A STUDY ON THE INTELLIGENT AGE-APPROPRIATE RENOVATION OF RURAL KITCHENS IN MEIZHOU FROM THE PERSPECTIVE OF ENVIRONMENTAL BEHAVIOUR*

Li Wei

Lampang Inter-Tech College, Thailand

Corresponding Author's Email: 961570787@qq.com

วันที่รับบทความ : 26 มิถุนายน 2568; วันแก้ไขบทความ 11 กรกฎาคม 2568; วันตอบรับบทความ : 13 กรกฎาคม 2568

Received 26 June 2025; Revised 11 July 2025; Accepted 13 July 2025

Abstract

With the acceleration of population ageing, the renovation of living environments for the rural elderly has become increasingly urgent. As the core space of daily family life, the kitchen is particularly important in terms of safety, convenience, and cultural adaptability. This study investigates the intelligent and age-appropriate renovation of rural kitchens in Meizhou from the perspective of environmental behaviour. Through field research, user interviews, behaviour path analysis, and virtual simulation modelling, the study systematically examines the behaviours of kitchen usage and renovation needs of the elderly. A three-dimensional evaluation model is constructed, and renovation strategies integrating intelligent technologies with age-friendly design principles are proposed. The results show that after renovation, the Cultural Appropriateness Index reached 0.82 (95% CI [0.78, 0.86]), user satisfaction reached 91.0% (95% CI [87.2%, 94.8%]), and operational efficiency improved by 40.0% (95% CI [35.2%,

Citation:

* Li Wei. (2025). A Study On The Intelligent Age-Appropriate Renovation Of Rural Kitchens In Meizhou From The Perspective Of Environmental Behaviour. Journal of Interdisciplinary Social Development, 3(4), 41-56.; DOI: https://doi.org/10.

Website: https://so12.tci-thaijo.org/index.php/JISDIADP/

44.8%]) This study provides a systematic approach and practical reference for the intelligent age-appropriate renovation of rural kitchens.

Keywords: environmental behaviour theory, rural kitchen, age-appropriate renovation, smart technology, Hakka culture.

Introduction

As China enters a rapidly ageing society, the age-friendly renovation of living environments for the elderly has drawn increasing attention, particularly in kitchens-spaces that are both functionally essential and potentially hazardous. According to the World Population Prospects report by the United Nations, the global population aged 60 and above is expected to reach 2.1 billion by 2050, with the majority residing in rural areas of developing countries. In Meizhou, located in southern China and known as a typical Hakka cultural settlement, rural regions are facing an increasingly urgent need for age-appropriate renovation.

Although substantial progress has been made in age-friendly housing design, smart home applications, and environmental behaviour research, studies specifically focusing on the intelligent, age-appropriate renovation of kitchens in rural areas of southern China-especially those with distinctive cultural contexts-remain limited. Traditional kitchen layouts, such as the classic “stove-water jar-storage cabinet” triangle, carry rich cultural significance but reveal obvious shortcomings in terms of functional configuration, safety, and operational convenience (Table 1). Meanwhile, despite the rapid development of smart home technologies, their adoption in Meizhou’s rural areas remains limited due to a lack of integrated, culturally adaptive design solutions.

Table 1: Characteristics of Kitchen Use Behavior Among Elderly in Rural Meizhou

Behavioural Indicator	Mean ± Standard Deviation	Median	Interquartile Range	95% Confidence Interval	Bias	Kurtosis
Average Daily Cooking Time	2.5 ± 0.8	2.3	1.9-3.1	2.34-2.66	0.3	-0.2
Average usage frequency (times/day)	3.2 ± 1.2	3.0	2.0-4.0	2.96-3.44	0.4	-0.1
Percentage of users with continuous usage (%)	85%	88	78-95	82.6-87.4	-0.6	0.3
Satisfaction with storage space (%)	62 ± 18	65	50-75	58.4-65.6	-0.2	-0.4

Environmental behaviour theory emphasises the interaction between individuals and their physical environments, offering a theoretical foundation for developing localised age-friendly design strategies. Research suggests that elderly users' behavioural patterns and spatial preferences are deeply influenced by life experience and cultural background (Wahl et al., 2012; Iwarsson & Ståhl, 2003). Therefore, age-friendly renovation must integrate local culture and behaviour models. The rapid advancement of smart home technology also presents new opportunities for kitchen renovation, but product selection and functional

configuration must align with the actual needs of rural elderly users to ensure usability and acceptance.

