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Improvement of Public Kitchen Layout through the Application of *Design Thinking* Method and *Work* Concept

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ABSTRACT IN ENGLISH

This study aims to improve the efficiency and functionality of the public kitchen layout in ST Village by integrating the design thinking method with the work triangle concept. Design thinking was applied to explore user needs and guide solution development through a user-centered, iterative process. The work triangle concept was used to assess movement efficiency across three primary kitchen zones: storage, washing and preparation, and cooking and serving. User needs were identified through interviews and observations, which led to the creation of two layout alternatives. The work triangle analysis evaluated movement efficiency across these zones. A concept scoring method assessed the alternatives based on space efficiency, ease of movement, occupational safety and health, and process flow. Alternative 1 emerged as the optimal design, scoring 5, compared to 7 for Alternative 2, with a reduced work triangle perimeter of 540.98 cm. The design improved accessibility, posture, and task coordination while minimizing unnecessary movements. Additional improvements included optimized lighting, achieving 500 lux with two 36-watt luminaires, and better ventilation. User feedback confirmed increased comfort, safety, and efficiency. This study demonstrates how user-centered design and ergonomic principles can optimize shared kitchen spaces in rural communities, addressing gaps in research on private or commercial kitchens.

1. INTRODUCTION

Kitchen spaces are often overlooked when planning a house, even though the kitchen is the highest functional room among all rooms [1]. The layout design should consider the type of work being done. Kitchen design and planning should be designed to facilitate safe, efficient, fast, and comfortable work. Kitchens are needed by us as humans because cooking is one of the activities carried out in everyday life. Cooking activities are often carried out and can last for a relatively long time, so the kitchen design must be designed with ergonomic aspects in mind. The need to move freely and tirelessly to complete cooking activities in the kitchen is often a goal that is not achieved satisfactorily.

A poorly planned kitchen layout can affect the efficiency and productivity of your day-to-day operations and pose long-term physical hazards to your business employees [2]. Ergonomics is essential in the design of kitchen layouts and equipment. Cooking is an activity that consists of several activities such as preparing ingredients, washing food ingredients, cutting food ingredients, serving, and cleaning tableware. The number of activities can cause fatigue. Because of these many activities, the kitchen needs to be designed as comfortably as possible so that residents, especially mothers, can do their activities comfortably, safely, and avoid excessive fatigue. The role of the kitchen is not only limited to its function in preparing food; this space has also evolved into a place for family gathering, social interaction, as well as a means of expressing personal style and technological advancement [3]. The discomfort of the kitchen space will lead to unnatural working postures that can quickly fatigue users and put them at risk of health and safety concerns. Work-related fatigue is an issue that affects health and safety. Severe long-term fatigue can affect physical, mental, and behavioral well-being, eventually leading to illness and inability to work [4], [5], [6].

Lack of awareness about ergonomics causes users to be unaware of cumulative trauma disorders, signs & symptoms, and risk factors for musculoskeletal disorders [7]. Kitchen ergonomics aims to minimize the movement and stress that users, especially women, face while in the kitchen [8]. Ergonomics not only saves time, but also reduces effort by eliminating unnecessary ways to get the job done [9].

Currently, there is a public kitchen in ST Village. When there are visits or meetings, this kitchen is often used by residents for cooking. However, the layout of the kitchen facilities and the physical work environment are still inadequate. Washing activities are still carried out outside the kitchen area, so it feels uncomfortable because you have to go back and forth. Lighting in the kitchen area is still inadequate due to the lack of lighting sources. Kitchen users also find it difficult to carry out cooking activities, especially when the weather is cloudy or late at night, because the lighting in the kitchen only comes from sunlight and a bulb lamp with dim lighting. The research objective is to design a public kitchen layout with optimal space utilization according to the needs and desires of ST Villagers, so that residents feel comfortable, safe, healthy, and efficient.

Research on kitchen layouts shows the importance of designs that are suitable for different needs. For example, research in Turkey on kitchen layouts for the elderly recommends using a U-shape to facilitate their activities[10]. In addition, a good kitchen layout also plays an important role in facilitating food hygiene practices, especially regarding the placement of sinks in the kitchen area. The safety triangle concept aims to reduce the risk of foodborne illness by creating an environment that supports hygienic practices [11].

