UNIVERSITI PUTRA MALAYSIA

ADAPTATION OF VERNACULAR ROOF FUNCTIONS IN CONTEMPORARY RESIDENTIAL BUILDINGS IN KASHAN, IRAN

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By

ELHAM MAGHSOUDI NIA

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, In Fulfilment of the Requirements for the Degree of Master of Science

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DEDICATION

With all my love, I would like to dedicate this thesis especially to my beloved husband, *Sattar*. No words can express my sincere thanks and boundless gratitude for your true and constant love, kindness, continuous and unfailing supports, and motivation. I owe you my strength and tranquillity.

And

To my lovely country, I am looking forward to a bright and great future for Iran. A future in which, people are its wealth, wisdom is its power and peace and love are purposes of our country.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

ADAPTATION OF VERNACULAR ROOF FUNCTIONS IN CONTEMPORARY RESIDENTIAL BUILDINGS IN KASHAN, IRAN

By

ELHAM MAGHSOUDI NIA

November 2014

Chairman: Associate Professor Nordin Abd Rahman, PhD
Faculty: Design and Architecture

Generally, roofs are designed to provide shelters and protect indoor against extreme weather, while, roofs of the vernacular residential buildings (VRB) in Iran served more than the protective function. In comparison to the past, roofs functions of the contemporary residential buildings (CRB) have been neglected in recent years. This study has aimed to explore the roofs functions in the VRB of Iran and identify the factors that have to be considered in considering adaptation of the vernacular roofs functions for the CRB. The mixed-method case study has been selected for this study and the research has focused on Kashan, a historical city with flat and domed roofs in hot and dry climatic condition. After analysing the literature, the study has developed the theoretical proposition including roofs of residential buildings can provide multiple functions including protective, aesthetic, environmental and cultural functions. The study has considered each local master builder and expert as the qualitative unit of analysis, while, each individual who is living in residential building of Kashan has been the quantitative unit of analysis. Data have been obtained through semi-structured interviews with selected local master builders and experts, non-participant observation of selected VRB, and survey of people's opinions. Validation of proposition has been obtained through using triangulation in qualitative data collection and statistical analysis. The triangulated data sources including interview, non-participant observations of the selected VRB in Kashan, and survey questionnaire have achieved the same results, all supported the roof functions constructs, and confirmed the proposition. Furthermore, the survey results have shown people have preferred the vernacular roofs and tended to adapt the vernacular roof functions for the CRB. However, economy, privacy, safety, thermal comfort, and people culture have to be considered in adapting the vernacular roof functions in the CRB. Therefore, the study has finalized the proposition to roofs of residential buildings can provide multiple functions including protective, environmental, aesthetic and cultural functions in a private and secured context. In conclusion, the study has contributed in merging modern architecture and lifestyle of people with vernacular roof concepts for improving the roof functions in the CRB of Iran and helped to sustain the vernacular concepts of architecture and traditional values of a developing country when following western lifestyle.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Sarjana Sains

ADAPTASI FUNGSI BUMBUNG VERNAKULAR DALAM BANGUNAN KEDIAMAN KONTEMPORARI DI KASHAN, IRAN

Oleh

ELHAM MAGHSOUDI NIA

November 2014

Pengerusi: Profesor Madya Nordin Abd Rahman, PhD
Fakulti: Rekabentuk dan Senibina

