Architectural Changes and Motivational Factors for Post-Earthquake House Transformation in Lar City, Iran

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ABSTRACT

Housing provision for post-earthquake victims requires consideration of the victims' cultural and social needs. Due to limited time and shortage of funds, quick construction of post-earthquake houses often fails to comply with the minimum needs of the occupants. Too often, such houses are either abandoned or transformed substantially, resulting in an overwhelming waste of resources. This paper aimed to investigate the transformation process of post-earthquake houses in Iran, in particular, people's motivational factors for these transformations. The methods used included systematic observations and map analysis of alterations to post-earthquake houses over a 30-year period (1970-2000), interviews with the households and questionnaire survey with 190 respondents. The results recommended that the design for these houses should address potential for transformability into pre-earthquake patterns and lifestyles, adaptability to new parts/construction and capability to reflect different requirements for indoor and outdoor spatial circulations. Analysis of house transformation in the 30-year period revealed that the majority of respondents were found to favour vernacular architecture design, which includes a courtyard in transforming their houses (51.1%) followed by the desire to follow the current trend (32%). The majority of houses had undergone major transformation, having added more than 98% of the original built-up area to the houses. This research found that the mixed *'Temporary-Permanent'* housing reconstruction model was highly successful since it involved participation of end users from the very early stages of design and development in order to predict and accommodate later housing alteration issues.

INTRODUCTION

Earthquake is one of the world's most catastrophic disasters, involving destruction of houses and infrastructure, injuries and loss of lives. The trauma after the disaster could also give impact to victims psychologically. Caia *et al*. (2010) asserted that impact of major earthquakes varies greatly as a function of both physical and social factors. They are generally highly fear-arousing and often traumatic due to a precarious lifestyle and the interruption to normal life that is associated with losing jobs, being relocated to a different area and living in temporary housing that is below normal standards of living (Kilic *et al*., 2006). The main aim of post-earthquake housing construction has always been to provide immediate shelter for the victims (Davidson *et al*., 2007). Baradan (2008) argued that even though most of the past attempts may have mitigated the risks, they have all failed in addressing people's future needs. In particular, due to time and financial constraints, there is a risk of not getting satisfactory long-term results in every project (Tasa *et al*., 2007). This problem is magnified in the context of Iran due to its particular cultural and financial conditions (Fallahi, 2007c). Parva and Rahimian (2014) ascertained that majority of post-earthquake housing (PEH) occupants transformed their houses after a short occupancy period with

the intention is to make adjustments to fulfil their lifestyle and minimum living requirements.

If planned well, the transformational process could potentially convert these houses with ease into preferred homes for the affected people. That is, a thoughtful initial design could leverage the later transformations in terms of adapting the semi-permanent houses to residents' needs and lifestyle. Caiaa *et al*. (2010) stress that we need to investigate more systematically the characteristics of temporary houses in order to promote the physical and psychological health of people who have suffered a significant trauma and loss of home. A considerable part of post-disaster temporary housing programmes has been unsustainable and culturally inadequate as a result of unsuccessful strategies, misunderstandings about users' real needs and misconceptions in dealing with local conditions and resources (Felix *et al*., 2013). This paper explores the PEH transformation in Lar, Iran in order to map and understand the problems of these transformations during a long-term occupancy. It investigates three core issues of post-earthquake housing transformations in Iran: 1) architectural characteristics of post-earthquake housing transformation, 2) people's motivations in transforming their PEH, 3) influencing factors on the specifications of post-earthquake housing transformations and 4) phase types of transformation.

LITERATURE REVIEW

Post-Earthquake Housing Problems

The need for shelter as immediate post-disaster interventions is imperative (Barakat, 2003, Davidson *et al*., 2007). This urgent need normally leads to large-scale reconstruction programmes commonly undertaken by the government and demanding overwhelming amounts of construction materials and skilled labour. (Peacock *et al*., 2007). After a disaster, it is crucial to provide temporary housing as soon as possible to offer a comfort level consistent with the common standard of living (Johnson, 2007).

Providing temporary housing for disaster victims requires understanding of cultural background and how different post-disaster housing designs may affect resident's lifestyles (Felix *et al*., 2013; Caiaa *et al*., 2010; Marcillia & Ohno, 2012; Parva & Dola, 2007). Felix *et al*. (2013) cautioned that insensitivity to residents' needs in temporary housing provision has been greatly criticised, mainly for being unsustainable and culturally inadequate. A lack of understanding could result in a loss of the sense of ownership and social safety among the occupants (Barenstein, 2005). Long-term post-occupancy problems could appear when occupants try to improve their living conditions as they felt that the house was not good enough to address their needs (Parva & Dola, 2007). This paper posits that long-term problems of post-earthquake housing reconstruction could be minimised by making PEHs capable of future modifications based on households' prospective needs.

