the footing (40x40x40) and block wall. Overall findings also support the claim that the selection of a wrong foundation type for the building could lead to project failure.

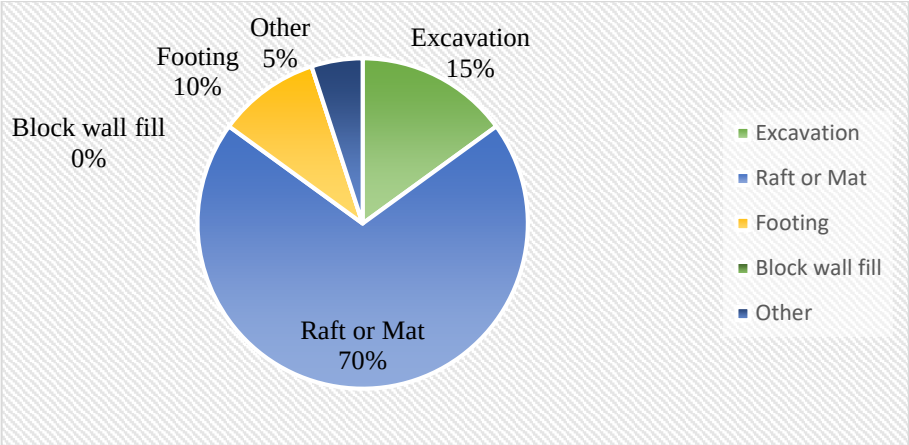

Figure 28: Architects Selected Type of Foundation for Residential Buildings

Figure 26 shows that 43% of respondents claimed that brick wall is the best type of materials to use in the construction of the wall in residential buildings in Northern Iraq. 30% of the respondents agreed that stone walls were good for use in residential projects, 14% of respondents chose block walls, 5% selected reinforced concrete, 3.35% selected timber, and 3.3% selected other wall materials and only 1.7% believed that glass was also a good materials to use in constucting a curtain wall within some types of residential buildings. Based on the above results, brick and stone walls appear to be the most suitable walls for residential buildings in Northern Iraq. Hence, during the observation for this research, the focus was more on the wall produced using block 20cm and some of the walls created by brick 24cm.

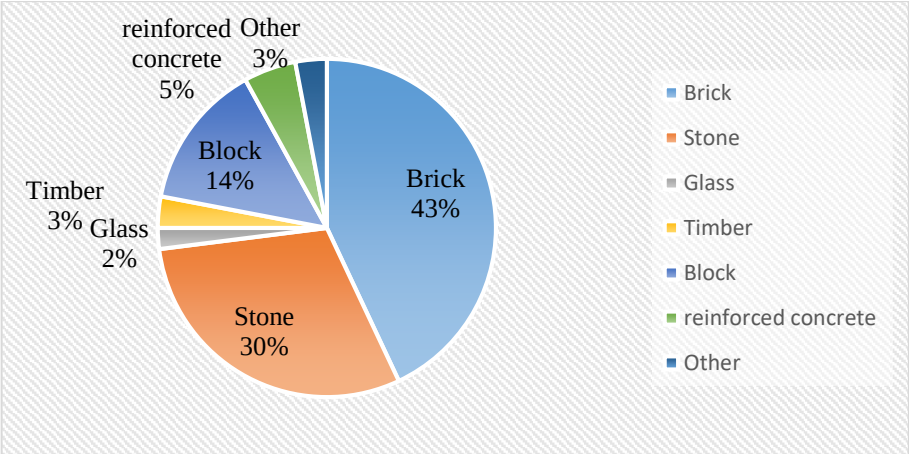

Figure 29: Architects Selected Type of Wall Materials for Residential Buildings

Figure 27 shows that 85% of the respondents believed that reinforced concrete is the best type of roof to use in residential buildings in Northern Iraq. Only 7% of respondents agreed that steel roofs were good to use in residential projects and 8% selected other types of roofing material. Based on the above results, the reinforced concrete roof seems to be the most suitable for residential buildings in Northern Iraq. Consequently, during the observation for this research, the focus was more on roofs constructed using reinforced concrete with 18cm thickness.

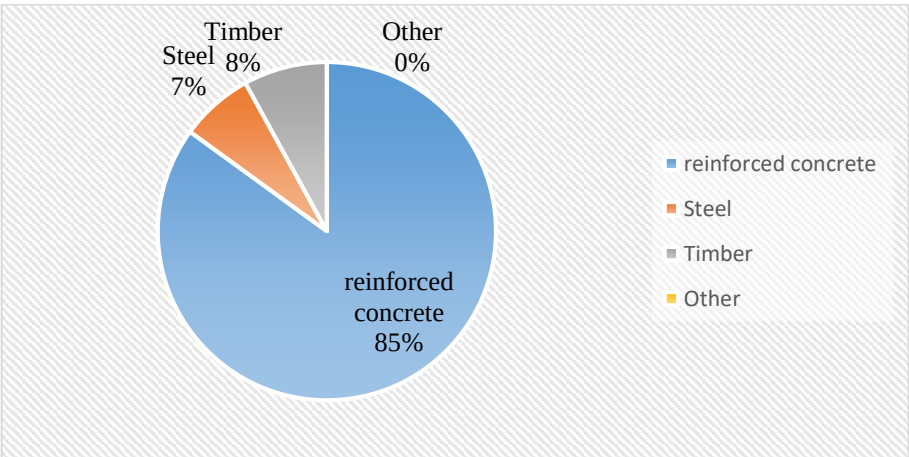

Figure 30: Architects Selected Type of Roof Materials for Residential Buildings

4.3.7 Main Success Factors for Foundation, Wall and Roof Construction in Residential Building

Figure 28 presents the factors that make the foundation design a success during construction in residential projects in Northern Iraq. From this table, it is obvious that there are three factors that may be recognized as foremost they are: the raft foundation 24%, soil test 22% and a suitable design. These factors dominated in construction projects in Northern Iraq.