Bumbung direka untuk memberikan perlindungan dan melindungi dalaman terhadap cuaca yang melampau, pada asasnya, manakala, bumbung dalam bangunan kediaman vernakular (VRB) di Iran berkhidmat lebih daripada fungsi perlindungan. Berbanding dengan masa lalu, bumbung fungsi bangunan kediaman kontemporari (CRB) telah diabaikan pada tahun-tahun kebelakangan ini. Kajian ini bertujuan untuk meneroka bumbung fungsi dalam VRB Iran dan mengenal pasti faktor-faktor yang perlu diambil kira dalam mempertimbangkan penyesuaian fungsi bumbung vernakular untuk CRB itu. Case study mixed-method telah dipilih untuk kajian ini dan penyelidikan telah memberi tumpuan kepada Kashan, sebuah bandar bersejarah dan kuno dengan bumbung rata dan kubah dalam keadaan iklim panas dan kering. Selepas menganalisis literatur, kajian telah membangunkan proposisi teori termasuk bumbung bangunan kediaman boleh memberikan fungsi perlindungan, estetik, persekitaran dan budaya. Kajian ini telah dianggap setiap tempatan pembina tuan dan pakar-pakar sebagai unit kualitatif analisis, manakala, setiap individu yang tinggal di bangunan kediaman Kashan telah unit kuantitatif analisis. Data diperolehi melalui temu bual separa struktur dengan pakar pembina tempatan dipilih dan pakar-pakar, non-participant observation terpilih VRB, dan survey pendapat rakyat. Proposisi validasi telah diperolehi melalui menggunakan triangulasi dalam pengumpulan data kualitatif dan analisis statistik. Sumber data tersegitiga termasuk temubual, non-peserta pemerhatian VRB yang dipilih dalam Kashan, dan survey soal selidik telah mencapai hasil yang sama, semua sokongan bumbung fungsi konstruk, dan yang disahkan proposisi. Tambahan lagi, hasil survey telah menunjukkan, orang lebih suka bumbung vernakular dan cenderung untuk menyesuaikan fungsi bumbung vernakular di CRB itu. Walau bagaimanapun, ekonomi, privasi, keselamatan, keselesaan terma, dan orang budaya perlu dipertimbangkan apabila menyesuaikan fungsi bumbung ibunda dalam CRB. Oleh itu, kajian itu telah dimuktamadkan proposisi untuk bumbung bangunan kediaman boleh memberikan fungsi perlindungan, alam sekitar, estetik dan budaya dalam konteks swasta dan terjamin. Kesimpulannya, kajian ini yang telah menyumbang bergabung seni bina moden dan gaya hidup orang dengan konsep bumbung vernakular untuk meningkatkan bumbung fungsi dalam CRB itu dan telah membantu mengekalkan konsep vernakular seni bina dan nilai-nilai tradisional sebuah negara membangun apabila berikut gaya hidup barat.

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I certify that a Thesis Examination Committee has met on **(25 November 2014)** to conduct the final examination of Elham Maghsoudi Nia on her thesis entitled "**Adaptation of Vernacular Roof Functions in Contemporary Residential Buildings in Kashan, Iran**" in accordance with the Universities and University Colleges Act 1971 and the constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis examination Committee were as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the Master of Science. The members of the Supervisory Committee were as follows:

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Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
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Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: _____	Signature: _____
Name of Chairman of Supervisory Committee: Nordin Abd Rahman	Name of Member of Supervisory Committee: Mohd Yazid Mohd Yunus

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LIST OF ABBREVATIONS AND GLOSSARY OF TERMS

Bahar-Khab	*Two r*ooms with flat roof in upper level in besides and along the *Sharomi*.
CRB	Contemporary residential buildings: The considered houses in this study that have been constructed since 1961.
Domed Roof	A type of roof similar to semi-sphere. The domed roofs in VRB are different with those in other types of buildings such as mosques. Indeed, they are a type of vaulted roof but bigger and more round and stand on ribs, but the master builders and expert called them dome.
Gheyd-Poush (*Sandouheh-Sazi*)	A technique for making double-surfaces roofs.
Godal-Baghcheh	The houses with central courtyard in lower level and into the ground.
Hozkhaneh	A space with a central pool.
Khancheh-Poush	A type of domed roof.
Taq-o Cheshmeh	A type of vaulted roof with four ribs in four sides of span, which can be repeated along the space.
Taq-o Tavizeh	A type of vaulted roof consisted of ribs, which repeated along the span.
Cheshmeh Taq	A central dome with four smaller dome around it, which they are known as dome in VRB.
Mahtabi	An open space without roof, usually located on the basement and in upper level, which surrounded by rooms in three sides.
Master Builder	The specialist builders of the vernacular residential buildings in Kashan with the knowledge of construction and architecture of the region and are well-known in their city, Kashan, due to their recognized experiences.
Roof	The final level of building, which mainly acted as a shelter.
Sharomi	A narrow and long open space around the courtyard, but in upper level, which its main function was corridor.
VRB	Vernacular residential buildings: The houses, which have been built between 1778 after a great earthquake upto1920.
Vaulted Roof	A curved roof that was used in large spans, in some cases extended between ribs and included different types.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Environmental and sustainability concerns have raised interest in roof design and consequently emerging new approaches such as green roofs and garden roofs in recent years. The roofs are known as the fifth elevations of buildings due to their importance (Sadeghipey, 2011). They are the most exposed surfaces to ambient among the external envelopes of buildings (Yannas, Erell, & Molina, 2006). Hence, roofs are normally designed to provide shelter and protect indoor against extreme weather. Nevertheless, in the past, some vernacular roofs within the residential buildings in Iran served more than shelters against extreme weather. Roofs were other efficient open spaces in the vernacular residential buildings (VRB), which the occupants could take advantage of them. They were considered as other living spaces with the multiple functions. The vernacular roofs, which utilized local and available materials such as mud and straw, provided spaces for residents' activities including sleeping at night, watching the stars, drying washed clothes, fruits and vegetables. However, these living roofs have been disappeared in the new residential buildings. Regarding the new appeared movements and history of the vernacular roofs in Iran, professionals should look back, reconsider the design of roofs, and revitalize this important element in the buildings (Sadeghipey, 2011). Therefore, this study has explored the different roofs functions of the VRB in Iran and identified the factors that have to be considered in adapting the vernacular concepts for contemporary residential buildings (CRB).