Much has been discussed about providing victims of disaster with temporary shelter (Arsalan, 2007; Barakat, 2003; Davidson *et al*., 2007). It was thought that quickly providing shelter could assist victims to cope with losses and resume their daily activities. Unlike in normal situations where people can choose the type of house and the neighbourhood in which they want to live, earthquake victims have no choice but to accept what is given to them. Many of these quickly constructed houses become permanent homes as they are transformed and modified over time.

Housing Transformation Phases and Types

Transformation in architectural studies refers to changing and modifying a building into better condition during occupancy period. It consists of changing the form, function and pattern of buildings. Most of the building transformations involve residential buildings (Brand, 1994). Votava (2006) defines housing transformation as some indoors and/or outdoors changes that are based on households' requirements for making temporary shelters into more permanent homes.

Housing transformation after disaster may take several phases (Arsalan, 2007; Cole, 2003; Turan, 1983). Turan (1983) discussed two stages of post-disaster housing reconstruction: 1) providing victims with urgent shelter, which often involves providing them with tents in relief sites, and 2) constructing permanent houses for long-term occupancy. Cole (2003) extended Turan's (1983) classification by identifying

two additional 'temporary' stages: 1) emergency sheltering, 2) temporary sheltering, 3) temporary housing, and 4) permanent housing. According to this category, emergency and temporary shelter is occupied during the relief period (for less than one month), temporary houses are occupied during reconstruction period (for less than two years), and permanent houses are constructed to provide normal life for people. Further study by Arsalan (2007) added a fifth stage called "*temporary housing transformation*". Temporary housing transformation is a more flexible model, comprising all the aforementioned four stages. The aim of this model is to provide the victims with a liveable home through long-term evolution, rather than demolishing altogether the temporary dwellings at some point and replacing them with new construction.

In discussing housing transformation, many works (e.g. Brand, 1994; Salama, 1998; Tipple, 1996) identified two main types of housing transformations, namely, "*add-In*" and "*add-On*" transformations. According to Brand (1994), in "add-In" transformations changes are applied inside the existing building without constructing any additional space whilst "*add-On*" transformations include additional constructions and have the potential to expand the built-up area of the original dwelling. Nguluma (2003) extended this view by defining "*interior transformations*" as referring to modifications of indoor spaces by only relocating internal walls and changing room sizes, and "*exterior transformation*" as consisting of changing

façade, windows and housing extensions. Okatay and Orcunoglu (2007) introduced a new step in housing transformations by explaining the characteristics of '*Rebuilt*' where the original houses are demolished and changed totally; e.g. transforming detached or terrace houses into apartments. Mahmud (2007) listed five categories of house transformation: Slight Adjustments, Addition and Division, Total Conversion, Reconstruction and Rebuilt.

According to Tipple (1996), housing transformation could always contribute to architectural qualities of the houses so that it could increase households' attachment to their houses and leverage their sense of belonging. From a different perspective, Habraken (1975) argued that housing transformation could develop quality of housing space and adjust social and economic conditions of living space. Tipple (1996) argued that any improvement in the quality of the living environment needs to be done during a long-term and based on the needs, interests and socio-economic status of households. Habraken (1975) asserted that studying housing transformations could reveal the households' expectations of their living environments, which could be developed into lifestyle approaches for designing affordable houses (Salam, 2006).

At the later stage, house transformation could be the process of changing the physical structure to fit the owner's preference and lifestyle, or to change a house into a home, or from being temporary to permanent. In short, house transformation phases are the evolution of the occupants in accepting and becoming comfortable with the PEH.

Motivation for House Transformations

In terms of motivation for transformations, Rapoport (1995) argued that socio-cultural goals are the main motivators for transforming houses. Shiferaw (1998) explained common motivation for housing transformation as follows: 1) socio-cultural goals, 2) changes in households' structure, 3) desire to generate more income, 4) addressing issues related to harsh climatic conditions, 5) desire to follow the prevalent housing forms and 5) new aspiration to reform the traditional design of houses. Salam (2006) analysed the impacts of lifestyle models on housing transformations and proposed three lifestyle models: *work-based, attitude-based* and *status-based*. In short, all these theories considered housing transformations as a result of three types of factor: *1) architectural factors, 2) socio-cultural factors* and 3) *economic factors*.