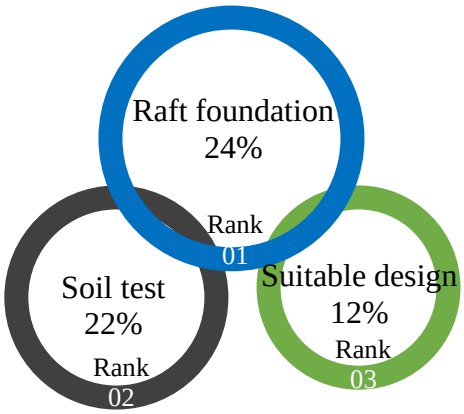

Figure 31: Success Factors Suggested by Architects for the Foundation Design of Residential Building

Figure 29 presents the factors that make the wall design a success in residential project construction in Northern Iraq. From this table, it is clear that there are three factors which might be recognized as the most important. These are the factors, related to the good quality of the materials 21.6%, walls with good insulation 16.6%, and changing the system to the use of non-load bearing walls in Northern Iraqi construction projects, would make projects successful.

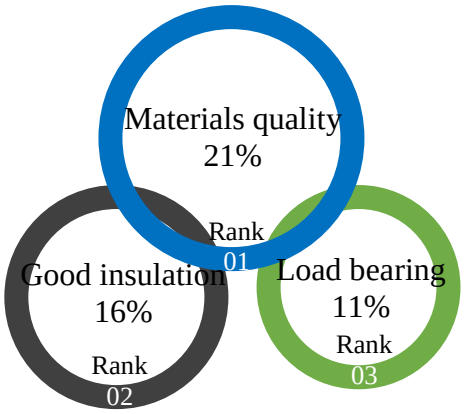

Figure 32: Success Factors Suggested by Architects for the Wall Design of Residential Building

Figure 30 presents the factors that make roof designs successful in residential project construction in Northern Iraq. From this table, it is obvious that there are three primary factors which might be recognized as most influenctial factors these are: the use of reinforced concrete with thermal insulation and waterproofing 25%, using insulation materials in the inner and outer parts of the roof 20% and an appropriate design for the slab in construction projects. All three factores contribute the most to the roof's success in Northern Iraqi residential projects.

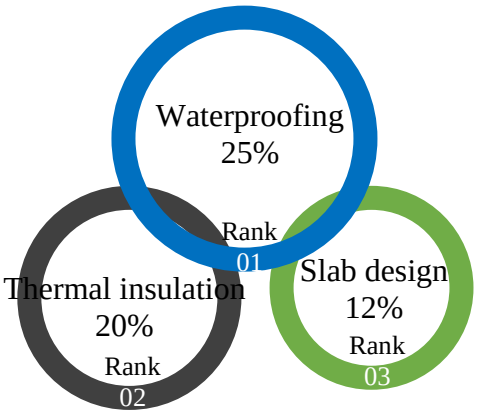

Figure 33: Success Factors Suggested by Architects for the Roof Design of Residential Building

4.4 Occupant Questionnaire Analysis

The demographic characteristics of the respondents relate to the type of house that they live in. Results in Table 12 show that majority of the participants live in attached houses at 75% and other in detached or semi-attached houses. The number of floors in the house is usually between one to three floors, but most of the houses, according to the table, consist of two floors 75% and one floor 25% because the culture of the city differs from that of other countries. All of the participants in the survey responded that they were the owner of the house in which they lived. One of the main questions asked to the participants was whether or not they were satisfied with their house and 65% responded that they were not satisfied with their house. According to Table 12, regarding the construction of the buildings, most of the participants appear to have bought the house at different stages. While 52% of the participants' houses were constructed between 1 – 3 years ago, 30% were constructed between 4-6 years ago, and these results are the good for the research as it shows that majority of the respondents' houses are relatively modern.

