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Developing and Testing a Live-Work Postoccupancy Evaluation Tool for Informal Settlements in Thailand

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Abstract: Live-work housing is a dwelling type that accommodates living and livelihood activities. In the Global South, live-work housing plays a vital role in income generation and is central to poverty alleviation at the household level. They are particularly vital to women and older people by giving them a level of financial independence that would otherwise be difficult to achieve. Despite these and owing to limited understanding, live-work housing in the Global South remains unpopular with planning and regulatory authorities because it is perceived to be synonymous with informal settlements and poor living and working conditions. However, in order to make adequate housing provision for residents of informal settlements, it is important not to just devise a vision of the new space to be created but to first understand how low-income people use their existing spaces to sustain their living and livelihood. The most suitable tool to generate such a knowledge base is postoccupancy evaluation. This project developed and tested a live-work housing evaluation tool for low-income informal settlements in Bangkok, Thailand.

Keywords: Postoccupancy Evaluation, Informal Settlements, Live-Work Housing, Living Spaces, Livelihood Spaces

Introduction

This article is a presentation of the process of developing and testing a live-work postoccupancy evaluation (POE) tool for the assessment of low-income informal settlements in Bangkok, Thailand. In Global South countries, informal settlements are a manifestation of housing inequality, which are most prominent in urban areas, and are often portrayed as a necessary societal ill that must be endured, not least because of their contribution to the local (informal) economy (Wekesa, Steyn, and Otieno 2011) and their self-sufficiency (Steyn 2008).

It is therefore not surprising that policy interventions aimed at addressing the challenges posed by informal settlements in the Global South are seldom effective because top-down approaches to housing planning and provision often guide these processes, with little recognition of the socioeconomic dynamics of the communities. This may result in further informal adaptation of the dwellings by their inhabitants, which could inherently lead to the perpetuation and expansion of the informal settlements (Tipple 2006).

Very few countries in the Global South have appreciated and embraced the nuanced approach needed to understand and address the challenges of informal settlements. However, in order to make adequate housing provision for residents of informal settlements, it is important

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not to just devise a vision of the new space to be created but to first understand how low-income people use their existing spaces to sustain their living and livelihood. The most suitable tool to generate such a knowledge base is through the application of POE.

Definitions and variations of POE abound (Preiser and Nasar 2008; Menezes et al. 2012), and it is a term that has been used broadly for the assessment of "building-occupant interactions" (Preiser 1994) to determine "how well buildings match users' needs" (Turpin-Brooks and Viccars 2006), as a "diagnostic tool" (Preiser 1995), or for the "assessment of public buildings" (Riley, Kokkarinen, and Pitt 2010). In this article, POE is defined as a tool that is used to evaluate the suitability of a building for its users after it has been built and occupied for some time (Menezes et al. 2012) and also to identify ways to improve building design and fitness for purpose (Turpin-Brooks and Viccars 2006).

The idea of conducting POE on low-income housing units is not newfound (Kaitilla 1994). Some scholars have argued that a POE has the potential to bring to bear a "positive influence upon the delivery of humane and appropriate environments" (Preiser 2001, 13) for building occupants, whereas other authors have highlighted the significance of the occupant's behavior (Stevenson and Leaman 2010) and user satisfaction (Mustafa 2017) in the POE exercise. Nevertheless, it has long been recognized that a paradigm shift is necessary in the POE process, from a mechanism for sustaining and reinforcing the status quo through minor adjustments to a more profound means of rectifying long-standing societal inequity and redistribution of power (Weiss 1998). More recently, there has been an increase in calls for a reconceptualization of users' interaction with what designers have created (Durosaiye, Hadjri, and Liyanage 2019).

Although it is hardly questionable that the contexts in which POE was first introduced and applied were mostly suitable to building procurement processes in the Global North (Preiser 1995), there is also an acknowledgment that POE has "evolved from early efforts at environmental evaluation that focused on the housing need of disadvantaged groups and efforts to improve environmental quality" for these groups (Vischer 2002, 24).

As noted by Hadjri and Crozier (2009), there could be a range of cultural contexts in which POE could be utilized, and this also, by implication, means there are a number of differing cultural perspectives as to what a POE may be. Indeed, whereas there are several instances where POE has been used to assess the suitability of the built environment from the users' perspectives in the Global South (Wongbumru and Dewancker 2016; David Jiboye 2012), very little is known about the use of POE on live-work housing in informal settlements in Global South countries. Some of the earlier research into the implementation of POE in low-income contexts has stemmed from the need to understand the lived experiences of low-income residents, without much regard for how their housing influences their livelihood. It is this gap in knowledge that offered a backdrop for undertaking to develop this POE tool, in order to understand how residents of informal settlements use their housing simultaneously as a dwelling and as a resource for their livelihood.

Rationale to Develop a Live-Work POE Tool for Informal Settlements

To understand the rationale to develop a live-work POE tool for informal settlements, it is first necessary to clarify the term "live-work housing" in informal contexts. "Live-work housing" refers to dwellings that combine the dual usage of a building both as a home and as a source or support for livelihood activities. In a broader context, Dolan (2012) suggests that live-work housing is a land use and building type that accommodates living and livelihood activities yet is at once neither and both. According to Gough, Tipple, and Napier (2003), in the Global South, live-work housing plays a vital role in income generation and is central to poverty alleviation at the household level. It is particularly vital to women and older people in that it gives them a level of financial independence that would otherwise be difficult to achieve (Gough, Tipple, and Napier 2003). Additional benefits include the way it makes a tremendous contribution to the

vitality of the neighborhood, and to building a lifelong community, especially for older people to "age in place." Despite these, Gough, Tipple, and Napier (2003) argue that owing to limited understanding, live-work housing in the Global South remains unpopular with planning and regulatory authorities with regard to building control, land use, and issues of employment conditions, because local authorities and policymakers perceive live-work developments to be synonymous with poor working conditions. However, Nadim (2016) observes that it is common in Global South countries to find informal developments encompassing mixed used typologies intertwining formal and informal economies, as a form of home-based enterprise, which are erected haphazardly with little regard for safety and often lack adequate infrastructure.