1.2 Problem Statement

Iran has been one of the great civilization of the world in the history and the Persian people have significantly contributed in the development and promotion of the culture (Kargar, 2003). Iranian architects have also contributed significantly in advancement of Islamic architecture. Islamic art inspired from Sasanian traditions and Iranian architecture characteristics such as semi-circular arches and elliptical domes. *Muqarnas* as a technique in domed or vaulted roofs of the buildings in Iran, have been influenced on Egypt and Islamic Spain (Shafa, 2006). These samples represent the influence of Iranian architecture on the design of buildings in the other countries. Nevertheless, these valuable concepts have been neglected in recent years, and foreign technologies, architecture and lifestyle have been emerged, which are unfamiliar with Iranian culture.

According to Mirmoghtadaee (2009) modernization and urbanization in Iran has led to substitute of apartments for individual houses. The physical and spatial characteristics of the vernacular houses in Iran were in response to the environment, geographical, culture and lifestyle of the people. The development changed the physical features of living, while, the culture, values and lifestyle has left unchanged. Hence, when the new types of residence are not according to the traditions and lifestyle of habitants and they cannot change it as their wishes, consequently their values would be disappeared. Foreign companies and most architects, who were educated abroad, designed most of the new constructions without considering Iranian

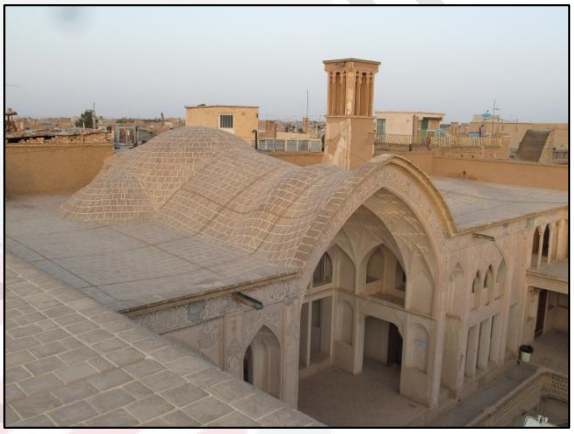
traditions. Therefore, they imitated western architecture in design of the buildings. The modern architecture brought western and new lifestyle for Iranian people (Mirmoghtadaee, 2009; Moradchelleh, 2011).