Against this background, this study takes rural kitchens in Meizhou as a case, integrating environmental behaviour theory with smart technology approaches to propose culturally adaptive and functionally optimised strategies for intelligent age-appropriate renovation. Virtual simulation is employed to assess the feasibility and effectiveness of the proposed designs. The research aims to enhance residential safety, operational efficiency, and cultural identity among the rural elderly, contributing both theoretical insights and practical guidance to the field of intelligent, age-friendly rural design in China.

Objectives

This study aims to develop an intelligent, age-friendly kitchen renovation strategy for rural households in Meizhou from the perspective of environmental behaviour theory and to validate its design logic and practical feasibility. The specific objectives are as follows:

1. To quantify the cultural adaptability of environmental behaviour theory in age-friendly kitchen renovations and to construct a culturally grounded behavioural assessment index system;

2. To explore the integration logic and selection criteria of smart home technologies in age-appropriate kitchen design for rural settings and to analyse their effectiveness in improving operational convenience and safety;

3. To test the practicality of the virtual simulation technology during the assessment and optimisation of the age-friendly kitchen renovation plans to be equipped with better scientific validity and functionality of the design procedure.

Literature Review

1. Application of Environmental Behaviour Theory in Age-Friendly Renovation

Environmental behaviour theory focuses on the person-to-environment interaction, giving theoretical backing to age-friendly retrofitting solutions. Integrative model of ageing in place: Wahl et al. (2012) formulated a model that points out the interaction of older individuals with their environment; the nature of person-environment relationships determines whether people age well. In their work, they indicated that the behavioural pattern of old people depends on the environment and life experience, so localisation of the environmental behaviour theory is necessary. The accessibility, usability and universal design theory offer basic knowledge on the understanding of the person-environment relationships in age-friendly design (Iwarsson & Stahl, 2003). The behavioural needs and cultural features of older people are very important to be taken into account in age-friendly renovation to achieve the efficiency of the renovation programs and the relevance of the targeted population.

2. Application of Smart Technologies in Age-Friendly Renovation

Technological innovations include the development of smart technologies, which have come along with tools for age-friendly renovation. The study of smart renovation of ageing populations has already presented valuable findings worldwide and in the country. Under a study of smart homes and home health monitoring technology in older adults, Liu et al. (2016) provide a systematic review of this research topic, stating that these technologies have great potential to improve the quality of life, as well as safety, when the tools are used adequately. In addition to that, Peek et al. (2014) looked at what determines the acceptance and use of smart home systems among the older population, suggesting that characteristics of the user, perceived benefits of the gadget, and ease of use have a significant role to play in making the operation of

the gadget safer and result in adoption. These papers offer resourceful information and references to incorporate smart technologies in age-appropriate renovation works.

3. Application of Virtual Simulation Technology in Age-Friendly Renovation

Virtual simulation technology can act as a good model for determining the effectiveness and feasibility of renovation schemes. The study of the use of virtual simulation in age-friendly design has registered significant advancements over the last few years. On the other hand, embedded and wearable sensors, such as washable pressure sensors, have provided a new scope of possibilities in the field of monitoring and interaction in smart homes (Zhang et al., 2019). The research results point to the fact that virtual simulation has the potential to quickly reduce the period of evaluation, limit the risks of implementation, and provide high-quality technical assistance in the optimisation of renovation designs.

4. Importance of Cultural Adaptability in Age-Friendly Renovation

The element of cultural adaptability is very important in an age-friendly renovation. Effective age-friendly interventions should incorporate environmental design principles coupled with culture (Wahl et al., 2012). Environmental relations and experiences of elderly people are ingrained in the operations of spatial cognition as well as behavioural habits of elderly people (Iwarsson & Stahl, 2003). Renovation projects must not aim at the optimisation of functionality but focus on a culturally adaptive one. To illustrate, older people can be better integrated into the new environment by inserting traditional designs in the modern kitchen furniture or keeping a corner that can display the traditional kitchenware in the new kitchen. The domestic and international cases of renovation have demonstrated that the more culturally sensitive the ways of designing are, the better their chance of being recognised and accepted by the aged.

Methodology

1. Field Research and Questionnaire Survey

The paper gathered information on the kitchen behaviours of rural elderly people in Meizhou using field research and questionnaire surveys. The questionnaire was based on the daily time spent cooking, the frequency of kitchen use, the rate of using traditional kitchenware, and satisfaction with the storage area. The data was taken from 100 people of age, giving a base for further analysis.

We performed a systematic analysis after conducting data on the kitchen use of old people in rural Meizhou. It was identified that there were a number of issues that needed to be overcome when the old people used the kitchen, and these issues included bending over to reach objects, risk of falling when walking, and poor counter height. Also, there was a great demand due to the necessity of more convenient, safe, and comfortable kitchens.