Housing Transformations in Lar City

After the 1960 earthquake, the government decided to construct a new town near Lar, rather than reconstructing the disaster site. There were two main reasons behind this decision: 1) the original city was located at a high-risk zone and 2) it was very difficult to rehabilitate the exhausted old site (Housing Planing Department, 1985). Consequently, the new city was founded on a land which was 4km from the southern border of the original city (Fig.1). The new Lar city comprises 48 urban blocks of which each block consists of 20 residential units. Each residential unit covers a 15m by 35m rectangle area (Fig. 2). During the first phase of this project, the government developed 375 residential units, which are dispersed all over the city to further motivate people to go and live there (Kashefy, 1970). Initially, the built-up area of every house was 35 m^2 and the houses were constructed using prefabricated semi-detached construction systems (Fig. 3).

According to the Housing Planning Department (1985), the main issues associated with these new constructions were: 1) the design did not address the

Fig. 1 Airplane view of old city and new city of Lar. Source: Google Earth.

Fig.2 Spatial planning of a pre-earthquake (Left) compared with the post-earthquake (Right) housing units in Lar.

Fig.3 A pre-earthquake housing façade (Left) compared with the semi-detached prefabricated houses (Right) in new Lar city.

minimum thermal comfort requirements of the area; 2) the road system was very inconvenient for the users; 3) the city was considered as being very far from the original town and 4) the design of the houses was very alien for the people of Lar. These factors were cited as the cause of dissatisfaction among the people and made it difficult to encourage them to move into the new houses in the early period.

Since the people needed to have a place to stay, eventually, they moved in and transformed or renovated their houses. Lar had two kinds of housing transformations. It was observed that in the old town of Lar, the changes to the size of households was slow and followed the traditional transformation. However transformations

in the new city of Lar and post-earthquake area indicated a much higher rate and impact. Although this could be considered an opportunity for documentation of the experience for future reference, there is no previous formal study to investigate Lar's housing transformation process (Housing Planing Department, 1991). As a result of these arbitrary transformations, the share of built-up area within the residential properties of Lar has recently recorded an increase by more than 320%, a sharp increase in only three decades. Although the existing roads are sufficient to support the new population, there are still many problems due to insufficient infrastructure and services to support sudden changes (Housing Planing Department, 1985).

RESEARCH METHODOLOGY

This study employed mixed research methodology (Creswell, 1994, Groat, 2002) to investigate the qualities and motivations for the housing transformations in Lar's PEHs. The study relied on literature review (qualitative) as well as systematic observation and surveying people's perceptions (quantitative). In terms of qualitative data collection, literature review and document analysis were conducted in order to provide basic insights into the matter of study. Building upon the theories developed through reviewing literature, this phase documented all constructional information about transformations in PEHs. The results of this phase helped the authors to formulate the final questionnaire survey to evaluate people's perceptions about the

motivation to transform the original PEHs. Finally and for triangulation purposes, more advanced observation were conducted in order to empirically affirm for the results of the survey.

Systematic Observations

The sample of this study comprised 189 post-earthquake houses that were investigated by systematic observation. The collected data were coded according to an observation checklist sheet in order to be analysable by Statistics Package for Social Sciences (SPSS). In accordance with the research objectives, the observation checklist comprised six parts: 1) House numbers; 2) Housing transformations with respect to the quality of extensions, changes in function, percentage of demolition, and division of post-earthquake house; 3) Date of major transformations throughout the four decades; 4) Comparison of transformed post-earthquake houses with original PEH and 5) comparison of PEH in terms of five characteristics (layout, typology, materials, openings, and ornamental elements; locations of houses with basic infrastructure and amenities). Moreover, two pictures and four plans of post-transformation houses were attached to each observation checklist.

Questionnaire Survey

The purpose of conducting a questionnaire survey was to investigate people's perceptions towards housing transformations in Lar's PEHs. In order to help the authors formulate the actual questionnaire survey, the study first conducted series of systematic

observations in order to have a better understanding of the type of transformations in the architectural characteristics (e.g. land and built area sizes, morphology, spatial planning, façades, constructional materials and constructional systems) of the PEHs (as suggested by Shiferaw, 1998).

Based on the theories discussed in the literature, this study divided the variables of the conducted survey into two groups:1) building-orientated variables and 2) human-orientated variables. Building-orientated variables explained housing architectural characteristics before and after transformation, which were analysed in three stages: pre-earthquake-1960 housing process, post-earthquake-1960 housing process and post-transformation housing process. The human-orientated variables described the residents' ability to perform housing transformations and their need for transformations.