In Malaysia, design strategies for the convenience of low-cost residential kitchens are often overlooked and are a cause of health and safety concerns [12]. Designing family kitchens with attention to work comfort, saving time and energy, and improving work efficiency are also important focuses in kitchen design [13]. In addition, kitchen layout designs that make optimal use of space are necessary in temporary emergencies [14], and strategies for designing kitchens for people with disabilities should consider setting optimal access points [15].

Improving the layout of the campus canteen kitchen with ergonomic evaluation and the work triangle method also showed good design relevance in improving efficiency [16]. On the other hand, a preliminary design of an emergency public kitchen for natural disasters has been developed, but it still needs improvement to be ready for mass production [17]. Research in Davao del Norte, Philippines, showed that a good kitchen layout was positively associated with high employee performance [18].

In restaurants, good kitchen design can reduce operational costs and improve staff work efficiency, taking into account factors such as physical space limitations and budget availability [19]. However, research on layout design for public kitchens is still very limited and has never been done in depth. Although the work triangle and design thinking methods have been widely applied in various kitchen design and innovation projects, their integration in this study offers a distinct contribution by addressing the specific context of public kitchens in rural communities. Most previous ergonomic and layout improvement studies have focused on private or commercial kitchens, with limited attention given to shared cooking facilities in low-resource settings. By involving local users directly in the problem identification and evaluation

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stages, this study applies a participatory design approach that not only responds to the real needs of users but also provides insights into how ergonomics can be embedded into grassroots-level spatial planning. The results contribute to filling a gap in existing ergonomic literature, particularly in terms of adapting well-established principles to socially driven, collaborative environments such as communal kitchens.

2. METHOD

Research Design. This research uses a mixed-method approach, which combines qualitative and quantitative analysis. Qualitative analysis uses the design thinking method to understand user needs and preferences through interviews and observations, while quantitative analysis is used to measure layout efficiency using the work triangle concept**. Research Subjects**. The research subjects involved active users of the public kitchen, namely community women from ST Village. These participants are housewives in general who usually prepare food for the family at home, and usually these housewives also jointly prepare food in this public kitchen when there is an event in this village. With close collaboration, they strive to serve food that not only tastes good, but also reflects the cultural heritage and preferences of the local community, while strengthening social ties among the residents. Participants were selected with consideration to ensure good representation. **Data Collection Procedure**. This study uses the design thinking method, a user-centered approach to problem-solving that integrates user needs with functional, contextual, and technological considerations to generate appropriate solutions [20]. The process consists of five stages: empathize, define, ideate, prototype, and test. These stages guided the redesign of the public kitchen layout through real user input and iterative evaluation. Direct observation was conducted to identify problems and user needs related to the kitchen layout, as well as to measure the availability of existing space. The third stage was to develop alternative ideas, of which there were 2 alternative layouts. The fourth stage is to create a prototype using 2D drawings. In the analysis stage, the efficiency of the layout is identified using the work triangle concept, which involves steps such as taking, washing, mixing, cooking, and serving food. The concept scoring method was used to compare the two proposed layouts across four ergonomic criteria: space efficiency, ease of movement, occupational safety and health, and process flow. Each alternative layout was rated by ten active users, and the results were used to determine the preferred design. Validation of the prototype involved user participation to measure the effectiveness of the proposed layout changes. This research method is expected to provide a comprehensive and in-depth look at the problems of public kitchen layouts and provide user-oriented and ergonomic solutions. This research method is expected to provide a comprehensive and in-depth look at the problems of public kitchen layouts and provide user-oriented and ergonomic solutions. The method that will be used in redesigning the layout of this public kitchen uses the design thinking method. Design thinking is a user-centered and collaborative approach to solving problems creatively, iteratively, and practically [21]. This method is widely applied in various fields such as product development, where craftsmen and designers generate innovative ideas through discussions [22], as well as in education [23], [24], mobile learning applications [25], business [26], [27], visual communication, and sustainable environmental development [28], [29]

3. RESULT AND DISCUSSION

The following are the results obtained from each stage of the design thinking method.

3.1 Stage 1: Empathize

At this stage, interviews were conducted directly with public kitchen users, namely mothers who are usually directly involved in cooking and serving food if there is an event in the village. In addition to interviews, direct observations and measurements were also made in the public kitchen area. The purpose of this first stage is to gain a deeper understanding of user expectations and needs, and to find solutions with consideration from the user's point of view [30].