Open spaces including roofs played the major role in greening, enhancing quality of the indoor environment and provision of living spaces. Rooftop in vernacular houses provided open space for living activities of occupants in different seasons (Mirmoghtadaee, 2009). They provided the possibility of watching the city, passages and neighbors communications, while living in apartments has diminished these functions and converted the roofs to useless spaces, which are full of chimneys and pipes (Haeri, 2010). By developing cities, increasing constructions and disappearance of the vernacular architecture principles, roofs have lost their importance in the CRB. Changing the vernacular introverted buildings to the multi-storey buildings has caused disappearing of privacy in the buildings and particularly roofs, which caused psychological disadvantages for people. Consequently, disappearance of the vernacular roofs functions are achievements of the new residential buildings (Mirmoghtadaee, 2009). High cost of the land necessitates maximum utilizing of it, while, large area of the roofs that can provide spaces for living, restoration, playing and exercising have been mainly abandoned (Sadeghipey, 2011). Contemporary roofs have been converted to forgotten and dead spaces in buildings with unsightly appearances. They have changed to spaces for keeping equipment, installations, chimneys, and antennas. They are more similar to storages rather than beautiful and living spaces (Fig. 1.1). Therefore, the identified research problem for this study has been neglecting roofs functions in the CRB. This study has aimed to encourage adaptation of the vernacular roofs function for the CRB.

(a) Mohseni house, Tehran, Iran

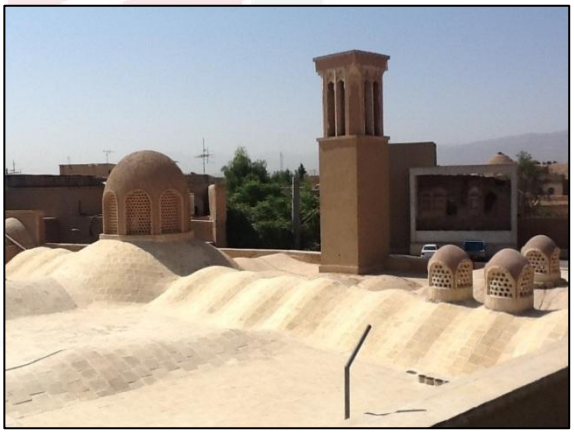
(d) Boroujerdi house, Kashan, Iran

(b) Mohseni house, Kashan, Iran



(e) Abbasian complex, Kashan, Iran

(c) Shab Zendehdar house, Kashan, Iran



(f) Ameriha complex, Kashan, Iran

Figure 1.1. Roofs in the VRB and CRB, a-c. New roofs in the CRB Made by Improper Materials – Used only for Keeping Chimney and Installation, d-f. Roofs in the VRB that Served Different Functions by Using Appropriate Materials and Elements on the Roofs, Using Natural Resources, and Providing Spaces for Residents' Activities
(Source: author, 2012)

1.3 Research Questions

The main question and the sub-research questions of the study are as follows:

Main RQ: What factors have to be considered in adapting the VRB roofs functions for the CRB in Kashan, Iran?

Sub-RQ1: What are the functions of roofs in the VRB of Kashan, Iran?
Sub-RQ2: What factors have to be considered in adapting the VRB roofs functions for the CRB in Kashan, Iran?

1.4 Research Aim and Objectives

The main aim of this study is to investigate the vernacular roofs functions in the VRB of Kashan, Iran. Thus, the study has set two objectives as follows:

Objective 1: To investigate the roofs functions in the VRB of Kashan, Iran.
Objective 2: To identify the factors that have to be considered in adapting the VRB roofs functions for the CRB in Kashan, Iran.

1.5 Significance of the Study

The large areas of the roofs have been abandoned in the CRB without significant use, while, unsightly contemporary roofs can be converted to the pleasant roofs (Sadeghipey, 2011). Rooftops have large surfaces in the cities, which affect the ecology function of the urban (Taheri, Rahman, & Salleh, 2009). The reduction of importance of open spaces in the residential buildings, air pollution, and lack of green spaces, necessitate reconsidering of the abandoned roofs. The movements such as green, sustainable, or eco-friendly architecture have been emerged recently in many countries in response to this issue. Green and living roof as one of the new approaches is a vegetated roof that can provide aesthetic and psychological benefits for people who live in the urban area (Oberndorfer et al., 2007). Moreover, relaxation and restoration advantages can be gained when the green roofs are accessible (Hartig, Mang, & Evans, 1991), and they can improve the human health (Oberndorfer et al., 2007).