Data Analysis

In terms of data analysis, this research carried out both qualitative and quantitative analyses. Groat (2002) asserted that qualitative data should be directly interpreted by the researcher. In terms of quantitative data analysis, the study therefore coded and clustered the data of the systematic observations according to the concerns of the study (Creswell, 1998). The collected data through the conducted survey was analysed using SPSS version 17.0. The employed tests included basic Descriptive Statistics (Mean, Standard Deviations etc.), Examination of Reliability Scale and

Hypothesis testing scales (e.g. Correlation Analysis and Regression, Variance Analysis (ANOVA), and Chi square).

Validation and Reliability

In terms of validation and reliability, the random error of the conducted survey was controlled by selecting an appropriate sample size. With regards to the controlling systematic error, Mansuorian (2002) asserted that three factors can facilitate the reliability of the findings in conducting a questionnaire survey: 1) designing a clear questionnaire for testing actual perceptions of people about research constructs, 2) employing different indicators with similar intention and running a reliability test among the similar indicators and 3) conducting a pre-test. This research employed local people as enumerators as they could adjust and explain the questions according to local terms of Lar. Moreover, some purposive repetitions were embedded in the questionnaire in order to facilitate future reliability tests. Finally, a pre-test survey was conducted for refining the questionnaire and reconsidering all vague questions. Cronbach's Alpha value was calculated for all groups of questions and when the value was less than 0.6, problematic questions were detected and reformatted. Consequently, as reported in different parts of the Results and Analysis section, the Cronbach's Alpha values of all groups of the final test were greater than 0.6, which is the significant level for showing the reliability of the questionnaire survey. In addition to considering these factors, this research also relied on the clarifications
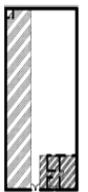
by trained enumerators/ distributers during the data collection phase. They were architectural students who were trained and quite familiar with this research and PEHs of Lar. This consideration was motivated by the low educational background of the majority of the people of Lar who were not able to read and understand the questions properly. Finally, triangulation of data gathered from different methods, literature review and findings of survey and observation further assured the construct validity and internal validity of this study.

RESULTS AND ANALYSIS

Architectural Characteristics of Transformations

Following Shiferaw (1998) and Portnov and Odish (2006), this study analysed morphologies, occupancy rate, function, building materials, and façades as important variables to describe the architectural characteristics of housing transformations. The distinctive similarities between the morphologies of pre- and post-earthquake houses in Lar illustrate that people wanted to transform the PEHs in order to link with their previous lifestyle. It was found that more than half of the cases in this study transformed the new semi-detached PEHs to include "*semi-central courtyard-houses*"

Table 2
Morphology of Different Types of Transformed PEHs in Lar

	TYPE1	TYPE2	TYPE3	TYPE4	TYPE5	TYPE6	TYPE7	TYPE8
Plan								
Type	Contiguity Longitude	Separate Longitude	Contiguity Widthwise	Separate Widthwise	Type 3 & 4	Type 1 & 2	Semi courtyard	Courtyard
Frequency	2	4	15	123	32	1	148	40
Percentage	0.5%	1.1%	4%	32.%	8.5%	0.3%	39.4%	10.7%

that they found more suitable for supporting their culture and daily activities. Table 2 presents the frequency of the eight types of transformed morphologies of PEHs in Lar in which more than 51.1% of the houses were transformed into semi-courtyard and courtyard houses. Further investigation reveals that these types are very similar to pre-earthquake houses. This shows that people had a strong tendency and attachment to culture and their vernacular lifestyle. In the meantime, 32% of houses were transformed in accordance to the current prevailing architectural styles. The results of the conducted observations also showed very significant transformations in land-use and built-up areas of PEHs. The residents added 98.4% more constructions to the original built-up area.

The results of this study revealed that the morphology of post-earthquake houses in Lar was dependent on two factors, namely, the morphology of pre-earthquake-1960 houses and the morphology of the current prevalent architecture. This is mainly aligned with the seminal literature. For instance, Shiferaw (1998) asserted that morphology of houses often changes during the transformation process. Portnov and Odish (2006) also claimed that transformations in morphology of houses are guided by the morphology of the current prevalent architecture. However, in the context of Lar's PEHs, the tendency towards rehabilitation of the previous lifestyle was an important issue that was neglected by the previous studies that investigated only normal (and not post-disaster) circumstances.

According to the findings, the average built-up area of Lar's PEHs increased by 75%, compared to its pre-earthquake houses. Based on Salam's (2006) theory, it was assumed that the first transformation in PEHs might be the expansion of the houses since sudden changes in lifestyle are not accepted by people. The findings of the systematic observations verified this assumption when it showed drastic increments in the built-up area of post-earthquake houses after transformations.