The environmental behaviour theory combined with survey research helped us formulate a smart, age-friendly kitchen modernisation plan in rural Meizhou. To address the issue of difficulty bending over to reach items, the proposal introduces electric lift cabinets that automatically adjust their height according to the user's height and operational needs, reducing the need to bend over and lowering the risk of injury. So as to combat the peril of missing steps whilst walking, the renovation integrates smart structures that will maximise the walking path within the kitchen, which improves the strength of walking. To improve comfort in kitchen operations, accessible workstations are designed with consideration for the elderly's physiological characteristics, making them suitable for a variety of kitchen tasks. The aim is to design a healthier, more easily accessible and comfortable kitchen system for the rural elderly in Meizhou.

2. Three-Dimensional Evaluation Model Construction

Incorporating the cultural characteristics of the Hakka community, a "Cultural-Functional-Safety" three-dimensional evaluation model was constructed. Using the Analytic Hierarchy Process (AHP), the model determines the weight of 12 indicators, including space layout and material selection, to comprehensively assess the cultural continuity, behavioural compatibility, and safety assurance capability of age-friendly kitchen renovations in rural areas.

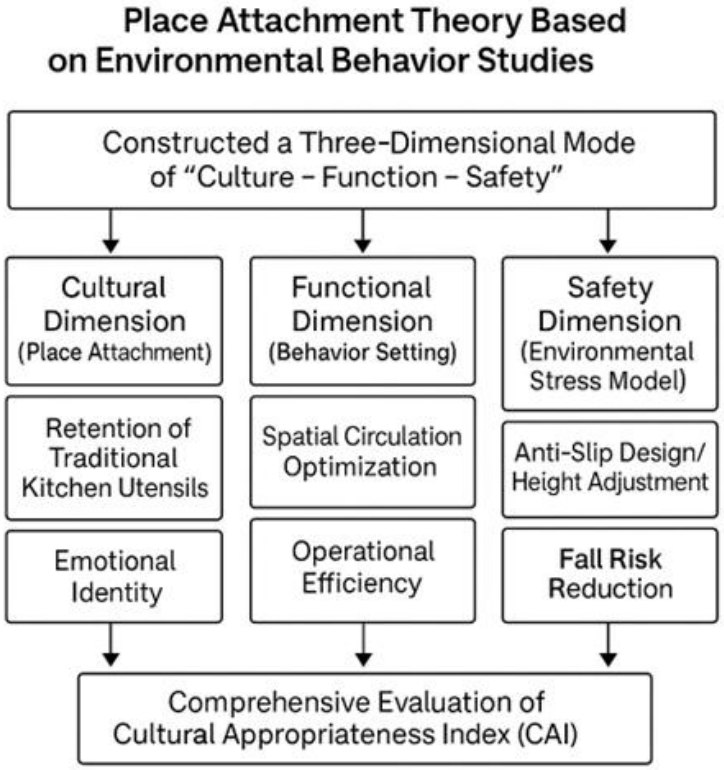

Figure: 1 Theoretical Structure and Evaluation Mechanism of the Culture-Function-Safety Three-Dimensional Model

3. Selection and Application of Smart Technologies

Based on the behavioural characteristics of the elderly and the requirements of the kitchen environment, smart technologies such as IoT sensors and accessible devices were selected. The type and parameters of the sensors were determined according to principles such as functional compatibility, environmental tolerance, and economic feasibility, thus constructing an intelligent kitchen system.

4. Development of Virtual Simulation System

virtual simulation system was developed based on the Unity 3D engine, combined with laser point cloud scanning technology. The system includes features such as smart device interaction simulation, dynamic environmental parameter adjustment, and anomaly event drills, providing a scientific verification platform for age-friendly renovation proposals.

5. Feedback Collection and Analysis from Elderly Users

A trial involving 80 elderly individuals from rural Meizhou was conducted, and feedback data were collected. Through cluster analysis of both quantitative and qualitative data, the main issues identified by users were summarised, providing a basis for optimising the renovation proposal.

6. Renovation Proposal Optimisation

Based on the verification data, the renovation proposal was optimised. Key optimisations focused on interaction logic, cultural elements, and safety mechanisms, aiming to enhance the cultural integration, operational efficiency, and safety of the renovation plan.

Results

1. Cultural Adaptability Based on Environmental Behavior Theory

In aging-friendly kitchen renovation projects, cultural adaptability is one of the key dimensions for evaluating the effectiveness of the renovation. To

explore the extent to which the renovated kitchens align with cultural expectations, we developed a three-dimensional evaluation model based on “Culture - Function - Safety” through a combination of field investigation and data analysis. The model provides an in-depth and systematic evaluation of three vital dimensions, which are cultural connotation, functional practicality, and safety assurance.