Table 12: Demographic Data of Occupants' Houses

Variable	**Options**	**Number of respondents**	**Percentage (%)**
Q1: Which type of your house?	a. Attached	30	75.0
	b. Detached	3	7.5
	c. Semi-attached	7	17.5
Q2: How many floors of your house?	a. One floor	8	20
	b. Two floor	32	80
	c. Three-floor	0	0
Q3: Are you……?	a. Owner	40	100
	b. Renter	0	0
Q4: Are you satisfied with your house?	a. Yes	14	35
	b. No	26	65

Q5: Are you build you house or bought?	No Bought in	a. Design stage, ,	23	3	57.5	17.6
		b. Construction stage		5		29.4
		c. Usage stage		9		52.9
	Yes		17		42.5	
Q6: When build your house?	Before 1-3 years		21		52.5	
	Before 4-6 years		12		30.0	
	Before 7-9 years		6		15.0	
	more than 10 years		1		2.5	

Question seven asked of the main problems occupant faced have in the house regarding the foundation, walls, and roof. Regarding the foundation, some of the respondents answered that in their opinion, they found no problems in the houses while some others replied that their house was built without a guiding design and this now causes some defects in the foundation. For the walls, most of the occupant said they experienced problems with cracking in the wall, and the lack of an insulation layer in the wall creates problems for their home during summer and winter. Moisture and inadequate waterproofing were the main problems cited with the roof. According to both the occupant and architects, the problems faced in their houses are similar to the problems in other residential houses in Northern Iraq.

Table 13 shows the house situation in Northern Iraq as its relates to changing: the facade of the house, where 55% answered that was no need to change it in their houses, 27.5% said it needed to be modified, and 17.5% said they had done it in the different building stages; the finishing materials, where 40% answered that they needed to change it, 32.5% that they did it already in the different stages of construction of the house, and only 27.5% answered that they don't need to change the finishing materials in their house; the interior space organization for which 47.5% answered that the needed to change it, 30% did it already during construction and only 22.5% answered

that they don’t need to change the space organization in their house; and partition where 60% answered that needed to add a partition in their houses, 20% did it already and 20% answered that they don’t need to add a partition to their house.

Table 13: Existing Problems with Occupants Housing Layout

Q8: Do you need to change the facades of your house? (size and location of openings)	We did it already in	a. Design stage,	7	0	17.5	0
		b. Construction stage		5		71.4
		c. Usage stage		2		28.6
	Yes		11		27.5	
	No		22		55.0	
Q9: Do you need to change finishing materials (paint, covering materials, door, and window)?	We did it already in	a. Design stage, ,	13	1	32.5	7.7
		b. Construction stage		7		53.8
		c. Usage stage		5		38.5
	Yes		16		40.0	
	No		11		27.5	
Q10: Do you need to change the space organization of interior spaces?	We did it already in	a. Design stage, ,	12	0	30.0	0
		b. Construction stage		2		16.7
		c. Usage stage		10		83.3
	Yes		19		47.5	
	No		9		22.5	
Q11: Do you need to add a part in your building?	We did it already in	a. Design stage, ,	8	0	20.0	0
		b. Construction stage		1		12.5
		c. Usage stage		7		87.5
	Yes		24		60.0	
	No		8		20.0	

4.5 Discussion of the Results

The findings and results of the survey are intended to reveal the current situation of architects in related to residential building construction and materials in Northern Iraq. Of the 132 architects in Northern Iraq to whom questionnaires were sent, only 45% responded. Most of the architects who responded were employed in small/medium-sized firms and were experienced in the areas of construction and materials. Analytical tests were conducted on the data and these tests included the mean, standard deviation, and factor analysis. The data was also grouped into tables, pie charts, frequencies and percentages. Furthermore, the results of the study corroborate the predictions made base on the literature review.

The general results of the research may be summarized as follows:

1. There are discrepancies between the awareness and implementation of new techniques in building construction which has led to an inability to attain their full benefits in residential projects. The research confirmed previous assertions that Northern Iraqi architects profess to be familiar with the impact of various building construction and materials as well as how their designs contribute to this, although study did discover an additional discrepancy between architects' knowledge claims and practices indicating their inability to translate their expertise into their decision-making processes.

2. Architects and designers alike agree that the success of the project should be taken into consideration in the design and construction processes. Sentiments regarding the use of new techniques in building construction and materials were also similar among the respondents.

3. The impact of architect concerns, occupant, stakeholder concerns, and government regulations on the use of new techniques in building construction and materials practices on the designer's decision-making was evident in this study. Results indicate that regulatory constrictions and designers' concerns were the two primary forces behind their implementation choices, while stakeholder pressure did not appear to exert any significant pressure. These findings reveal the importance of the designer's personal convictions on their decision making.

4. The study discovered that occupants, unsurprisingly, exert the greatest influence on the methods used in the construction process and materials selection. Occupants preferences determine the overall context within which decisions are made, and are instrumental in determining whether or not environmental goals are implemented in a project thereby constituting a pragmatic 'starting point' for design decision making. Conversely, the stakeholder is the least involved and exerts the least influence on decision making.

5. Over the course of the study, it was revealed that certain barriers to the incorporation of insulation materials in design decision making exist. "Cost" was repeatedly found to be a fundamental factor impacting the designer's ability to implement building construction methods. Respondents also noted that their inadequate understanding of design concepts and a lack of information on materials made it difficult to evaluate alternatives and inform their occupants adequately.

6. Within the context of the growing international focus on the development of new building construction techniques, the study found that there is a fundamental need to develop a simple and efficient method of construction assessment at the various stages of a project as it was discovered that current assessment tools had been compromised by practical issues such as a lack of familiarity with the tools, the skills necessary for their utilization, and the complexity of present assessment methods.

7. The primary challenge facing architects now is determining how to evaluate building materials options by aggregating performance.

8. The majority of architects displayed an interest in using some new techniques in construction and materials selection but face challenges in implementation.

The three main implementation barriers identified in the study were cost and time, materials, and occupants.