"California Academy of Sciences" is an applicable example of living roof, which shows the growth of interest in the roof design in recent years (Reid, 2008). The roof consists of seven mounds, inspired by the natural landscape of San Francisco, is covered by native plants, which do not require irrigation. The vegetated roof keeps inside temperature cooler around 5.6 $^{\circ}$C and absorbs 90-98 per cent of the rainfall. Moreover, it decreases noise and the urban heat effect. Photovoltaic cells around the roof supply 60KW electricity. Furthermore, the natural ventilation and lighting are provided through the openings (Chino, 2008; Reid, 2008). In this building, the roof not only provides protective function, but also offers many benefits for people and the environment.

Iranian vernacular architecture also were eco-friendly, used local materials within the houses (Moradchelleh, 2011). There were various vernacular buildings in Iran, which their roofs served more than a shelter, similar to the green roof of California

Academy of Sciences, and benefited both the environment and people. In comparison to the roof of the academy, the roofs of the vernacular buildings located in hot and dry climate regions of Iran, consisted several domes, and made by eco-friendly materials (Fig. 1.2). They admitted sunlight to indoor and ventilated the air (Figs. 1.3). The vernacular roofs improved indoor air quality and were energy efficient. There is a need to in-depth study of all aspect of the vernacular architecture in order to reuse the concepts in the modern style (Moradchelleh, 2011). "California Academy of Sciences" building is an obvious evidence that proves the significance of this study. Relooking and considering the roofs functions are important in order to incorporate the vernacular concepts into the new designs and provide multi-functional roofs in the CRB.

1.6 Scope of the Study

The study has explored the different roofs functions of the VRB in Kashan, Iran by using triangulated qualitative data sources including review of literature, semi-structured interview, and non-participant observation. Furthermore, it has aimed to identify the factors that have to be considered in adapting the vernacular concepts for the CRB by using a survey of opinions of people who are living in the residential buildings in Kashan, Iran.

1.7 Research Framework

The case study approach has been selected as the main methodology of this study. Five components of case study offered by Yin (2009) has been followed and illustrated in the framework of the research (Fig. 1.4).

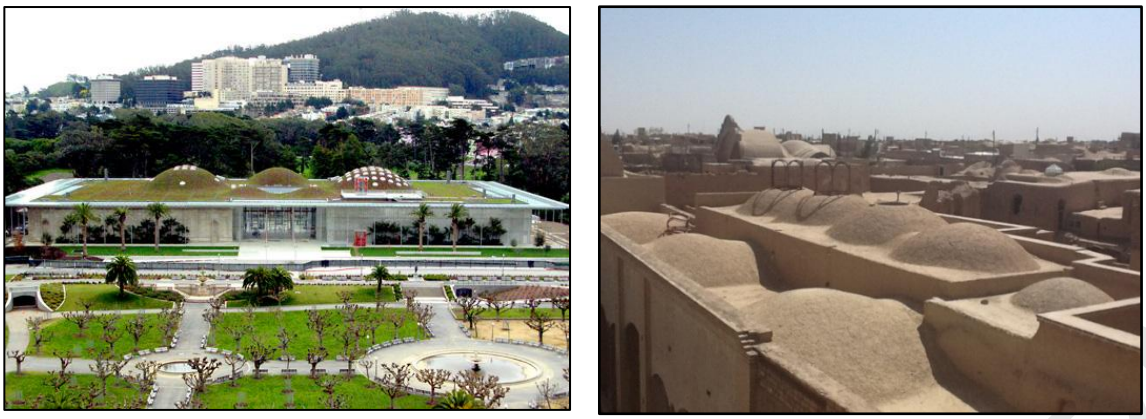


Figure 1.2. Comparison between Forms of the Roofs in Iranian VRB and Green Roof of California Academy- a. Green Roof of California Academy of Sciences Building
(Source: Peter Kaminski, 2008)
b. The Domed Roofs of the VRB, Ameri-ha Complex, Kashan, Iran
(Source: Author, 2012)

