ECONOMIC AND SOCIAL FEASIBILITY IN PROVIDING VERTICAL EXTENSION FOR SINGLE STOREY TERRACE HOUSES IN MALAYSIA

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Specially dedicated to my wife and my supervisor.

Also for those who want to become a researcher.

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ABSTRACT

Terrace houses are operationally defined as a row of connected housing units that share common partition walls with neighbors at both sides. These walls are placed on the property line and stipulate structural support to itself and the adjoining property. At different stages of life, households need to expand their habitable spaces. Housing extension can be done in two ways, horizontally and vertically. In the current scenario in Malaysia, terrace houses have little option to expand horizontally. However, they still have the potential to expand vertically through retrofitting. So far, not much study has been done on vertical extension of terrace housing through retrofit. Even more, retrofit in residences by using modern technologies such as steel I section beam, H section column, precast slab and footings, are not investigated at all. This study aimed to find out a socially acceptable, economically sustainable, structurally sound, and architecturally efficient retrofit method through vertical extension of existing one storey terrace housing in the context of Malaysia. Social data were collected from households living in single storey terrace houses in Johor Bahru to find out their requirements for vertical extension. After that, architectural solutions were provided according to users' requirement. Thereafter, structural solutions were done that fit within their expected budget. Finally, social validation was also performed to check the social acceptance of the solutions. The social data were obtained from random samples of 73 households living in single storey terrace houses in Johor Bahru, Malaysia. The legislation for vertical extension was studied through literature review, and conforming to that, and through the survey, householders' required additional spaces were found to be two bedrooms and one bathroom in the expanded upper floor. Through comparative analysis, five typologies were selected for the next step. The structural retrofit design was using Euro Code was conducted on the selected typologies. Keeping the cost below the budget, the best structural solution was chosen. For social validation, the required duration of retrofit works, and the minimum spaces required by the users during construction were asked through the social survey. An effective project schedule was proposed that can allow users to stay in the house with minimum hazard during construction, allowing them not to be forced to be dislocated during retrofit. The study thus came up with an affordable and socially accepted structural retrofit solution that can be applied to all typologies of single storey terrace houses in case of vertical extension. It can offer a better standard of living especially for the low income group without sacrificing financial loss.