According to works by Salam (2006) and Shiferaw (1998), functional transformations mainly are caused by the desire of generating more income. This kind of transformation appeared in Lar when people tried to change the function of their houses from residential to small commercial entities. This transformation on one hand partly increased people's income, but on the other hand, disturbed the neighbours' privacy. In the meantime, according to the results of the systematic observation, the level of this kind of transformation was dependent on the location of post-earthquake houses and in most of the cases these transformations happened only in the houses that had direct access to the main roads. The results show that only 6.9% of PEHs (26 units) were transformed in terms of function. In those cases, houses that were facing main streets were transformed into small commercial buildings (e.g. grocery shops, butchery and vegetable and fruit shops), limited service centres (e.g. travelling agencies, house dealers and beauty centre) or local clinics. All those facilities are equally distributed especially near main streets all over the city.

The findings ascertained that one of the purposes for material transformations in Lar's PEHs was to rehabilitate the identity of pre-earthquake architecture. This also was explained by Barenstein (2005) when mentioning that applied contractor-driven approaches in post-earthquake houses hinder the quality of materials used. However, since later transformations were conducted by people and local workers, normally they utilised more similar materials to what was used in the pre-earthquake houses. The results of the conducted systematic observation revealed that only 6.5% of PEHs (18 houses) were transformed using similar materials as the original house. Nevertheless, these changes were often caused by either changes in function or housing extension.

Alizadeh (2003) claimed that residents of PEHs usually alter the original façades since the original houses were considered as simple and ordinary. As two houses shared a single structure in the original house design, the desire to be different has resulted in various changes in façades. In most of the cases even façades of two houses which share a single structure differ from each other. These drastic changes in façades show that the future need for transformation in façades must be taken into account in the design of such houses. This may be done by either using an individual structure of façade for each house or flexible design in order to ease the work on future transformability. In terms of transformation in façades, 53.5% of PEHs undergo some transformations in façades, comprising changes in colour,

materials, volume and reconstruction of the whole façade. Most of these transformations with respect to façade occurred after 1990.

People's Motivations in Transforming Their PEHs in Lar

In order to investigate people's motivations, 190 questionnaires were distributed among the residents. As presented in Figure 4, based on the descriptive analysis of the findings, "*to adjust physical-living comfort*" and "*Growing household size*" were the most predominant motivations for transformations in Lar's PEHs. According to this figure, *"Increasing income"* and *"Thermal comfort considerations"* were found to have the least impact on people's decisions for transforming their PEHs in Lar.