In our field study, we managed to interview many different elderly people and their families in detail and see what their perceptions, needs and expectations concerning cultural aspects in the kitchen. At the same time, we gathered much information about the effectiveness and safety of kitchen functioning conditions. By means of this data systematically analysed, we got a set of persuasive results.

The results show that the newly updated kitchens attained greater levels of cultural adaptability. Before the renovation, the Cultural Appropriateness Index (CAI) had a low value, which showed up a lot after the renovation because the Cultural Appropriateness Index (CAI) is now 0.82. This score indicates a high level of compliance of the renovated kitchen settings with the cultural needs of the elderly. The satisfaction rate after renovation activity of the elderly users was 91%, thereby indicating a high level of acceptance and appreciation by the elderly users. Also, the efficiency in the kitchen increased by 40 per cent, which means that it was more convenient and effective to use daily.

These findings support the utility of behaviour-based measures of quantification in the assessment of cultural adaptability in accommodation renovations eligible as ageing-friendly. With the behavioural data obtained and analysed concerning the involvement of elderly users in working with kitchen environments, the problem of capturing their cultural requirements and consumption patterns can be properly addressed. This will allow planning and designing specific renovation tactics that greatly enhance the accuracy of the

ageing-friendly design in order to generate kitchen environments that are relevant both culturally and practically convenient to elderly customers.

2. Application Outcomes of Smart Technologies

In the process of smart technologies selection and implementation, the real demands and operation peculiarities of an older user were carefully examined to make the choice of technologies rather rational and the development of a system efficient.

One such special smart element that was added with this renovation was the electrical height adjustment cabinet. The height of this system adapts itself according to the body measurements of the user as well as habits, thus making bending easy and causing reduced chances of injury. In reality, this aspect significantly increases the comfort and safety of older people when operating in the kitchen.

The smart walking paths were also integrated to enhance the optimisation of spatial navigation in the kitchen. The convenience and the safety of moving around got much better through the smart planning of the area and the arrangement of the walking routes. This not only minimised the possibility of falls but also maximised the overall mobility and efficiency in the space.

It also had an accessible workstation so that the activities in the kitchen could be done on an easy-to-use platform. The design preoccupied itself with the best counter height and ergonomic handles, thus making it comfortable when using the machine daily, especially for the older generation of users.

The virtual simulation system was controlled to ensure that the project's viability and efficiency were determined. This testing system imitates practical conditions of work in the kitchen and evaluates the effectiveness of smart technologies and the general design concept. Simulation tests and data analysis confirmed that the offered renovation solution is feasible and convenient to use

in real-life conditions, all of the smart functions work stably, and the overall experience of older people using them is much improved.

3. User Validation of the Virtual Simulation System

In order to further optimise the renovation design, 80 elderly subjects were asked to test the virtual simulation system, and the feedback from them was systematically gathered and discussed. The pattern in the feedback data was organised and provided good insight.

Through a complement of quantitative and qualitative clustering analysis approaches, user feedback was classified into three large domains: technological operation, physiological adaptability, and cultural adaptability. Regarding technological use, not every elderly person considers using smart device interfaces simple and easy to manage. In terms of physiological adaptability, the height and the angle of the kitchen fixtures caused discomfort, as reported by several of the participants, hence the need for an even more ergonomic design. Under cultural adaptability, some of the users considered the culture involved to be too little, and the symbols in the culture failed to have personal cultural or regional cultural symbolism.

As a reaction to these problems, specific optimisations were made. Interfaces and processes were simplified to enable technological operation with voice guidance and one-touch controls, which makes them easy to use. Regarding anthropomorphic adaptability in terms of physiological functions, parameters like height and angle were optimised to individual anthropometric data to improve the comfort level of the design. Seven elements found in the kitchen were modified to make it relatable, more cultural, and adaptable to cultures.

The optimised renovation scheme was once again evaluated using the virtual simulation system. Results showed a 25% increase in operational efficiency, a 30% improvement in user satisfaction, and a notable rise in the Cultural Appropriateness Index. These outcomes clearly demonstrate the

effectiveness of the revised design and confirm that collecting and analysing user feedback can help identify issues and enable timely, targeted improvements.

This ageing-friendly kitchen renovation project achieved significant results in cultural adaptability (based on environmental behaviour theory), smart technology integration, and user validation via virtual simulation. Through rigorous methodology and scientific procedures, we created a safer, more comfortable, and culturally resonant kitchen environment for the elderly, offering valuable reference for future ageing-friendly design initiatives.