ABSTRAK

Rumah teres ditakrifkan sebagai deretan unit rumah yang berkongsi dinding yang sama antara kedua-dua jiran bersebelahan. Dinding tersebut ditetapkan sebagai sempadan dan menjadi struktur sokongan unit rumah tersebut dan unit rumah bersebelahan. Di setiap peringkat kehidupan, isi rumah perlu menambah ruang kediaman mereka. Penambahan dan pembesaran ruang rumah boleh dilakukan dengan dua kaedah iaitu secara mendatar atau menegak. Dalam senario semasa di Malaysia, rumah teres mempunyai pilihan yang terhad untuk menambah ruang rumah secara mendatar. Walau bagaimanapun, isi rumah masih berpotensi untuk menambah ruang rumah secara menegak menerusi pengubahsuaian. Setakat ini, kajian mengenai penambahan ruang rumah secara menegak adalah amat kurang. Lebih-lebih lagi, kajian mengenai pengubahsuaian ruang kediaman rumah dengan menggunakan teknologi moden seperti rasuk keluli keratan rentas I, tiang keluli keratan rentas H, lantai dan asas pratuang masih belum dibuat lagi. Kajian ini bertujuan untuk mengetahui penerimaan sosial, kemampanan ekonomi, kekukuhan struktur, kaedah pengubahsuaian yang bersistematik melalui penambahan secara menegak bagi rumah teres yang sedia ada dalam konteks Malaysia. Data sosial dikumpulkan daripada isi rumah berpendapatan rendah yang tinggal di rumah teres satu tingkat kos rendah di Johor Bahru untuk mengetahui keperluan mereka bagi menambah ruang rumah secara menegak. Seterusnya, penyelesaian dari segi senibina disediakan mengikut keperluan pengguna. Selepas itu, penyelesaian dari segi struktur dilakukan mengikut jangkaan bajet pengguna. Akhirnya, pengesahan sosial juga telah dijalankan untuk mengkaji penerimaan sosial terhadap penyelesaian tersebut. Data sosial diperoleh daripada sampel rawak sebanyak 73 isi rumah berpendapatan rendah yang tinggal di rumah teres satu tingkat di Johor Bahru, Malaysia. Menurut kajian literatur, undang-undang bagi tujuan penambahan ruang rumah secara menegak, disokong dengan kaji selidik yang sama, didapati bahawa isi rumah memerlukan ruang tambahan iaitu dua bilik tidur dan satu bilik mandi di bahagian tambahan ruang tingkat atas. Melalui analisis perbandingan, 5 tipologi telah dipilih untuk kajian lanjut. Reka bentuk penambahan struktur menggunakan Kod Euro dijalankan terhadap tipologi yang telah dipilih. Setelah berjaya mengekalkan kos di bawah jangkaan bajet pengguna, penyelesaian dari segi struktur yang terbaik telah dipilih. Bagi pengesahan sosial, tempoh yang diperlukan untuk penambahan ruang rumah, dan ruang minima yang diperlukan oleh pengguna semasa proses pembinaan dijalankan disoal melalui kaji selidik yang sama. Satu jadual projek yang berkesan telah dicadangkan bagi membenarkan penghuni rumah berada di rumah dengan kadar bahaya yang minimum, membenarkan mereka untuk tidak terpaksa berpindah semasa tempoh penambahan ruang rumah. Oleh itu, kajian ini menghasilkan penyelesaian dengan penambahan struktur yang mampu dimiliki dan diterima secara sosial yang boleh diguna untuk semua tipologi rumah teres satu tingkat dalam kes penambahan secara menegak. Ia juga menawarkan taraf hidup yang lebih baik terutamanya kepada golongan berpendapatan rendah tanpa mengalami kerugian kewangan.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Terrace houses are the most common type of townhouses in urban Malaysia. They are usually single or double storied, single residential units sharing common structural walls on property line with neighbors at both sides. Households need changes in their habitable spaces during habitation. But, these terrace housing units do not provide much room for extension, at least horizontally. However, they still have the potential to extend vertically up to a limited scale if structural retrofitting can be done properly. Weak foundation might be a potential drawback for such extension, but modern technologies such as steel I section beam, H section column, precast slab and footings, could provide an efficient solution to structural retrofit. This study searched for basic structural solution of vertical retrofit of the single storey terrace houses in urban Malaysia along with its social and economic feasibility.

1.2 Background of the Research

New Economic Policy (NEP) which was implemented in 1971 is the major factor in the urbanization process of Peninsular Malaysia. NEP and other push 'factors' caused rapid migration of rural people to urban areas. In 1980, the percentage of Malays living in the urban areas increased from 11.2% to 25.2% compared to 1957. Also, the percentage of the non-Malay population living in urban areas continued to increase. At the same time urban Chinese population went up from 44.7 per cent in

1957 to 56.1 per cent in 1980; while over the same period, the urban Indian population increased from 30.7 to 41 per cent (Agus, 2002). More than half of them moved in to terrace houses, which is approximately 57% of the total Malaysian housing stock in the year 2002 (Nugroho, *et al* 2007).

There were many different types of housing stock in urban Malaysia such as terrace houses (single and double storey), row shop houses (partially residential), cluster houses, semi-D houses, detached bungalows, low cost low rise and high rise condominiums, high end apartment (low, middle and high rise) etc. Among them, terrace houses are currently the bulk of the houses with more than 70% housing stock belonging to this typology (Mohd et al, 2010). There are three basic types of terrace houses, namely, one (single) storied, two (double) storied, and row shop houses with shops at the ground floor and flats at upper floors. While the row shop houses involve multiple ownership, and kept out of the scope of this study, Single storey terrace houses are generally for the low income people and these were first built during the '70s. Single storey terrace house is operationally defined as row houses which share partition wall with the neighbouring units on both sides and are one storey high at the point of delivery. Double storey terrace house is operationally defined as row houses which share partition wall with the neighbouring units on both sides and are two storey high at the point of delivery. The first generation of single storey terrace houses in Malaysia has become old and dilapidated. On the other hand, income of maximum of these owners has not increased that much. But housing needs changes along time due to demographic changes, or other different household reasons (Fenton, 2010). Therefore, households always search for a better house. It is usually hard for low affluence people to buy and move to a new house when they start to feel that they require extra living space (Khan, 2014). Therefore, many of these houses experienced extension over their period of inhabitation.