A linear regression analysis was conducted in order to determine how much each motivational factor affected the formation of housing transformations in Lar's PEHs. Therefore, this study further traced the impacts of all sub-categories of PEH specifications in forming the category of socio-cultural considerations. Figure 5 illustrates the impact level of each sub-factor of PEHs specifications in forming transformation motivations. In this diagram, R^2 represents the impact level of each factor. The diagram shows that the impact of PEH specifications on formation of socio-cultural motivations for transformations is 8.5% (R^2=0.084). In other words, 8.5% of the model of socio-cultural motivations for transformations is determined by PEH specifications. Based on this result, the
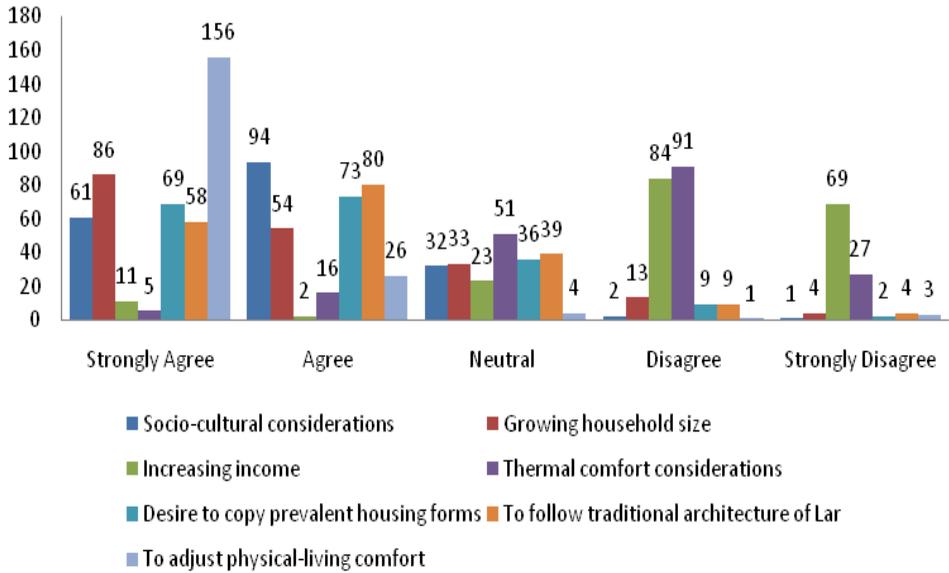
Fig. 4 Descriptive analysis of people's motivations for transforming Lar's PEHs.
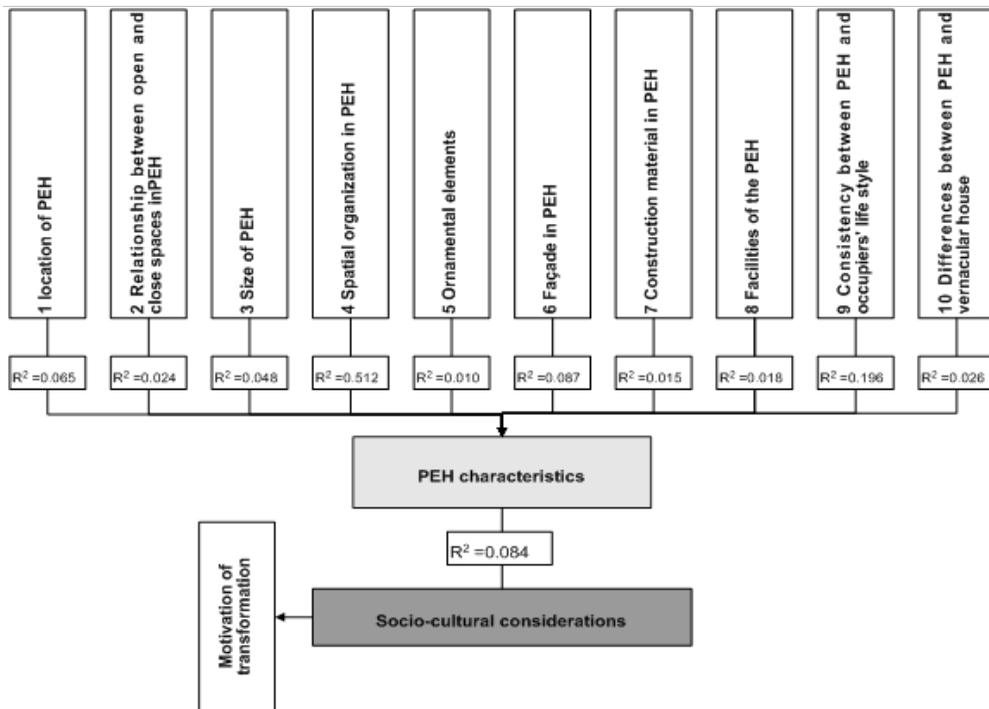

Fig. 5 Analysis of impacts of PEHs characteristics on emergence of motivations for PEH transformations.
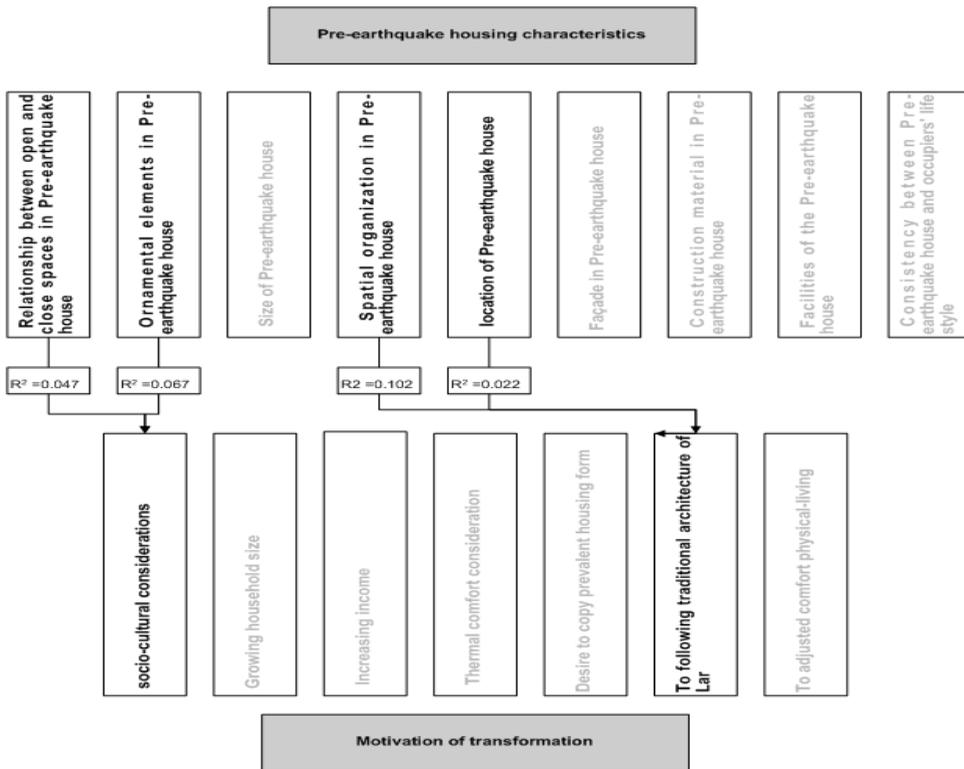
Fig. 6 Analysis of impacts of pre- and post-earthquake housing characteristics on forming the
motivational model of housing transformations.