Methodology

This live-work POE tool was developed to assess the suitability of the living and livelihood environments of low-income residents of informal settlements in the Klong Toey area in Bangkok, Thailand. A case study methodological approach was employed (Yin 2014), which is similar to the research methods adopted in the development of other POE tools (Durosaiye et al. 2020). This study was approved by the Ethics Review Committee both at the University of Sheffield, United Kingdom, and at Kasetsart University, Thailand.

Case Study Communities

Klong Toey comprises approximately twenty-six low-income urban communities on the land of Port Authority Thailand. Based on a review of the housing types in Klong Toey, three communities, including Baan Kluay (BK), walk-up flat (FL), and Baan Mankong (MK), were selected as case studies for the development and testing of the live-work POE tool. Fifteen households were randomly selected from each of the three communities, making a total of forty-five households that participated in the study. The basic information, including the similarities and differences between the communities, is provided in what follows:

Baan Kluay

BK is located on land owned by Port Authority of Thailand (PAT). Most of the residents are squatters and do not pay the landowner, PAT. BK is located along an overpass and ditch, with approximately 212 households, and is generally crowded, with poor environmental conditions and a lack of adequate infrastructure. Some of the houses have access to electricity and sanitary lines, whereas others rely mostly on neighboring houses' utilities. The size and condition of the houses depend on the household's capacity to self-build and maintenance, as well as family size. However, it is not unusual to have more than one family living together in a household as part of the Thais' culture of expanded family. The ownership of the land remains unclear, so most houses are located next to each other with different layout plans on the same piece of land.

Walk-Up Flats

The walk-up flats (FL) in Klong Toey consist of four communities, which have been subsidized by the National Housing Authority (NHA) since the 1980s. Most of the tenants moved in from different locations, either because they have been evicted from their previous home or because they were occupants of houses that have become inhabitable owing to a fire incident. To earn extra income, some of the tenants often sublet parts of their homes to others. Unlike residents in BK, the occupants of the FL pay rent to PAT, which ranges between £15 and £35 per month. For the purpose of this study, house nos. 23 and 24, consisting of 430 units, were selected. All the flats are of the same size, at 30 m^2, with balcony area. Most of the tenants have adapted their homes or some of the spaces to suit their household size and living condition. Adaptation, such as self-built partitions or mezzanine are not uncommon. This also explains why some of the

flats are overcrowded, with instances of seven to eight members living together in one room. There are also several instances when the tenants have adapted their spaces for live-work activities, such as running a grocery shop, salon, laundry, or food preparation.

Baan Mankong

MK is the only cooperative housing community in Klong Toey, under the secure housing scheme supported by Community Organizations Development Institute (CODI), a government authority responsible for low-income housing for the poor in rural and urban areas in Thailand through a participatory approach. The communities that participated in this scheme must be organized as a cooperative in order to access housing loans and infrastructure subsidy from CODI. At the time of this study, there were 114 households in the selected community, each of which needed to have its own savings as a collateral to access a low-interest housing loan. Most of the residents of MK have secured tenancy, with some having official land lease permits from PAT. Each house has two stories of 80 m^2 floor space and cost around £3,750 to build. The house allows the occupants to live and run a business on the ground floor.

Procedure

The process of developing the live-work POE tool consisted of three steps, as shown in Figure 1, namely drafting, piloting, and testing. In Step 1, the initial live-work POE tool checklist was drafted based on an extensive review of academic and gray literature. In Step 2, two rounds of on-site POE pilot surveys were carried out. The results of the pilot survey were reviewed, based on which a revision of the live-work POE tool was undertaken. In Step 3, the revised version of live-work POE tool was tested in the three case study communities. A follow-up descriptive analysis was carried out to check the suitability and efficacy of the POE tool.

Prior to the fieldwork, Thai research assistants (RAs), with knowledge of the study area, were recruited to carry out the pilot POE survey. The RAs were invited to a training session before being assigned to carry out the POE. The training session was necessary to make sure all the RAs understood the basic principles of the POE fieldwork and were provided with detailed instructions for completing the POE checklist. The training session also allowed the RAs to ask questions and give their feedback about the tool.

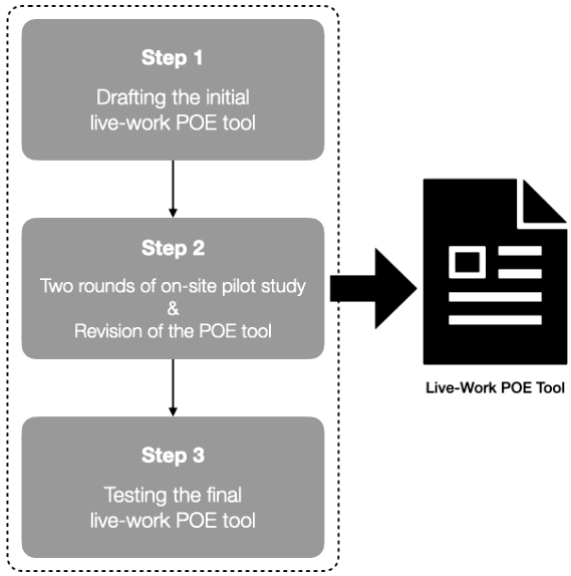


Figure 1: Live-Work POE Tool Development Steps

The RAs worked in teams of two people. On the day of the POE survey, a research team of two paid a visit to the household and carried out the evaluation. The data collection instrument used in the fieldwork was the live-work POE checklist. During the POE survey, one RA was in charge of completing the POE checklist, whereas the other prepared sketches of the floor layouts and sections of the physical environment of the household and also took measurements of the spatial areas of each of the spaces. They were also expected to record any other observations in relation to the live-work conditions of the housing unit under survey. The research teams were equipped with two tablet devices. One tablet was used to complete the live-work POE checklist, whereas the other was used for sketch drawing.