Extension of a house is a natural phenomenon for households (Tipple, 2000). It is even more common for low income groups of people as they can hardly afford to buy a bigger house (Khan, 2014). However, after living in a house for many years, if they can afford, and given a choice between moving to a better house in new location and extending their existing house, most of them would choose the second option

(Carmon, 2002). One of the major reasons cited by Khan (2014) is because most families move to advanced stages with the household owners becoming old enough, and they do not want to move to a new neighbourhood, where they could lose their sense of belonging and sense of attachment with the neighbourhood. Therefore, extension remains the most popular option for such situation.

Extension can take place in many forms such as addition, alteration, renovation or modifications. Extension in the form of addition can be done horizontally or vertically. In case of Malaysian terrace houses, horizontal extension is possible only either in the front or in the back side, and there is lack of enough space to make the extension effective.

The scope in vertical extension has much better potential than horizontal extension. It is because in horizontal extension one can add only 20% to 30% to the main structure (Saji, 2012). But vertically, 100% to 200% can be extended if one or two floors can be added, although local laws are applicable wherever necessary regarding vertical extension.

However, if legislation allows, or even if one argues that legislation can be modified if such necessities can be cited, the point is whether this extension is sustainable or not. First point to check is that if it is economically sustainable or not because these terrace houses mostly belong to low income group, and money or affluence is their foremost concern. Then comes the other two: social and environmental sustainability. Environmentally it may not be unsustainable because of the small scale of construction involved. The final check is the check for social sustainability. Sometimes social norms are more powerful than the other pillars of sustainability especially in housing. Keeping that in mind, this study aims to address all these issues of sustainability, and tried to offer a potential architectural and structural solution that can be feasible from both economic and social point of view.

1.3 Statement of the Problem

A house is a shelter for humans. This is the place where they can get comfortable and get relaxed. Through habitation, they get to know their neighbors, and in long term, can earn social respect. Lower affluence erodes dignity, and earning a social respect for low income people takes comparatively longer time (Khan, 2014). Household's housing needs increase along time and they need to increase the accommodation area. A solution is to buy a bigger house and move to new neighborhood. But for a low income household, this is very tough because of money. Moreover, they worry about losing that social dignity and respect that they gained throughout the years of living. Moreover, to extend the house horizontally may not be that effective as Malaysian single storey terrace houses do not have option to extend sidewise, and can only extend a little bit in the front or in the back. Also, to extend vertically, the inhabitants might need to be relocated to other place during construction, which is also hazardous for them as it might affect their daily routine significantly for a prolonged period. This study identified vertical extension as a possible solution for house extension, but tried to provide an effective architectural and structural solution so that the construction hazard remains minimum. It also searched for methods that can allow the inhabitants to stay at their place even during the construction time hence avoiding relocation, with special care to minimize the construction period as well. That could provide the best possible solution for such extension. Thereafter, the knowledge could be used in further studies related to extension of houses.

1.4 Research Gap

Apparently there are enough studies on house extension and there are also studies on how social issues control the typologies of the extensions. For example Tipple (1999) has studied extensions on low cost houses in Ghana, Egypt, Zimbabwe and Bangladesh (Tipple, 1999; Khan, 2014). But there are only few studies on extension of single storey in the context of Malaysia, and no significant study on vertical extension of single storey terrace houses in the context of Malaysia. Studying structural system in retrofit for the solution of vertical extension is even more

important. Therefore research is needed to study the capacity of the structures of existing terrace houses. But there is no such research on this topic. So the two research gapes are:

i. No significant study on vertical extension of terrace houses.
ii. No study on the structural retrofit of existing terrace houses.