most influencing factor in forming PEH specifications was the quality of spatial planning (R^2=0.512) whilst the lowest impact in this formation belonged to the quality of ornamental elements (1%).

Figure 6 shows the results of the conducted linear regression test in order to analyse impacts of each factors on forming the motivational model of housing transformations. According to Figure 6, the model of motivations for housing transformations is independent from the specifications of PEHs and is only shaped by 4 out of 9 specifications of pre-earthquake houses. The results showed that of the 4 characteristics significantly influencing

the transformation, only two motivations received the highest score, namely, socio-cultural considerations and to follow Lar's traditional architecture.

The strongest motivation for Lar's post-earthquake housing transformations was the willingness to adjust physical-living comfort conditions to most occupants. This is evident from this research that Lar's PEHs were originally considered as '*not comfortable*'. At the same time, the least important motivation was to naturally improve thermal comfort conditions, notwithstanding the fact that Lar is located in the arid zone area of Iran. This could be justified by taking into account the fact that currently people in

Iran are being subsidised in terms of prices of electricity, so they show no attempt for replacing active thermal conditioning (air condition) systems with passive and energy-saving techniques (e.g. wind catcher).

The analysis in this study revealed that there is a positive significant relationship between the development of all transformational factors in Lar's PEHs and the people's four major transformational motivations which target socio-cultural considerations, increasing income, growing household size and rehabilitating the qualities of Lar's traditional architecture. It could be concluded from this finding that changing housing specifications in PEHs strongly skewed towards socio-cultural considerations. This could counter Alexander (1984) and Fallahi's (2007b) idea that preparing urgent shelter for victims should be the main policy in PEH construction. In other words, this study claims that since in a developing country like Iran, PEHs are considered semi-permanent residential units (rather than completely temporary shelter), socio-cultural considerations must be taken into account during the initial planning phase in order to prevent serious future problems.

Another important finding from this study explained the existing significant positive relationship between growth in household size and increase in motivation for PEH developments. Indeed, this finding verifies Habraken (1975) and Friedman's (2002) findings in which any changes in household size definitely is accompanied by changes in the house's physical size.

Parva and Rahimian (2014) categorised these types of issue into long-term and short-term developments. They ascertained that short-term transformations of Lar's PEHs are due to shortage of living spaces and the need to emulate previous living style, whilst long-term developments follow the normal conditions of normal housing transformation, that is, the growth in household size and the desire to follow current trends. This concurs with previous literature published on this matter (e.g. Hojrup, 2003; Salam, 2006; Shiferaw, 1998).

This study found significant relationship between spatial organisation in PEHs and socio-cultural motivations for transformations. Kashefy (1970) and Alizadeh (2003) asserted that sudden changes in PEHs may precede many socio-cultural problems for residents. It also verified Salam's (2006) idea that those inconsistencies in pre- and post-earthquake lifestyle may trigger motivations for transformations in PEHs. Finally, the study found a significant relationship between comprehensive changes in spatial organisation of PEHs and motivations for transformations. This study interprets that this was due to people's tendency for following the vernacular architecture of Lar, which can be considered as an instance of socio-cultural issues.

TABLE 1
Comparison Among Frequencies Of 5 Levels of Transformations in Lar

	Slight Adjustment	Additionand Division	Total Conversion	Reconstruction	Rebuilt
Number of PEHs	6	220	76	50	23
Percentage of PEH	1.6%	58%	20%	13.3%	6.1%

Influencing Factors on the Specifications of Post-Earthquake Housing Transformations

Socio-cultural issues in developing PEHs are frequently supported by the published literature (e.g. Barakat, 2003; Marcillia & Ohno, 2012; Tasa *et al*., 2007) that asserted that rehabilitation of socio-cultural qualities should be taken into account in constructing and designing PEHs in the same degree of importance as for rehabilitation of the buildings. The results of this study also showed that socio-cultural issues are one strong motivator for transforming PEHs. It revealed that more than 8% of transformational motivation is rooted on socio-cultural issues (R^2=.084). This is based on the idea that socio-cultural issues triggered by inconsistencies between pre- and post-earthquake housing led people to transforming their houses. The conducted factor analysis revealed that socio-cultural motivation and motivation for following traditional architecture of Lar follow the housing specifications of pre-earthquake houses in Lar. Moreover, among all the mentioned motivation, two instances, namely "*adjusting relationship between open and close spaces in pre-earthquake houses* (R^2=0.047)" and "*re-applying ornamental elements of pre-earthquake houses* (R^2=0.067)" were found to be the most important factors in determining the model of socio-cultural motivation.