Results

The following is a detailed description of each of the three steps undertaken to develop the live-work POE tool:

Step 1: Developing

An initial checklist of the POE tool was drafted following a literature review of environmental assessment tools, including Lewis et al. (2010); Parker et al. (2004); Sloane et al. (2002); Lawton et al. (2000); Moos and Lemke (1980); Neufert and Neufert (2012), and United Nations (UN) (2003). The review covered three aspects: (a) current available POE tools, which are used to evaluate different built environments for frail older people; (b) building regulations and standards for housing in Thailand and the UK; (c) literature review regarding live-work approaches and designs. The literature review established that there was virtually no existing POE tool suitable for assessing low-income live-work environments, which would be able to capture the real-life situation and issues of the residents of Klong Toey. The review study contributed to the construction of the main body of the POE tool, which includes the living spaces, the livelihood spaces, the domains, the design criteria, and the scoring system.

Live-Work Spaces

In order to better evaluate participants' live-work environment, the POE tool needed to look at the different spaces that supported the residents' living and livelihood activities. Based on the initial walk-through review of the living and livelihood activities, as well as the review of typical household layouts by the RAs in the three communities in Klong Toey (Albright et al. 2011; Morales Castillo et al. 2018), the research team proposed seven different space types (Table 1), each providing the essential functions to support either the living or the livelihood needs of the residents.

Table 1: Seven Different Space Types in the Live-Work POE Tool

Space Type		*Examples of Functional Activities*
Living Spaces	*Day Space*	Family interaction, social interaction, resting, entertainment, exercise
	Night Space	Sleeping, dressing, meditation, retreat
	Cooking Space	Food preparation, cooking, dishwashing
	Dining Space	Food preparation, eating
	Bathroom & WC	Personal hygiene, toileting, laundry, personal washing
Livelihood Spaces	*Indoor Trade Space*	Goods preparation, goods display, storage, transaction, social interaction
	Outdoor Trade Space	Goods preparation, goods display, storage, transaction, social interaction, reception

For the living spaces, the POE tool evaluates five areas, including day space, night space, cooking space, dining space, and bathroom & WC space. For the livelihood needs, the spaces include the indoor trade space and the outdoor trade space. Owing to the relatively small sizes of the housing units (some of them were as small as 30 m^2), some of the spaces overlapped, and hence these functional spaces were not necessarily independent of each other. Overlaps were allowed and needed to be accounted for in the "comments" column of the POE tool checklist completed by the RAs during the POE surveys. The RAs were required to identify the functional spaces of each household while conducting the POE survey. The seven spaces were given a specific color code for easier visual identification. When the RAs conducted the POE survey, the sketches produced on-site were expected to correlate with the color codes provided, as shown in Table 1.

Domains and Criteria

Beyond the assessment for functional suitability of the living spaces and livelihood spaces, it was necessary to establish the essential domains of human interaction with the built environment and the corresponding design criteria that these spaces should meet, given that these spaces should support the needs of the older people residing in these informal settlements. A number of studies have identified different domains of interest, while assessing physical aspects of care facilities, including the availability of space; safety features; orientation cues; psychological attributes, such as dignity, choice, and individuality; and universal, physical, and cognitive requirements (Parker et al. 2004; Sloane et al. 2002; Bowie, Mountain, and Clayden 1992; Moos and Lemke 1980). The review of these studies was expressly conducted to explore how to establish whether there was a fit between frail older people and their living environment.

In the development of the POE tool, a rigorous review of the studies identified six essential domains that were selected for the POE checklist: (1) design: architectural design criteria, such as the size of the space, layout plan, and orientation and cognition cues; (2) safety: architectural design criteria supporting residents' safety, such as floor and wall surfaces, lighting, structure, mobility aids, and antitheft elements; (3) health: architectural design criteria related to the hygiene and health of the residents, such as ventilation, daylight, mold, and smell; (4) comfort: architectural design criteria promoting the residents' comfort level such as thermal comfort, antiglare environment, tactile feeling and noise level); (5) Privacy: architectural design criteria ensuring social and privacy needs, such as partitions, boundaries, and community connections; and (6) adaptability: architectural design criteria showing the flexibility of the space to be adaptable to the changing needs of the occupants, such as movability of the furniture, storage area, and multifunctional use of spaces. The presence or absence of these architectural design criteria for each of the six domains was explored in all the seven types of spaces.

Within each domain, a number of specific architectural design criteria were suggested for detailed examination during the POE survey.[2] In total, 152 architectural design criteria were provided in the POE tool checklist (Table 2). Most of these architectural design criteria can be assessed through direct visual observation, simple measurement (such as meter rule), and sensory perception (such as auditory, olfactory, or tactile).