The cost was highlighted by architects as a major challenge faced in building construction and materials. Occupants demands for a suitable design and new construction approaches tended to raise costs especially for implementation which became a prevalent barrier. Regarding cost implications, one veteran respondent commented that “it is more expensive, so you need occupants to be on board to pay a little bit extra. In total, I think it is about a 10 or 20 percent extra cost, but still, that extra 20 percent makes a difference”. Time was also identified by respondents as a cost-related barrier as the time and cost demands for knowledge acquisition, and even

acquiring an understanding of design concepts were major barriers to their implementation.

Some barriers were also identified with materials selection. The reliability of information from product suppliers and manufacturers was difficult to decipher as although manufacturers and suppliers were attempting to make products more environmentally responsible, it was hard for the designers to differentiate between authentic and non-authentic products due to a lack of certification practices. This problem was also compounded by a lack of transparency on the part of the manufacturers and suppliers. Consequently, designers face challenges when attempting to source locally produced environmentally responsible products in place of imported products.

The greatest obstacles cited were feasibility and cost which often resulted in the client choosing to disregard the chosen design as the clients were unwilling to pay for environmentally responsible materials which tended to be more expensive. Although, respondents did not show this because the majority of designers were unfamiliar with the process of selecting environmentally responsible material costs should decrease over time as more experience is gained. Until such a time, however, this remains an expense to the client. Participants also highlighted the fact that clients expressed a preference for environmentally responsible materials until they were faced with the limited options and the not so user-friendly systems indicating clients' unwillingness to compromise on their aesthetic materials choices or the convenience the non-environment friendly systems offer. Until such a time where there is a wider selection of materials, designers and clients are forced to decide between limited alternatives.

Chapter 5

CONCLUSION

This research investigated building construction and materials practices in residential building design in Northern Iraqi projects. During the study, it was observed that additional research outside of the aims and scope of the present study is necessary. The focus of this study, however, has been identifying success factors, new techniques, and the effect of cost, time, quality, etc., on residential projects.

Architects' awareness of the increase in new construction methods warrants particular attention. From the literature, it is observed that the perception among professionals is that modern environment-friendly methods incur additional costs making conventional methods preferable as a way to keep costs low. The practical incorporation of environmental considerations in construction and materials selection practise was not ranked highly, as minimizing costs remained a fundamental concern.

Based on the review of the literature, criteria for building construction and materials were outlined for use in the construction materials selection process. The study ordered and summarized building construction and materials criteria in groups using a questionnaire of Northern Iraqi architects. It is noteworthy that the estimations and rankings gotten as a result of the survey are somewhat restricted to Northern Iraqi projects.

The methodology used in this study was mixed involving interviews, observation, and a questionnaire survey. The survey was conducted on architects that worked on Northern Iraqi construction projects. Data collection was done primarily through observation, questionnaires, and also interviews of the same architects to discuss the main problems and their suggested solutions to ensure the success of residential projects.

The questionnaire survey revealed that almost all of the participants employed different identification and evaluation methods in construction and materials selection in addition to benefitting from specific frameworks when deciding between which strategies to adopt as a response to risk.

Results revealed that almost all the costs of the construction process were incurred by the occupants and the lack of experience, coordination among architects, occupants, contractors and insufficient supervision resulted in increased costs. The analysis also revealed that the top ranked factors: cost, time, and quality, affected the overall progress of the projects in that order.

A comparison of these factors found them to be mutually reinforcing risk factors grounded in five foremost determinants: minimizing cost, architects themselves, budget constraints, unwillingness to change the conventional construction methods, and aesthetics. Most of the problems in residential building elements were found to relate to: a lack of design, settlement and soil study, and construction with blocks as the main problems in the foundation element; wall cracking, lack of insulation, type and poor quality of materials such as block as the main problems in the wall element; and moisture, inadequate waterproofing, cracks or segregation, and the lack of

insulation materials as the main problems in the roof element. On the other hand, it was found that the factors that would make projects successful were: in the foundation, raft foundation, soil test and a suitable design; for the walls, using good quality materials, good insulation, and changing the system to the use of non-load bearing walls; while the use of reinforced concrete with thermal insulation and waterproofing, insulation materials in the inner and outer parts of the roof, and an appropriate design for the slab in construction projects to contribute the most the roof's success in Northern Iraqi residential projects.

Results revealed that: a. There are gap between the awareness and implementation levels of new techniques in building construction by the architects b. The clients have the greatest influence on the methods used in the construction process and material selection. c. The architects displayed an interest in using some new techniques in construction and material selection but face challenges in implem entation. d. The lack of policies for controling building construction stages by the minusipality and comparing with the orginal drawings during the constraction perid.

Finally, this research into the building construction and materials issue shed light on the problems faced in residential projects in Northern Iraq. Although completed, the study has paved the way for similar inquiries especially those involving an international dimension. As the focus of this study was residential buildings subsequent studies could expand the scope to include other types of buildings such as commercial, offices, education building, etc.

REFERENCES

Ahadzie, D. K., Proverbs, D. G., & Olomolaiye, P. O. (2008). Critical success criteria for mass house building projects in developing countries. *International Journal of Project Management, 26*(6), 675-687.