The study found that the quality of transformations in houses is dependent on the occupiers' perceptions and preferences. Based on the results of this study, different motivation could cause a different transformation in PEHs. The study also revealed that changes in typology, built-up area, constructional materials and façades are mainly motivated by the desire to copy prevalent housing forms as shown in Al-Naim (2008) and Shiferaw's (1998) studies. In addition, this study found that location also played an important role in determining house transformation, which influenced the transformation of function of PEHs. The results showed that this type of motivation appeared only when the houses were located beside the main roads for improving income

as the houses were transformed to serve as shops. The study revealed that the utilised materials in constructing initial PEHs were adjusted neither to conform with traditional housing of Lar nor with the prevailing architecture of the region (Housing Planing Department, 2001).

Façade transformations are often guided by the patterns of the current prevailing architectural style of the region. However, according to the results of this study, façade changes in Lar were guided by the motivation to follow the traditional architecture of Lar as well as the motivation to model the prevalent housing style. This was an interesting finding as during the early stages of development of PEHs, people were attached to their memories from their previous lifestyle and during the early period, transformations were attempts to emulate previous pre-earthquake houses. It was only in the later periods (1980s onwards) that the need to copy prevalent architecture style was seen as prevalent. This paper argues that this is because of the historical value of architecture and culture in central parts of Iran.

Phases and Types of Transformation

The results of the systematic observations indicated that most of the cases in Lar's post-earthquake houses have undergone the "Addition and Division" type of transformation, whilst only a few cases comprise the "Slight Adjustment" type. This can be explained by Arsalan's (2007) theory which asserted that sustainable transformation is possible only when the transformations do not entail full demolishment of the post-earthquake houses. In addition, according to the systematic observations, the appropriate location of construction on the land was the main support for preventing demolishment. This small number of "Slight Adjustments" could be considered as evidence of the need for transformations in PEHs, even slightly. In other words, it could indicate these original houses were usually not acceptable by residents without any transformation.

The current characteristics of PEHs are highly dependent on the qualities of both the original PEHs and the later transformations. Thereby, this study thoroughly investigated the quality of transformations in Lar's PEHs. The results of the conducted systematic observations revealed that 98.9% of PEHs were transformed between 1962 and 2008, and all instances of transformation were made by the residents. This study classified the instances of housing transformation in Lar's PEHs into five categories: Slight Adjustments, Addition and Division, Total Conversion, Reconstruction and Rebuilt acording to Mahmud's (2007) categorisation. As presented in Table 1, the majority of instances of transformation in Lar's PEHs were classed as Addition and Division, and there was little evidence of Slight Adjustment and Rebuilt. This shows that the original house structure in Lar city was often retained (not totally demolished) but was given additions or add-ons whilst their specifications were significantly changed in order to address the minimum requirements of the residents.

CONCLUSION

Post-earthquake shelter is usually not acceptable to occupants due to many factors. Unlike in normal situations, the tendency towards rehabilitation of the previous lifestyle is an important issue for disaster victims. In addition, occupants usually need to transform initial temporary shelter in order to become more comfortable and useable for permanent occupancy purposes. This study analysed the process of housing transformation in four areas: architectural characteristics of post-earthquake housing transformation, people's motivations in transforming their PEH, influencing factors on the specifications of post-earthquake housing transformations and phases types of transformation. This study found that "to adjust physical-living comfort" was the strongest motivation during the early occupancy period followed by "growing household size" as the most dominant motivation for transformation in Lar's PEHs. The study posits that leveraging transformability in PEHs could promote temporary houses into permanent homes in post-earthquake areas without much waste. The results revealed "*socio-cultural*" aspect as the strongest influencing factor in transforming a house in PEH in Lar, Iran, as the majority of house transformation includes a courtyard according to the vernacular house design. The majority of houses had undergone major transformation as reported in the findings. This study found that the original house structure was retained in most cases but changes, especially the façade, had caused difficulties for transformation, and proposes that house design should be flexible enough to assist future changes or transformation. In terms of reconstruction of PEHs, planners and designers should consider vernacular architecture in the initial housing plan, and the design should have the capacity for future transformations.

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