[2] https://www.sheffield.ac.uk/sites/default/files/2022-02/AgeingHood_POE%20Checklist_RVS_1.xlsx

Table 2: Summary of the Criteria Numbers in the Live-Work POE Tool

Domains	*Living Spaces*					*Livelihood Spaces*		*Total*
	Day Space	*Night Space*	*Cooking Space*	*Dining Space*	*Bathroom & WC*	*Indoor Trade Space*	*Outdoor Trade Space*	
Design	5	5	5	5	5	7	7	39
Safety	5	5	4	4	4	4	3	29
Health	4	4	4	4	4	3	2	25
Comfort	4	5	4	4	3	4	4	28
Privacy	3	2	2	2	2	2	2	15
Adaptability	3	3	2	2	2	2	2	16
Total	24	24	21	21	20	22	20	152

Scoring System

For each architectural design criterion, the RAs could select one option from a dropdown menu of four options to indicate whether a particular architectural design criterion was present, absent, modified, or not applicable (Table 3). The RA must select "Yes" (when an architectural design criterion was present and used as designed/performs as designed); "No" (for architectural design criterion absent or not suitable for use as designed or not available); "Modified" (for architectural design criterion modified); "N/A" (for architectural design criterion not applicable or nonexisting). When "Yes" was selected, the architectural design criterion was scored 1. When "No" or "N/A" was selected, the architectural design criterion was scored 0. When "Modified" was selected, the architectural design criterion was scored 0.5. For each space or domain, these scores were summed and expressed as a percentage of their total number of architectural design criteria.

Table 3: Dropdown Options for the Design Criteria in the Live-Work POE Tool

Selection List	*Explanation*	*Action*
Yes	For architectural design criterion present and space used as designed/performs as designed	No comments required
No	For architectural design criterion absent or space not used as designed	No comments required
Modified	For space modified to meet architectural design criterion or partly used as designed	Please comment
N/A	For space not applicable or nonexisting	Please comment

For example, as presented in Table 2, the Day space has twenty-four architectural design criteria across the six domains. If a household's Day space meets eighteen of these criteria, a percentage score will be given as 75 percent (i.e., 18 as a percentage of 24: 18/24). The same process applies to the calculation of all the seven spaces.

Comments

The live-work POE tool checklist offers the researcher an opportunity to provide qualitative comments about the spaces that were observed but whose characteristics could not be captured in the POE tool checklist. During the POE survey, the RAs were expected to add their comments in the column provided in the POE checklist, following the scoring of each architectural design criterion to allow the collection of further information, if necessary. These

comments enabled further examination of the spaces alongside the POE scores to identify issues related to the live-work conditions of the residents. During the POE survey, it was mandatory for the RAs to add comments if they marked the architectural design criterion as "Modified" or "N/A" (see Table 3). No comment was required if they marked an architectural design criterion "Yes" or "No."

Step 2: Piloting

Once the initial POE checklist was drafted, it was sent for review within the research teams in both Thailand and the UK to enhance its robustness and rigor. After the review process was completed, the initial POE checklist was distributed to the research team in Thailand for the first round of pilot POE survey. After the households had confirmed their intention to participate in this study, a day was agreed with a member of the household when the RAs would visit the household to conduct the live-work POE surveys.

Two housing units were selected to carry out the first pilot studies. The POE tool was used to undertake data collection during the pilot POE survey. Where adequate, the RAs also prepared sketches and took pictures of the live-work housing conditions (see Figure 2 as an example). The research team was required to complete the POE tool checklist, take pictures, and draw sketches of the layout of the built environment of each household unit. The purpose of this was to ensure that data collected during the pilot POE survey could be subsequently triangulated with the sketches and pictures.

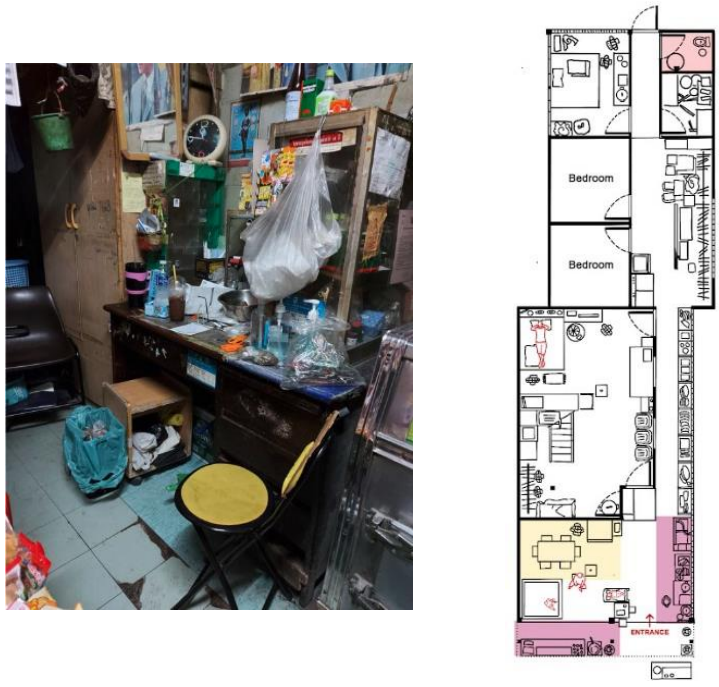


Figure 2: Example of Fieldwork Picture and Layout of a Household in Ban Kluay Community

After the first round of the pilot POE survey, all the data collected, as well as the RAs' comments were shared with the research team in both Thailand and the UK. The findings were shared and cross-checked for correlations and discrepancies. The research teams identified a

few issues that may cause confusion and misunderstanding if a user who could be less familiar with the research setting attempted to use the POE tool. For example, the dropdown menu in the pilot POE survey contained numerical figures, which was being mispresented by some of the RAs. The research team observed that some of the RAs were scoring the spaces "0.5," as a "middle-ground" rating, so that a space was neither downrated nor uprated. In the revised pilot POE survey, this problem was addressed by simply asking the RA to provide a "Yes" or "No" response, and the scoring was calculated with a macro formula in the Excel sheet of the live-work POE checklist. The revised POE tool was then shared with the RAs for the second round of the pilot POE survey.