Akintoye, A. (2000). Analysis of factors influencing project cost estimating practice. *Construction Management & Economics*, 18(1), 77-89.

Alibaba, H. (2016). Determination of Optimum Window to External Wall Ratio for Offices in a Hot and Humid Climate. *Sustainability*, 8(2), 187.

Alibaba, H. Z., & Özdeniz, M. B. (2004). A building elements selection system for architects. *Building and Environment*, 39 (3), 307-316.

Alibaba, H. Z., & Ozdeniz, M. B. (2016). Energy Performance and Thermal Comfort of Double-Skin and Single-Skin Facades in Warm-Climate Offices. *Journal of Asian Architecture and Building Engineering*, 15(3), 635-642.

Alibaba, H. Z., (2003). An expect system for the select of building elements during architecture design. (Doctoral Dissertation, Thesis. Eastern Mediterranean University. Famagusta, Cyprus).

Alibaba, H. Z., (1999). An analysis of materials supplier organization in construction sector of Northern Cyprus (Master, Thesis. Eastern Mediterranean University. Famagusta, Cyprus).

Aljanabi, H. K. (1987). Erbil City a Study on Geographical Urbanism. M*ousel: Dar Alkutb pre*ss -University of Mousel.

Al-Sanjary, H. A. (2008). The role of change in Resident needs on the properties of forming the Elevation of the Residence Unpublished Ph.D thesis, University of Technology Baghdad.

Al-Shwani, S. Y. B. (2011). Influence of Modernity versus Continuity of Architectural Identity on House Façade in Erbil City, Iraq (Doctoral Dissertation, Thesis. Universiti Sains Malaysia. Penang).

Alwi, S., Keith, H., & Sherif, M. (2001). Effect of quality supervision on rework in the Indonesian context. *Asia Pacific Building and Construction Management Journal*, *6*, 2-6.

Ashby, M. F., & Johnson, K. (2013). Materials and design: the art and science of materials selection in product design. Butterworth-Heinemann.

Aubin, N. N., Melo, U. C., Richard, M. J., Azigui, N. D., & Jean, N. (2016). Typology of Local Construction Materials. *Geomaterials,* 6(02), 50.

Auping, M., & Andō, T. (2002). Seven Interviews with Tadao Ando; [published in Conjunction with the Opening of the New Modern Art Museum of Fort Worth, Designed by Tadao Ando, December 2002]. Modern Art Museum of Fort Worth.

Babbie, E. R. (1990). Survey research methods, Wadsworth Pub. *Co., Belmont, CA*.

Baker, J. A., & Hamilton, L. H. (2006). The Iraq study group report: The way forward–A new approach. US Institute of Peace.

Bernold, L. E., & AbouRizk, S. M. (2010). Indicators of an Industry in Transition. *Managing Performance in Construction*, 1-12, John Wiley & Sons, Inc., Hoboken, NJ, USA

BSH3, 2016. Housing Construction Regulation. Retrieved from (2017, February, 2) http://www.bsh3.com/Default.aspx?page=page&c=ourservices

Chinyio, E. A., Olomolaiye, P. O., & Corbett, P. (1998). An evaluation of the project needs of UK building clients. *International Journal of Project Management*, 16(6), 385-391.

Czaja, R., & Blair, J. (1996). Designing surveys. A guide to decision and evaluation. Thousand Oaks, California; London, Pine Forge Press.

Desmet, P., & Hekkert, P. (2007). Framework of product experience. *International journal of design*, 1(1), 57-66.

Didenko, I., & Konovets, I. (2009). Success Factors in Construction Projects: A Study of Housing Projects in Ukraine. (Master Thesis. Umeå University Sweden).

Drewer, S. (2001). A perspective of the international construction system. *Habitat International*, 25(1), 69-79.

Durairaj, S. K., Ong, S. K., Nee, A. Y., & Tan, R. B. (2002). Evaluation of life cycle cost analysis methodologies. *Corporate Environmental Strategy*, 9(1), 30-39.

Emmitt, S., & Yeomans, D. T. (2008). Specifying Buildings: A Design Manangement Perspective. Routledge 261.

Erbil Governorate (2012). Kurdistan Region Citizens Live in Cities. (2016, June, 15) Retrieved from http://www.hawlergov.org/en/article.php?id=1341311956

Fellows, R. F., & Liu, A. M. (2015). Research methods for construction. John Wiley & Sons.

Fernandez, J. (2006). Materials architecture: emergent materials for innovative buildings and ecological construction. Taylor & Francis.

Gann, D. M., & Salter, A. J. (2000). Innovation in project-based, service-enhanced firms: the construction of complex products and systems. *Research policy*, 29(7), 955-972.

Gunter., M. M. (2004). Historical dictionary of the Kurds Lanham, Maryland and Oxford: Scarecrow Press, Inc.

HCECR. (2009). High Commission for Erbil Citadel Revitalization. Retrieved January, 2017, from http://www.erbilcitadel.org/index.php

Heshmati, A., Dilani, A., & Baban, S. M. (Eds.). (2014). The regional development strategy for the Kurdistan region 2012–2016. *Volume II*. Cambridge Scholars Publishing.

Ismael, A. Kh., & Ngah, I. (2010). Urban planning for small and medium cities in Kurdistan Region-Iraq: problems and available opportunities: *International Journal of Engineering Science and Technology*, 2(12), 7070–7077.