1.5 Aim and Objectives of the Research

The aim of this research was to find out an effective structural retrofit system for vertical extension for single storey terrace houses. To achieve the aim, three objectives were set in order to simplify the research path, and they were as follows;

i. To find out effective architectural solutions for the transformed spaces in the extended upper floor.
ii. To find out the structural retrofit system that can effectively match with the architectural solution.
iii. To determine economic and social feasibility of the proposed solution

1.6 Research Methodology

This project was a combination of qualitative and quantitative research methods. Several basic data were searched through literature review and reconnaissance survey in order to understand the detail of the research problem. It included existing typologies of single storey terrace houses, examples of existing attempts on vertical extension of single storey terrace houses, and the spaces the owners have tried to create during such extension. It also included issues on household's budget for such extension. After developing these ontological knowledge bases, and building up the theoretical framework, the methods to achieve objectives were set up. The three basic steps were followed to achieve each objective. There were namely Data Collection, Data Analysis, and Data Interpretation.

For the first objective, primary and secondary data was collected on household's space requirements in the proposed extended upper floor. Conditional random sampling was the method of sampling for the social survey, and the survey was done on low income groups living in single storey terrace houses. The results were analysed through quantitative method by using statistical software SPSS. This data was used to derive architectural solution. Three graduate practising architects were given the task, and after the solutions were provided, final proposals were reached through peer discussion. This was an example of qualitative inference.

To achieve the next objective, those architectural design solutions were used as the basic data. Structural design was searched that can effectively match the architectural solutions. These solutions were done by the use of Software ETABS.

After reaching the structural solutions, economic and social feasibility was checked in order to achieve objective three. Graduate professional Quantity surveyor was engaged to calculate the total costing of the extension work. This was compared with the market rate found from literature review in order to check economic feasibility. Finally, another set of primary data was used to check the acceptance of the users for the total construction work. Project scheduling was used as a tool to measure that. Project scheduling is done by using Microsoft project and quantity survey was done manually and checked by a professional company named Meritree E&C consultants. The primary data was collected simultaneously during the first survey, and the results of project scheduling were checked to match the information gathered from the survey. After checking the social feasibility, objective three was achieved. The methodological framework is shown in the diagram below in figure 1.1.