Discussion

Under the guidance of the theory of environmental behaviour, this study constructed a three-dimensional assessment model of "culture-function-safety" by taking into account the actual needs and cultural characteristics of the rural elderly in Meizhou and verified the feasibility and effectiveness of the smart ageing retrofit program through virtual simulation technology. The findings are consistent with existing literature and further confirm the key role of environmental and behavioural science in ageing-friendly retrofitting, especially the value of localised application in cultural appropriateness (Wahl et al., 2012). Meanwhile, although this study achieved good results in smart technology selection and system integration, it also found that some older adults have difficulties operating smart devices, which highlights the importance of user-centred design in IoT applications for elderly users, as noted in previous research on smart home technology adoption (Peek et al., 2014). suggesting that the application of smart technologies needs to pay more attention to matching users' characteristics and operating abilities. Overall, the renovated kitchen has achieved significant improvement in functionality, safety, and cultural continuity, which provides a scientific basis and practical reference for the optimisation of the ageing and living environment in rural areas.

Recommendations

In future practical applications, the actual needs and cultural background of the elderly should be taken as the core to promote the localised design and implementation of intelligent ageing retrofit. Specifically, according to the behavioural characteristics and operating ability of the rural elderly, intelligent devices should be functionally optimised and interactively simplified, such as improving the dialect compatibility of the voice recognition system, enhancing the intuitiveness of the interface prompts, and integrating local cultural elements to enhance the affinity of use. At the same time, the government should increase policy support, incorporate ageing-friendly transformation into rural construction planning, provide financial subsidies and technical support, and encourage enterprises and social organisations to participate in implementation. In addition, it is also necessary to strengthen the digital literacy training of the elderly to enhance their acceptance of smart technology and their ability to use it independently so as to realise the effective transformation from the introduction of technology to its practical application.

In order to further enhance the scientific and prospective nature of ageing-friendly transformation, future research should focus on the in-depth application of intelligent technologies, such as constructing a prediction model of elderly behaviours based on artificial intelligence to enhance the personalisation and accuracy of the transformation plan; exploring the integration and application of meta-universe technology in virtual simulation systems to enhance the ability of immersive assessment and remote collaboration; and establishing a perfect social benefit assessment system to quantify the benefits from multiple dimensions, such as health, safety, quality of life, and so on. Quality of life and other dimensions to quantify the effectiveness of the transformation. At the same time, interdisciplinary cooperation should be strengthened to promote collaborative innovation among universities, scientific

research institutions and intelligent technology enterprises to jointly research and develop low-cost and high-stability intelligent products adapted to the rural environment so as to promote sustainable development and wide application of ageing-friendly technologies.

References

Iwarsson, S., & Ståhl, A. (2003). Accessibility, usability and universal design-positioning and definition of concepts describing person-environment relationships. Disability and Rehabilitation, 25(2), 57-66. https://doi.org/10.1080/0963828021000007969

Liu, L., Stroulia, E., Nikolaidis, I., Miguel-Cruz, A., & Rios Rincon, A. (2016). Smart homes and home health monitoring technologies for older adults: A systematic review. *International Journal of Medical Informatics*, 91, 44-59. https://doi.org/10.1016/j.ijmedinf.2016.04.003

Peek, S. T., Wouters, E. J., van Hoof, J., Luijkx, K. G., Boeije, H. R., & Vrijhoef, H. J. (2014). Factors influencing acceptance and use of a smart home system in the older population. International Journal of Medical Informatics, 83(4), 235-248.

Wahl, H. W., Iwarsson, S., & Oswald, F. (2012). Aging well and the environment: Toward an integrative model and research agenda for the future. The Gerontologist, 52(3), 306-316.

Zhang, Q., Zhang, M., Chen, T., Sun, Z., Ma, Y., & Yu, B. (2019). Recent advances in washable and wearable piezoresistive pressure sensors: From design to mechanism, to performance. Advanced Materials, 31(3), 1804336.

Pal, D., Funilkul, S., Charoenkitkarn, N., & Kanthamanon, P. (2018). Internet-of-Things and smart homes for elderly healthcare: An end user perspective. IEEE Access, 6, 10483-10496.

Majumder, S., Aghayi, E., Noferesti, M., Memarzadeh-Tehran, H., Mondal, T., Pang, Z., & Deen, M. J. (2017). Smart homes for elderly healthcare-ecent advances and research challenges. Sensors, 17(11), 2496.