Karana, E., & Van Kesteren, I. (2006). Materials effects: the role of materials in people's product evaluations. *In conference on design and emotion* (Vol. 5).

Kishk, M., Al-Hajj, A., Pollock, R., Aouad, G., Bakis, N., & Sun, M. (2003). Whole life costing in construction: a state of the art review. *RICS Research Paper Series*.

KRG. (2013 a). Kurdistan's geography and climate. *Kurdistan Regional Government*. (2016, July, 12) Retrieved from http://www.krg.org/p/p.aspx?l=12&s=020000&r=303&p=213

KRG. (2013 b). The people of the Kurdistan Region. *Kurdistan Regional Government*. (2016, July, 12) Retrieved from http://www.krg.org/p/p.aspx?l=12&s=020000&r=304&p=214

Ling, F.Y.Y., Hartmann, A., Kumaraswamy, M. and Dulaimi, M. (2007) Influences on innovation benefits during implementation: client's perspective. *Journal of construction Engineering and Management,* 133 (4), 306-315.

Liu, A. M. (1999). A research model of project complexity and goal commitment effects on project outcome. *Engineering Construction and Architectural Management*, 6(2), 105-111.

Malnar and Vodvarka (2004) Sensory Design. University of Minnesota Press.

Ministry of Construction and Housing, (MOCH), (2010): Iraq national housing policy. Retrieved from (2016, September, 5) http://humanitarianlibrary.org/sites/default/files/2013/05/634247_INHP_English_Version.pdf

Nam, C. H., & Tatum, C. B. (1989). Toward understanding of product innovation process in construction. *Journal of Construction Engineering and Management*, 115(4), 517-534.

Naoum, S. G. (2012). Dissertation research and writing for construction students. Routledge.

Nassar, K., Thabet, W., & Beliveau, Y. (2003). A procedure for multi-criteria selection of building assemblies. *Automation in Construction*, 12(5), 543-560.

National Urban Housing Policy (NUHP) (2008): Retrieved from. (2017, February, 5) http://kcps.gov.rw/aset_uplds/files/National%20Urban%20housing%20Policy.pdf

Ngowi, A. B., Pienaar, E., Talukhaba, A., & Mbachu, J. (2005). The globalization of the construction industry—a review. *Building and Environment*, 40(1), 135-141.

Nooraddin, H. (2012). Architectural Identity in an Era of Change: *Developing Country Studies*, 2(10), 81–96.

Ofori, G. (1990). The construction industry: Aspects of its economics and management. NUS Press.

Pheng, L. S., & Hongbin, J. (2004). Estimation of international construction performance: analysis at the country level. *Construction Management and Economics*, 22(3), 277-289.

Polit, D. F., & Beck, C. T. (2004). Research: Principles and methods. *6th edition*. Lippincott Williams & Wilkins. Philadelphia.

Schifferstein, H. N., & Cleiren, M. P. (2005). Capturing product experiences: a split-modality approach. *Acta psychologica*, 118(3), 293-318.

Sorrell, S. (2003). Making the link: climate policy and the reform of the UK construction industry. *Energy Policy*, 31(9), 865-878.

Stansfield, G. R. V. (2003). Iraqi Kurdistan Political Development and Emergent Democracy. London: Routledge Curzon.

Stukhart, G., (1995) Construction Materials Management, Marcel Dekker Inc. NewYork.

Takim, R., Akintoye, A., & Kelly, J. (2004). Analysis of measures of construction project success in Malaysia. *In 20th Annual ACROM Conference* (pp. 1-3).

Tas, E., Yaman, H., & Tanacan, L. (2008). A building materials evaluation and selection model for the Turkish construction sector. *Engineering, Construction and Architectural Management*, 15(2), 149-163.

Toor S. and Ogunlana S (2008). Critical COMs of success in large-scale construction projects: Evidence from Thailand construction industry. *International Journal of Project Management*, 26(4), 420-430.

Trubka, R., & Glackin, S. (2016). Modelling housing typologies for urban redevelopment scenario planning. Computers, *Environment and Urban Systems*, 57, 199-211.

Utne, I. B. (2009). Life cycle cost (LCC) as a tool for improving sustainability in the Norwegian fishing fleet. *Journal of Cleaner Production*, 17(3), 335-344.

Van Kesteren, I. E. H. (2008). Product designers' information needs in materials selection. *Materials & Design*, 29(1), 133-145.

Vidogah, W., & Ndekugri, I. (1998). A review of the role of information technology in construction claims management. *Computers in industry*, 35(1), 77-85.

Weisberg, H., Krosnick, J. A., & Bowen, B. D. (1996). An introduction to survey research, polling, and data analysis. W.H. Freeman company. New York USA

Yitmen, I., and Alibaba, H. Z. (2005) An investigation of self-sustaining finance systems for property development in north Cyprus. *Management*, 1, 249-58.