After the first revision of the POE tool, the RAs carried out the second round of the pilot POE survey. Four housing units were selected for this round of the pilot study. The format, requirements, and procedure remained the same as in the first round. The RAs also followed the same procedure as that in the first round to complete the data collection during this step. Based on the data collected and the feedback from the RAs during the second round of the pilot POE survey, the research team checked the data collected and finalized it with some minor corrections.

Identifying the Threshold

After two rounds of pilot POE surveys, it was observed and recognized among the researchers that the score of 60 percent should be agreed as a typical threshold to determine the suitability of a space, based on the design criteria of the six domains. A space score below 60 percent would identify the specific space of the live-work housing unit as needing attention for improvements; a space score above 60 percent would identify the specific space of the live-work housing unit as satisfactory.

Step 3: Testing

To test the revised live-work POE tool, the RAs visited each of the fifteen housing units in the three case study communities to collect POE data on the live-work housing conditions of the communities, using the revised version of the live-work POE tool. The testing was completed on a total of forty-five live-work housing units. After the completion of the POE survey, the research team analyzed the data, comparing the differences and similarities of the housing conditions across the three communities. To illustrate the results of the testing step, one case study household was selected from each of the three communities.

Size of Live-Work Spaces in Case Study Household

Table 4 shows a summary of the average areas of the fifteen case study households in each of the three communities. From these results, it can be seen that the average areas of the households in the BK community are bigger than the other two communities in almost all the space types.

Table 4: Summary of the Average Areas of Each Space in the Three Communities

	Communities[a]					
Spaces	*BK*	*n*	*FL*	*n*	*MK*	*n*
Day Space	31.46	15	19.55	15	15.84	15
Night Space	27.15	15	13.67	14	21.01	15
Cooking Space	6.99	14	3.33	14	6.16	14
Dining Space	11.34	15	8.53	15	9.37	15
Bathroom & WC	4.04	14	2.95	15	2.67	15
Indoor Trade Space	18.77	8	13.09	8	12.77	6
Outdoor Trade Space	12.26	9	5.84	5	5.57	6
Total Area	85.26	15	30	15	65.82	15

a BK: Baan Kluay; FL: Walk-up flat; MK: Baan Mankong

The average areas in the walk-up flats are generally similar to those in the MK community, with some variations in the arrangement of the Day spaces, Night spaces, and Cooking spaces. In addition, it was observed that the households in the BK and the Baan Mankong communities usually have extra floors, whereas only some of the households in the walk-up flat community have mezzanines to create extra spaces for living. The summary table also shows that not all households have the indoor trade space or outdoor trade space for livelihood activities.

Live-Work Condition in Baan Kluay Community

Figure 3 shows the results of the live-work POE survey of a selected case study household in the BK community. In the case study household, the living spaces and the livelihood spaces scored above the 60 percent threshold in the design and adaptability domains, but below the threshold in the safety and health domains. The livelihood spaces scored above the threshold in the comfort domain, but below the threshold in the privacy domain, while the living spaces scored below the threshold in the comfort domain and above the threshold in the privacy domain.

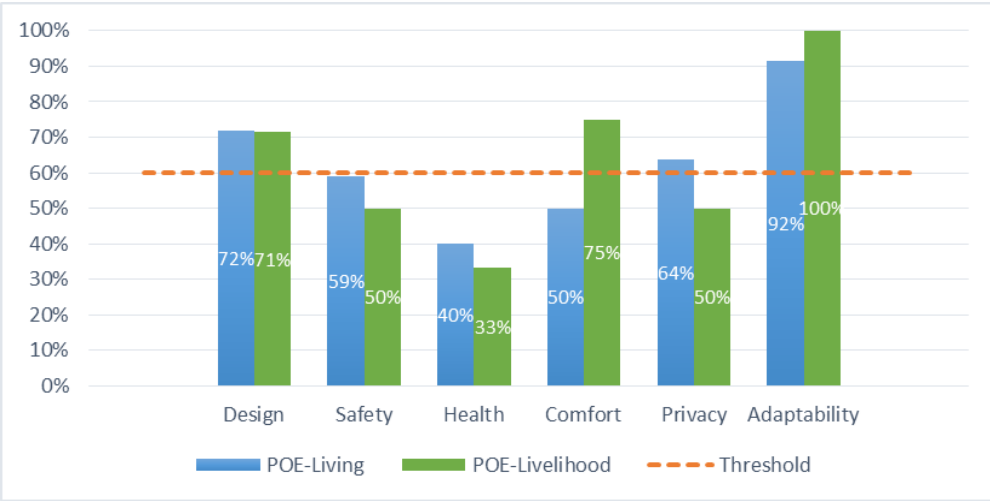


Figure 3: POE Results of Case Study Household in Baan Kluay

Overall, for the living spaces of the fifteen households in the BK community, ten households (66.67%) and eleven households (73.33%) scored above the 60 percent threshold in the design and adaptability domains, respectively (see Table 5).