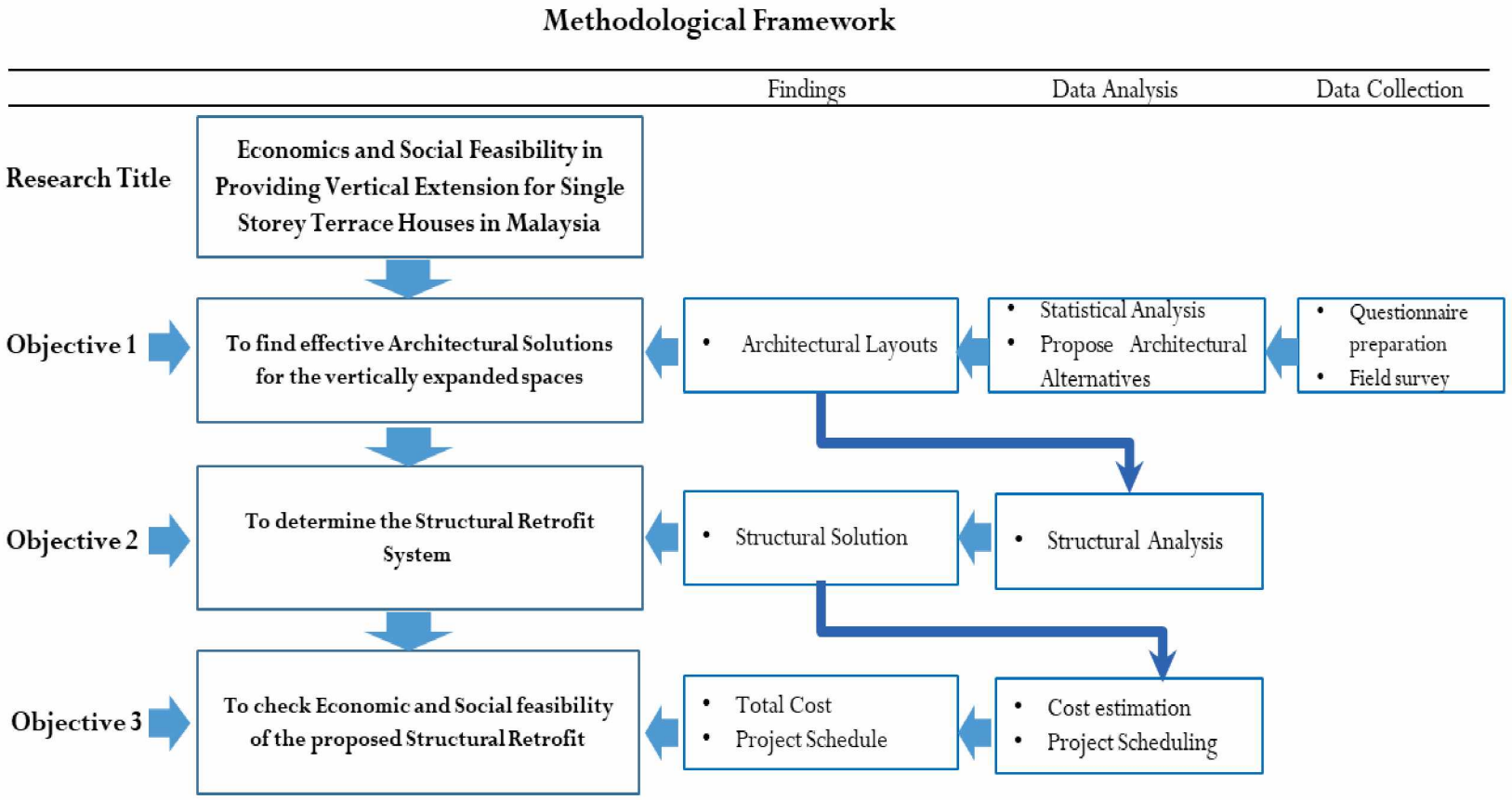

Figure 1.1 Methodological framework

1.7 Significance of the Study

Relocation is the quicker system to improve the standard of housing. But relocation has some serious disadvantages. Living in a neighborhood gives a resident a sense of attachment, a sense of belonging, a sense of dependence, and finally a sense of identity which is one of the most significant issue in human life (Shamai, 1991). For people with lower affluence, it is even more important. That is why most low income people transform their houses rather than relocating to new places, especially when they reach a mature stage of their family life. Therefore the study tried to give a solution to a better standard of living without sacrificing financial loss, and more importantly without sacrificing sense of identity, sense of dependence, sense of belongings, and sense of familiarity that they earned though prolong habitation. Besides, this study will provide guidelines to the house owners and the professionals as well.

1.8 Scope and Limitation of the Study

The research was conducted to find out a socially feasible cost effective method of vertical extension of a single storey terrace house in context of Malaysia through structural retrofit. The research focused on single storey terrace houses and their vertical extension. Because of lack of time the extension study was done using some selected structural materials like precast slab, precast footing, steel column and steel beams. Funding and duration of study was the other issues, which was the reason why the samples were selected from the state of Johor Bahru only.

1.9 Organization of Thesis

This thesis was divided into five chapters. Chapter 1 provided an overview on research area, existing situation and problems associated with current scenario, aim and objectives, brief methodology, and the significance of the study.

Chapter 2 presented all previous major works related to this research topic including housing typologies in Malaysia, concept of extension, best materials to choose for retrofit work. This section also focused on different materials that can be used in the structural retrofit.

Chapter 3 is where the methodological framework is elaborated. There were different methods to achieve different objectives. This chapter explained all the methods and procedures regarding this research. Total flow of this research was discussed in this section.

Chapter 4 focused on the outcomes from the social survey that used statistical tools and statistical methods of analysis, the alternative architectural drawings that were constructed, the structural solutions that were produced, and a proper project scheduling which met the house owners' requirements. In this way, they explained how the objectives were achieved in this study.

Finally, Chapter 5 recapped the major contributions of this study and recommendations for future research.

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