APPENDIX

Appendix A: Questionnaire Survey

Eastern Mediterranean University
Faculty of architectural
Master in Architecture _ (2016 – 2017)

Dear Sir. or Madam :- Date: 1 / 7-8-9 / 2016

Research about:

Many residential projects in northern Iraq suffer construction problems and inappropriate materials usage. Our effort in this research is to determination the main causes of obstacle and given a suitable solution to the barrier. The designing of this questionnaire by the way that you able to make your proposals as a feature of your priceless commitments to this work. We want to appreciate you very much if you range of a couple of minutes to finish the questionnaire survey. All answers will be dealt with in total certainty and utilized for academic purposes as it were. In finally, we might want many thanks for your esteemed and kind thought.

Hasan Kalwry, M.Sc. Researcher

Supervised by: **Assoc. Prof. Dr. Halil Alibaba**
Eastern Mediterranean University
Tel: **0964 750 404 9722 + 0090 533 821 4479**

Email: **Hasan.samih@yahoo.com** Code (…….)

Section A: General Information: -

1- **Work experience in the construction industry and materials?**

a. 0 - 5 years ☐ b. 6 - 10 years ☐ c. 11 - 15 years ☐ d. more than 15 years ☐

2- **What type of organization do you work for?**

a. Architecture office ☐ b. Contractor ☐ c. Government ☐ d. Education ☐ e. Other ☐

3- **What is your position in your firm?**

a. Director/ CEO ☐ b. Project Manager ☐ c. Office Architect ☐ d. Site Architect ☐
e. Other ☐

4- **What kind of construction project you specialize in?**

a. Residential □ b. Commercial □ c. Industrial□ d. Institutional □ e. Other □

5- **Approximately, a number of annual projects?**

a. 0 - 5 Projects □ b. 6 - 15 Projects □ c. 16 - 30 Projects □ d. More than 30 Projects □

6- **Please indicate your level of skill in building construction and materials?**

Extremely aware □ Moderately aware □ Somewhat aware □ Slightly aware □ Not aware□

7- **Select main importance part in the construction of Northern Iraq.**

a. Foundation □ b. Ground (Floor) □ c. Wall □ d. Roof □ e. Satire □ f. All □ g. Other□

8- **What is the most important factor in the construction of a residential project in Northern Iraq?**

a. Cost □ b. Time □ c. Quality □ d. Safety □ e. Environment f. Others □

9- **Does your design face any pressure from stakeholders?**

Yes □ No □ if yes please select!

a. Client □ b. Community □ c. Environmental □ d. Government □ e. Colleague □

10- **Do you have any system in building construction and materials?**

Yes □ No □ if yes please select!

a. Recommendation □ b. Price □ c. Experience □ d. Market reputation □ e. Others □

Section B: Awareness and related action in building construction and materials of residential projects in Northern Iraq:

11- **Rate the following as they affect building construction and materials of a residential project practices in Northern Iraq?**

Lowest (Ls) (1) Low (L) (2) Medium (M) (3) High (H) (4) Highest (Hs) (5)

Statements	**1 (Ls)**	**2 (L)**	**3 (M)**	**4 (H)**	**5 (Hs)**
a. Lack of access to current and relevant information	□	□	□	□	□
b. Inadequate instructions about materials	□	□	□	□	□
c. Lots of manpower and time in analysing & selecting proper material	□	□	□	□	□
d. Consideration of sustainable materials	□	□	□	□	□
e. Budget constraints	□	□	□	□	□
f. The problem in determining priorities	□	□	□	□	□
g. Inadequate current construction techniques	□	□	□	□	□
h. Building regulation(codes & ordinances)	□	□	□	□	□
f. Others	□	□	□	□	□

12- **Please rate on the following project objectives when starting a building construction project?**

Lowest (Ls) (1) Low (L) (2) Medium (M) (3) High (H) (4) Highest (Hs) (5)

Statements	**1 (Ls)**	**2 (L)**	**3 (M)**	**4 (H)**	**5 (Hs)**
a. Meet project deadline	☐	☐	☐	☐	☐
b. Satisfy client specification	☐	☐	☐	☐	☐
c. Minimize cost	☐	☐	☐	☐	☐
d. Minimize project impact on the environment	☐	☐	☐	☐	☐
e. Meet building regulations	☐	☐	☐	☐	☐

13- **Please indicate how much impact each following professionals in building construction and materials of residential project in Northern Iraq?**

Lowest (Ls) (1) Low (L) (2) Medium (M) (3) High (H) (4) Highest (Hs) (5)

Statements	**1 (Ls)**	**2 (L)**	**3 (M)**	**4 (H)**	**5 (Hs)**
Contractors	☐	☐	☐	☐	☐
Site Managers	☐	☐	☐	☐	☐
Project Managers	☐	☐	☐	☐	☐
Architects	☐	☐	☐	☐	☐
Client	☐	☐	☐	☐	☐
Technical consultants	☐	☐	☐	☐	☐
Others (Please specify)	☐	☐	☐	☐	☐

14- **What obstacles currently face you in building construction and materials in your design?**

Least Important (L I) (1) Fairly Important (F I) (2) Important (I) (3) Very Important (V I) (4) Extremely Important (E I) (5)

Statements	**1 (L I)**	**2 (F I)**	**3 (I)**	**4 (V I)**	**5 (E I)**
Lack of tools and data to compare materials alternatives	☐	☐	☐	☐	☐
Lack of information on building construction materials	☐	☐	☐	☐	☐
Maintenance concern	☐	☐	☐	☐	☐
Limited availability & reliability of suppliers	☐	☐	☐	☐	☐
Unwillingness to change the conventional way of specifying	☐	☐	☐	☐	☐
Problem in Evaluating information	☐	☐	☐	☐	☐
aesthetically less pleasing	☐	☐	☐	☐	☐