Table 5: Overview of the POE Survey Results in Baan Kluay

Domain	*Living Space*				*Livelihood Space*			
	Below Threshold		*Above Threshold*		*Below Threshold*		*Above Threshold*	
	n	*Percentage*	*n*	*Percentage*	*n*	*Percentage*	*n*	*Percentage*
Design	5	33.33	10	66.67	3	20.00	12	80.00
Safety	14	93.33	1	6.67	13	86.67	2	13.33
Health	15	100.00	0	0.00	13	86.67	2	13.33
Comfort	15	100.00	0	0.00	10	66.67	5	33.33
Privacy	7	46.67	8	53.33	9	60.00	6	40.00
Adaptability	4	26.67	11	73.33	6	40.00	9	60.00

Fourteen households (93.33%) scored below the threshold in the safety domain. All the households scored below the threshold in the health and comfort domains. For the livelihood spaces, twelve households (80%) and nine households (60%) reached the threshold in the design and adaptability domains, respectively. Six households (40%) and five households (33.33%) scored below the threshold in privacy and comfort domains, respectively. Only two households (13.33%) each reached the threshold in both the safety and health domains.

Live-Work Condition in Walk-Up Flats Community

Figure 4 shows the results of the live-work POE survey of a selected case study household in the walk-up flat community. For the selected walk-up flats case study, the living spaces and the livelihood spaces scored above the 60 percent threshold only in the privacy domains. However, the household's spaces scored below the threshold in all other domains, including design, safety, health, comfort, and adaptability. The household's living spaces scored below the threshold in the design (12%), comfort (15%) and health (20%) domains. The household's livelihood spaces also scored below the threshold in the design (43%), health (0%), comfort (38%), and adaptability (25%) domains. However, it should be noted that this single case is not representative of the community. It has been purposely selected for presentation in this article to illustrate the variability of the quality of the living spaces and livelihood spaces of some of the homes in the walk-up flats.

The overall POE results of the households in the walk-up flat community show that the living spaces were generally in poor condition in the safety, health, and comfort domains (see Table 6). Out of the fifteen households, thirteen (86.67%), fourteen (93.33%), and thirteen (86.67%) scored below the threshold of 60 percent in the safety, health, and comfort domains, respectively. Conversely, 10 (66.67%) households in the design domain and eleven households each (73.33%) in the privacy and adaptability domains scored above the threshold.

The livelihood spaces in the walk-up flat community were generally good in the design domain, where twelve (80%) of the households reached the 60 percent POE threshold score. Eight (53.33%) households in the safety domain and seven (46.67%) households in the adaptability domain reached the threshold. Three (20%) and five (33.33%) of the households reached the threshold in both the health and privacy domains, respectively. However, just one (6.67%) of the households reached the threshold in the comfort domain. These results suggest that most of the households were in poor condition in the comfort, health and privacy domains.

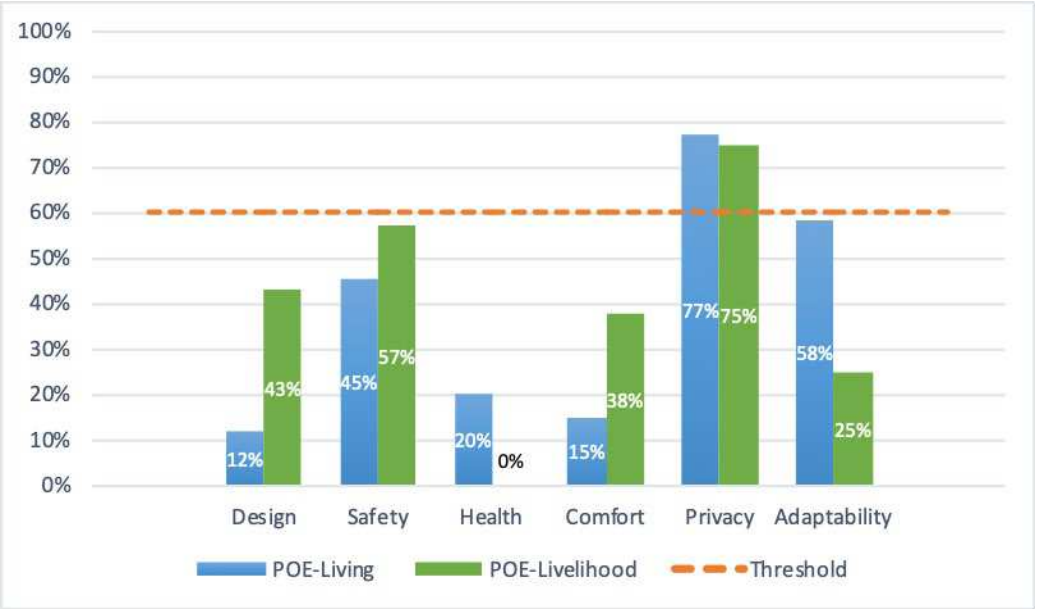


Figure 4: POE Result of Household Case Study Walk-Up Flat

Table 6: Overview of the POE Survey Results in the Walk-Up Flats

Domain	*Living Space*				*Livelihood Space*			
	Below Threshold		*Above Threshold*		*Below Threshold*		*Above Threshold*	
	n	*Percentage*	*n*	*Percentage*	*n*	*Percentage*	*n*	*Percentage*
Design	5	33.33	10	66.67	3	20.00	12	80.00
Safety	13	86.67	2	13.33	7	46.67	8	53.33
Health	14	93.33	1	6.67	12	80.00	3	20.00
Comfort	13	86.67	2	13.33	14	93.33	1	6.67
Privacy	4	26.67	11	73.33	10	66.67	5	33.33
Adaptability	4	26.67	11	73.33	8	53.33	7	46.67

Live-Work Condition in the Baan Mankong Community

Figure 5 shows the results of the live-work POE survey of a selected case study household in the MK community. In the selected household, the living spaces and the livelihood spaces both scored above the 60 percent threshold in the safety and comfort domains, but below the threshold in the design, health, and adaptability domains. Both the living spaces and the livelihood spaces scored poorly in the health domain, with 30 and 33 percent, respectively. The household's living spaces scored below the threshold in the privacy domain, whereas the livelihood spaces scored 100 percent in the privacy domain.