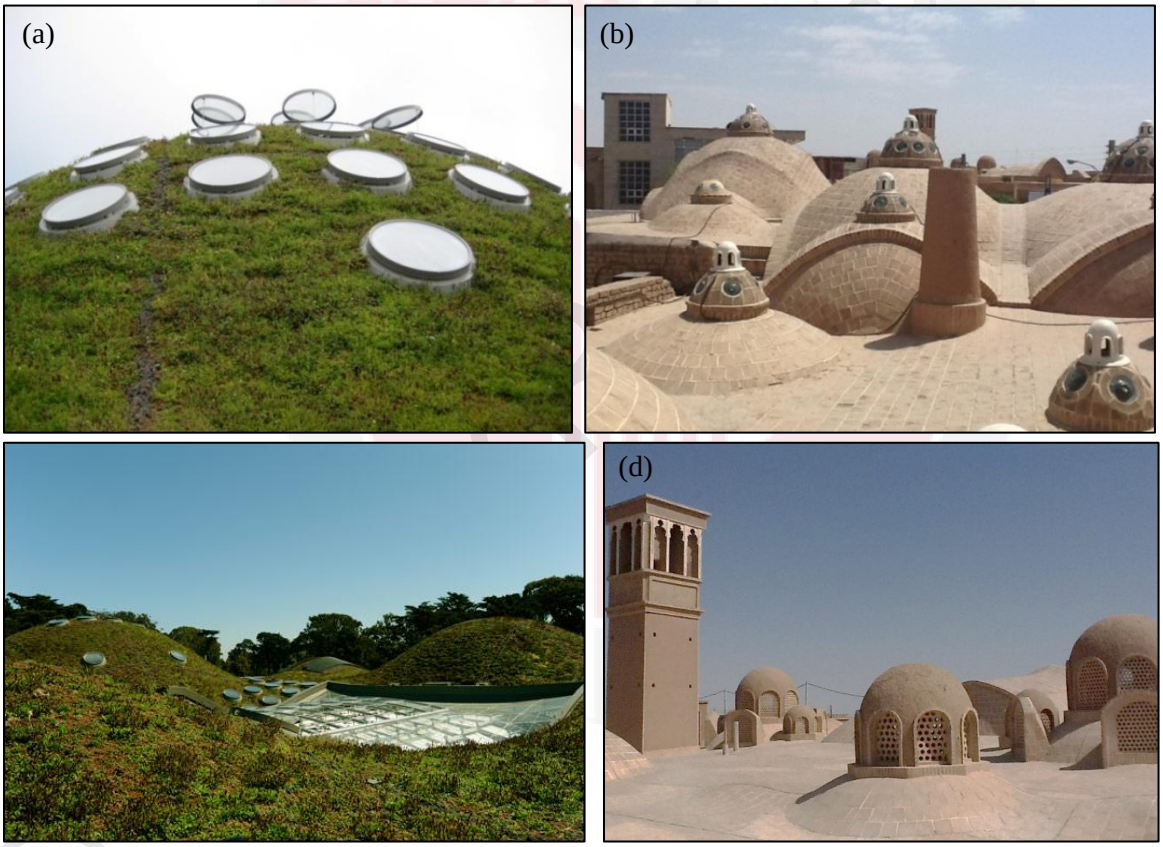


Figure 1.3. Comparison between Openings of Vernacular Roofs in Iran and Green roof of California Academy for Provide Natural Lighting and Ventilation - a, c The openings on the Domes (Source: Mike Chino, 2008)
b. The Roof of a Public Bath Building with the Openings on Domes, Soltan Mir Ahmad Bath, Kashan, Iran, d. Openings on the Roof of the VRB, Ameriha house, Kashan, Iran
(Source: Author, 2012)