15- **Please rate the criteria of their significance in the building construction and materials in a residential project in Northern Iraq?**

Least Important (L I) (1) Fairly Important (F I) (2) Important (I) (3) Very Important (V I) (4) Extremely Important (E I) (5)

Statements	1 (L I)	2 (F I)	3 (I)	4 (V I)	5 (E I)
Maintainability	□	□	□	□	□
Life expectancy of materials (e.g. strength, durability, etc.)	□	□	□	□	□
Fire resistance	□	□	□	□	□
Sound insulation	□	□	□	□	□
Methods of extraction of raw materials	□	□	□	□	□
Energy saving and thermal insulation	□	□	□	□	□
Materials availability	□	□	□	□	□
Health and safety	□	□	□	□	□
Aesthetics	□	□	□	□	□
Life cycle cost (initial cost, maintenance cost, repair cost etc)	□	□	□	□	□
Use of local material	□	□	□	□	□
Ease of construction / buildability	□	□	□	□	□

Section C: Foundation in residential building construction and materials:

Q1: Please explain three to five main problems in Foundation in Northern Iraq?

a ……. b ……. c ……. d ……. e …….

Q2: Do you use any new technique in Foundation construction?

Yes □ No □ Sometime □ if Yes or Sometime please explain: □…….

Q3: Do you use any insulation materials in Foundation construction?

Yes □ No □ Sometime □ if Yes or Sometime please write type a ....… b……

Q4: In your experience which the type its best to Foundation in a residential building in Northern Iraq.

a. Excavation □ b. Raft or Mat □ c. Footing d. Block wall fill □ e. Other □ …….

Section D: Wall in residential building construction and materials:

Q1: Please explain three to five main problems in Wall in Northern Iraq?

a ……. b ……. c ……. d ……. e …….

Q2: Do you use any new technique in Wall construction?

Yes, □ No □ Sometimes □ if Yes or Sometime please explain: . □…….

Q3: Do you use any Insulation materials in Wall construction?

Yes □ No □ Sometimes □ if Yes or Sometime please explain: □…….

Q4: In your experience which the materials its best to Wall in a residential building in Northern Iraq.

a. Concrete □ b. Timber □ c. Block □ d. Brick □ e. Stone □ f. Glass □ g. Other □…

Section E: Roof in residential building construction and materials:

Q1: Please explain three to five main problems in Roof in Northern Iraq?

a ……. b ……. c ……. d ……. e …….

Q2: Do you use any new technique in Roof construction?

Yes □ No □ Sometimes □ if Yes or Sometime please explain: □…….

Q3: Do you use any Insulation materials in Roof construction?

Yes □ No □ Sometimes □ if Yes or Sometime please explain: □…….

Q4: In your experience which the materials its best to Roof in a residential building in Northern Iraq.

a. Reinforced concrete □ b. Timber □ c. Steel □ d. Other □…….

Section F: Success in residential building construction and materials:

In your opinion what of main factors make residential projects successful in your design of building construction and materials in Northern Iraq regarding to:

1- **Foundation and Floor** please define factors:

a ……. b ……. c ……. d ……. e …….

2- **Wall** please define factors:

a ……. b ……. c ……. d ……. e …….

3- **Roof** please define factors:

a ……. b ……. c ……. d ……. e …….

This is the end of the questionnaire, if you have any comments regarding to the all questioner, please feel free to mention them here

……

Thank you very much for your time.

Section G: Occupants questionnaire in construction and materials:

Q1: Which type of your house

a. Attached □ b. Detached □ c. semi-attached □

Q2: How many floors of your house?

a. One floor □ b. two-floor □ c. three-floor □

Q3: Are you.....?

a. Owner □ b. renter □

Q4: Are you satisfied with your house?

Yes □ No □

Q5: Are you build you house or bought?

Yes □ No Bought □ if bought in which stage did you buy this house

Design stage □ Construction stage □ Usage stage (it was complete) □

Q6: When build your house?

Before 1-3 years □ Before 4-6 years □ Before 7-9 years □ more than 10 years □

Q7: What kind of main problems you have in your house regarding to:

1. **Foundation** please define problem:

a ……. b ……. c ……. d ……. e …….

2. **Wall** please define problems:

a ……. b ……. c ……. d ……. e …….

3. **Roof please define problems:**

a ……. b ……. c ……. d ……. e …….

Q8: Do you need to change the facades of your house? (size and location of openings)

Yes □ No □ We did it already □ in (Design stage, Construction stage, Usage stage)

Q9: Do you need to change finishing materials (paint, covering materials, door, and window)?

Yes □ No □ We did it already□ in (Design stage, Construction stage, Usage stage)

Q10: Do you need to change the space organization of interior spaces?

Yes □ No □ We did it already□ in (Design stage, Construction stage, Usage stage)

Q11: Do you need to add a part in your building?

Yes □ No □ We did it already□ in (Design stage, Construction stage, Usage stage)

This is the end of the questionnaire, thank you very much for your time.

……