The overall POE results of the Baan Mankong community show that the households' living spaces were generally in poor condition in the design, privacy, and adaptability domains (see Table 7). Out of the fifteen households, ten (66.67%), twelve (80%), and eleven (73.33%) reached the threshold score of 60 percent in the design, privacy, and adaptability domains, respectively. Six (40%) households reached the threshold in the safety domain, whereas only two (13.33%) and three (20%) of the households reached the threshold score in the health and comfort domains, respectively.

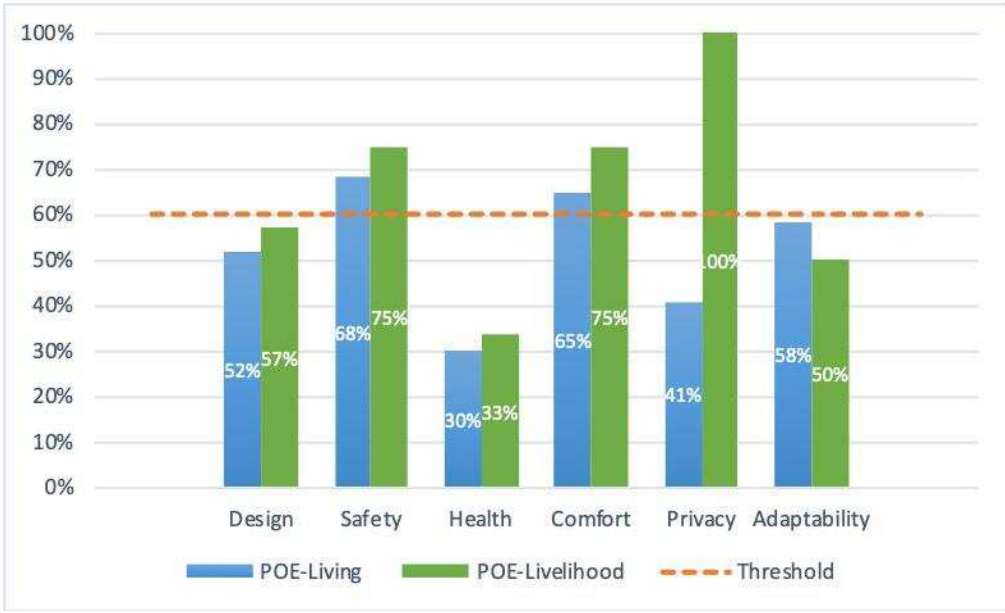


Figure 5: POE Results of a Case Study Household in Baan Mankong

For the livelihood spaces in the MK community, twelve (80%) of the households reached the 60 percent POE threshold in the design domain. Eight (53.33%) and six (40%) of the households reached the threshold in the safety and comfort domains, respectively. Conversely, five (33.33%) households each scored above the threshold in the health and privacy domains, whereas only three (20%) of the households reached the threshold in the adaptability domain.

Table 7: Overview of the POE Survey Results in Baan Mankong

Domain	*Living*				*Livelihood*			
	Below Threshold		*Above Threshold*		*Below Threshold*		*Above Threshold*	
	N	*Percentage*	*N*	*Percentage*	*N*	*Percentage*	*N*	*Percentage*
Design	5	33.33	10	66.67	3	20.00	12	80.00
Safety	9	60.00	6	40.00	7	46.67	8	53.33
Health	13	86.67	2	13.33	10	66.67	5	33.33
Comfort	12	80.00	3	20.00	9	60.00	6	40.00
Privacy	3	20.00	12	80.00	10	66.67	5	33.33
Adaptability	4	26.67	11	73.33	12	80.00	3	20.00

Comparison across Three Communities

Figures 6 and 7 show the comparison of the POE results across the three case study communities with respect to their living spaces and the livelihood spaces. It was observed that most of the households in the survey reached the 60 percent threshold in the design and adaptability domains compared with the other domains. On the other hand, there are fewer households that met the live-work POE threshold in the health and comfort domains. This finding suggests that design and future improvements of these live-work housing should aim to enhance the environmental quality of the spaces in the health and comfort domains. Such improvements may include the provision of better ventilation and more daylight or

interventions that could reduce mold and dampness issues or measures that enhance residents' experience in thermal comfort and noise reduction. In addition, the privacy domain seemed to be better in the living space than in the livelihood space. Hence, future improvements of the livelihood space may focus on providing better privacy solutions in the trade spaces.

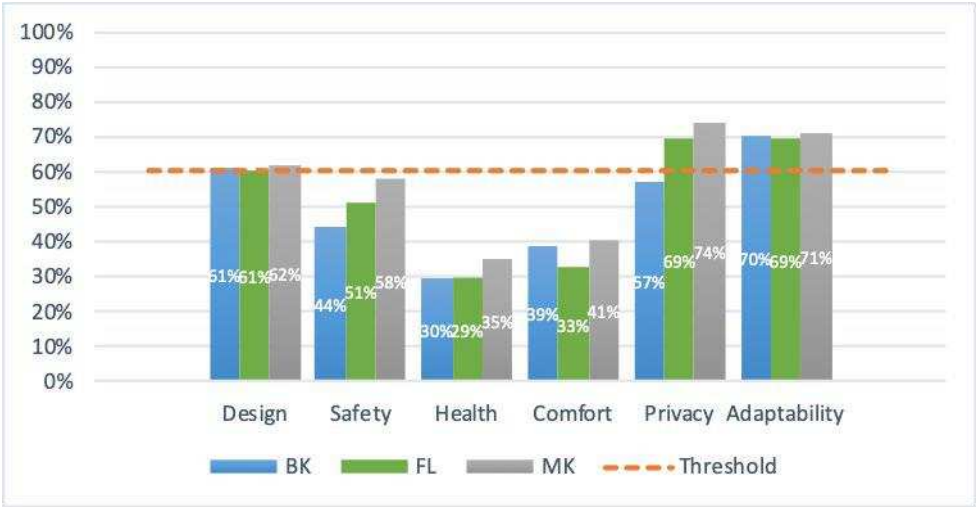


Figure 6: Comparison of POE Results of the Living Spaces across Three Communities