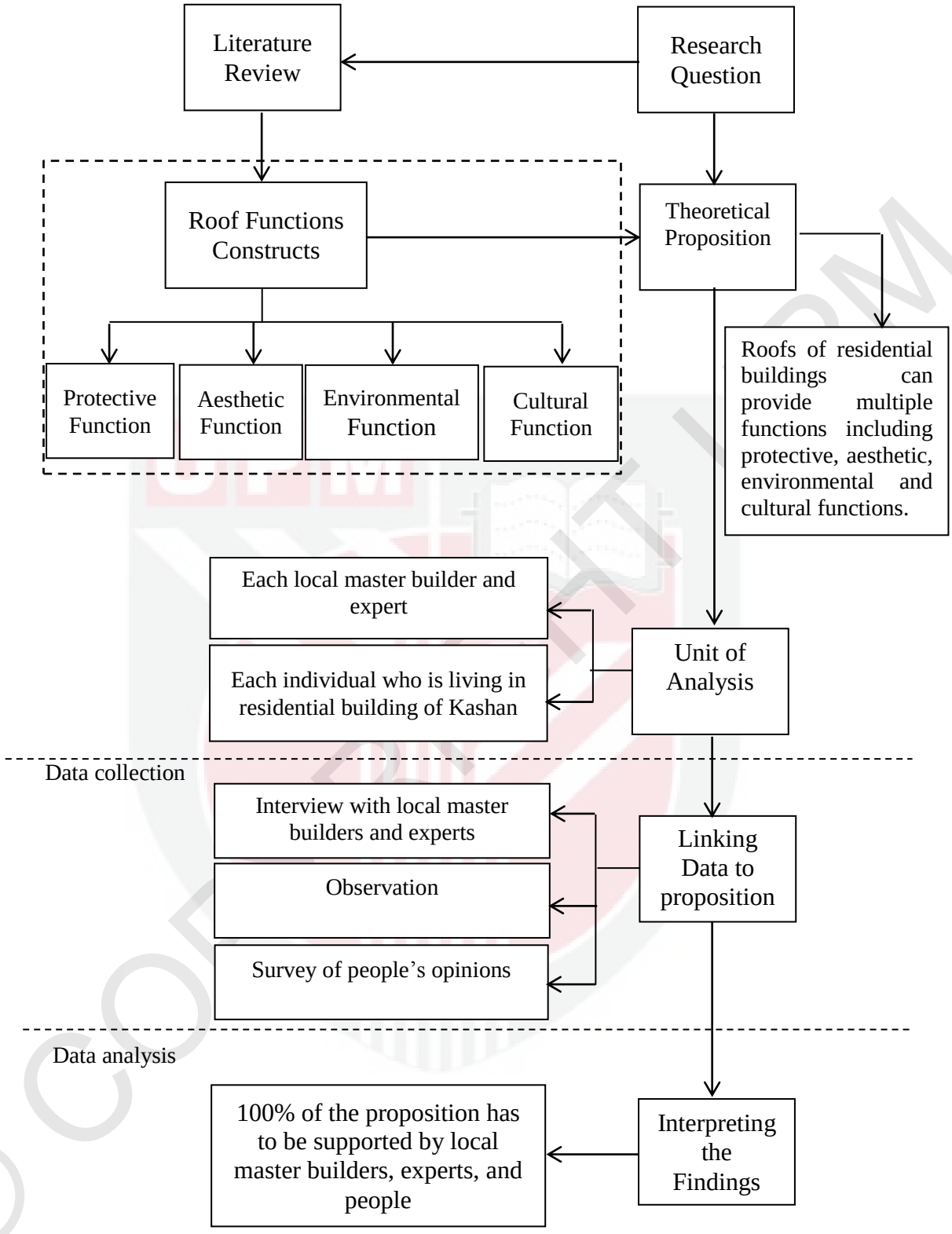


Figure 1.4 Research Framework of the Study
(Source: Author, 2013, regarding the case study components defined by Yin, 2009)

1.8 Organization of Thesis

The study has been organized in five chapters. Each chapter has been described as follows:

Chapter One: This chapter has introduced the background of the study, and embedded the problem statement, research questions, objectives, significant of the study and framework of the research.

Chapter Two: This chapter has reviewed the literature and drawn the conceptual framework based on the western and Persian scholars. First, the vernacular residential buildings (VRB) in Iran, climatic conditions of Iran and vernacular climatic responsive roofs have been introduced. Then, the study has focused on the vernacular roofs in hot and dry climate and selected city of Kashan as a case study. Moreover, the current situation of the roofs in the CRB has been described. Finally, the four constructs obtained through reviewing the literature related to roofs functions of the VRB in Iran, the proposition of the study, and conceptual framework of literature review has been concluded.

Chapter Three: This chapter has explained the research methodology, the case study research design, mixed-method for data collection and linking data to proposition, data analysis and validation.

Chapter Four: This chapter has presented the analysis and results of the qualitative approach date including interview and non-participant observation, and quantitative approach including survey questionnaire design. It has concluded the confirmation of the proposition.

Chapter Five: This chapter has integrated all the findings and linked them to the objectives. It has included limitation of the study and knowledge contributions.

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