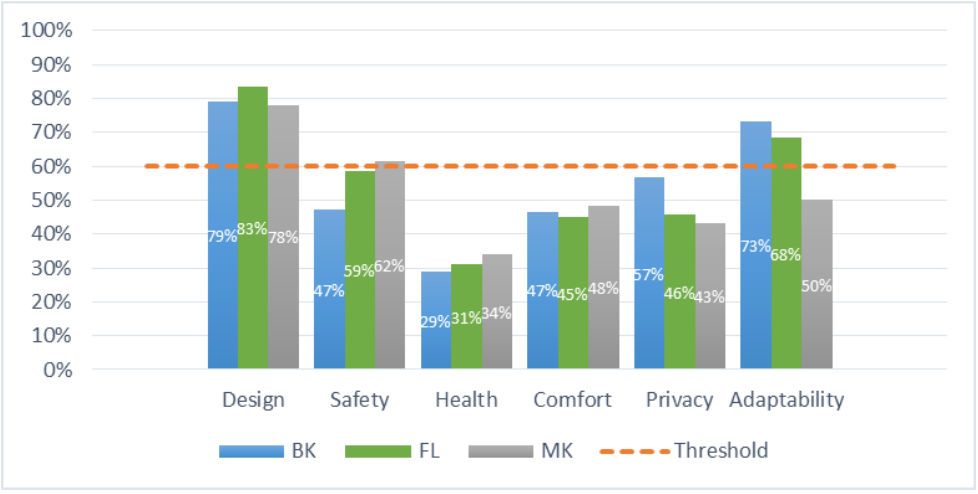


Figure 7: Comparison of POE Results of the Livelihood Spaces across Three Communities

Conclusion

In the development of the live-work POE tool, five environmental assessment tools were reviewed, namely, Lewis et al. (2010); Parker et al. (2004); Sloane et al. (2002); Lawton et al. (2000); and Moos and Lemke (1980). However, none of them would have served as a suitable POE tool for the assessment of housing in low-income informal settlements at Klong Toey. The closest match was the Evaluation of Older People's Living Environment tool (EVOLVE), developed in the United Kingdom by Lewis et al. (2010), which was included in the review because of its support for specific needs of older people in certain domains.

EVOLVE is a comprehensive evaluation checklist consisting of 487 need items for a single dwelling and 2020 need items for a housing scheme. These need items are categorized into

thirteen domains divided into two large groups, based on the types of needs these domains are expected to support. The first group of needs is called the "universal needs" domains, which is described as the needs of all persons using the built environment, including (1) dignity and privacy; (2) comfort and control; (3) social support inside building, and (4) social contact outside building. The second group of needs is called the "support for older age" domains, including (1) accessibility; (2) physical support, and (3) health and safety. Apart from these domains, EVOLVE was chosen for review for the development of this live-work POE tool also because of its authors' detailed and simplified account of how the tool was developed, piloted, tested, and validated.

However, EVOLVE could neither be adopted as it was nor adapted to be fit for purpose for the evaluation of informal settlement housing, necessitating the development of the live-work POE tool. The live-work POE tool is the first environmental assessment tool that could be used to assess the environmental quality of low-income informal settlements in urban environments in the Global South. The tool offers researchers the potential to establish an evidence-based assessment of the environmental quality of live-work housing in informal settlements in developing countries. This live-work POE tool would not only reveal the potential deficiencies in the current live-work environment in the assessed household but could also inform future housing project developments for low-income people by varying its approach to establishing the most potent domains with the most significant and direct impact on the living and livelihood activities of the residents.

This live-work POE tool could be used by a range of stakeholder groups, such as community organizations, local authorities and national government bodies, design practitioners, and charities, which could use the tool to identify the most common issues shared by most of the households within a community and develop more specific and targeted strategies to better support these low-income groups.

POE has been recognized as a useful tool to obtain feedback on the performance of an existing building or after a refurbishment project. However, POE could be used not only for the one-off evaluation of recently completed projects, but also as part of an ongoing assessment process for any building in use (Building Research Establishment [BRE] 2018). Design practitioners may use the live-work POE tool to help identify the needs of local residents in newly built design projects or refurbishment projects in the Global South. This live-work POE tool could also help designers to evaluate the existing housing from a particular perspective or on a combination of residents' living and livelihood needs and support both a creative design process and future improvements to meet users' needs.

This live-work POE tool was developed for the environmental assessment of low-income housing with home-based enterprises. The tool could be used to improve the quality of the living and livelihood environments of not just a single low-income household but also the community they reside in, because the assessed housing may be diagnostic or representative of the entire community.

The live-work POE tool was designed to be user-friendly, and hence a researcher with an average knowledge of the built environment would be able to use it. The live-work POE tool is free and accessible at the following URL: https://www.sheffield.ac.uk/sites/default/files/2022-02/AgeingHood_POE%20Checklist_RVS_1.xlsx.

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