Information was obtained from 10 active users that the layout of the public kitchen was not optimal and felt uncomfortable. Limited facilities and the distance between the cooking area and the washing area make cooking activities less efficient. The public kitchen is shaped like a house on stilts, so the washing area outside the kitchen requires users, especially mothers, to frequently go in and out of the room and pass through two flights of stairs when carrying equipment or food ingredients. This increases fatigue, the risk of knee injuries, and hinders the smoothness of the cooking process, especially when it rains.

Apart from the layout, inadequate lighting is also an issue. During the day, the kitchen relies solely on sunlight, while at night or during cloudy weather, a single dim bulb lamp is the only source of illumination. This condition makes cooking activities, especially cutting food ingredients and processing dishes with fire, less comfortable. In addition, the position of the stove that is still on the floor causes users to bend over, which risks causing back pain.

Air circulation in the kitchen is also poor. When several users are in the room and the smoke from the fryer accumulates, the air becomes stuffy and uncomfortable. As shown in Figure 1, the current condition of the kitchen does not meet the principles of optimal ergonomics, especially in applying the work triangle concept. The long distance between the

cooking area and the sink not only prolongs cooking time but also increases the potential for contamination of foodstuffs as well as the risk of accidents due to height differences or slippery floors.

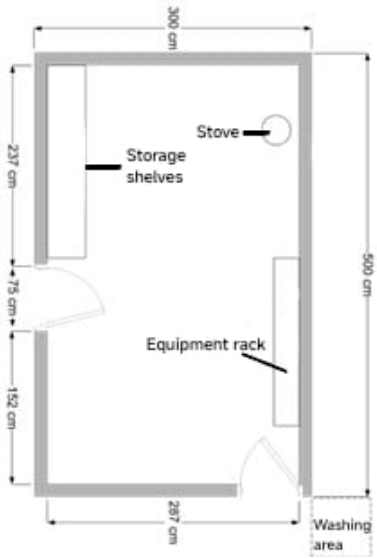

Figure 1. Actual Condition Layout and Situation

3.2 Stage 2: Define

This stage aims to summarize the needs and problems identified in the previous stage. In this stage, it was found that users expected the washing area to be inside the kitchen to make it more practical, with better lighting, especially at night, and additional ventilation to improve air circulation. In addition, users still want to maintain the bamboo booth material as the kitchen wall because it reflects the characteristics of the ST Village. Overall, the women expect the kitchen layout to reduce fatigue when preparing food, have sufficient lighting, and better air circulation to make the kitchen feel more comfortable. Based on the problems and needs obtained in stage 1, a summary of the needs statement is presented in Table 1.

Table 1. User Needs and Technical Statement

No	User Needs	Technical Statement
1.	Users are exposed to rainwater when doing washing activities when it is raining because there is currently no adequate washing place.	Effective and layout design is required
2.	The kitchen area feels dark due to inadequate lighting.	Designing the physical work environment in the kitchen area is needed.
3.	The kitchen area is stuffy due to minimal air circulation.	

3.3 Stage 3: Ideate

This stage aims to find alternative creative ideas for solutions to problems and needs found in the previous stage. Ideation is the process of finding alternative creative ideas and solutions to the problems and needs found in the previous phase. At this stage, an analysis is carried out with an ergonomic evaluation of the solution provided. There are 2 alternative kitchen layout design plans in the form of 2D drawings as the realization of the prototype stage. This stage turns further ideas into physical form quickly and cheaply, so that we can understand and interact with ideas. At this stage, the results of the final design of the alternative proposal will be displayed in the form of a 2D layout design visualization. The prototype design will be useful for minimizing errors before reaching the implementation stage [31].

A well-planned kitchen layout will have an impact on the efficiency and productivity of daily activities and reduce the incidence of physical hazards for users in the long term. In designing the layout of the public kitchen in ST Village, the division of work zones must be considered to make the workflow more efficient. The zones include the raw material storage area, washing and preparation area, cooking area, and serving area. A good layout not only improves the efficiency of movement but also prevents accidents, such as bumping into cabinets or cutlery. In addition, an optimized design can reduce the risk of users blocking each other during activities, especially when the kitchen is used by many people.

To support smooth activities, the kitchen is designed with a gallery-style layout, which extends on two sides. This design is adapted to the position of the door on the right and the window on the left, allowing for better air circulation. Alternative kitchen layout solutions can be seen in Figures 2 and 3. The design of kitchen spaces and dining areas has a significant influence on the cooking and eating experience, with factors such as size, layout, and indoor environmental quality playing an important role[32].

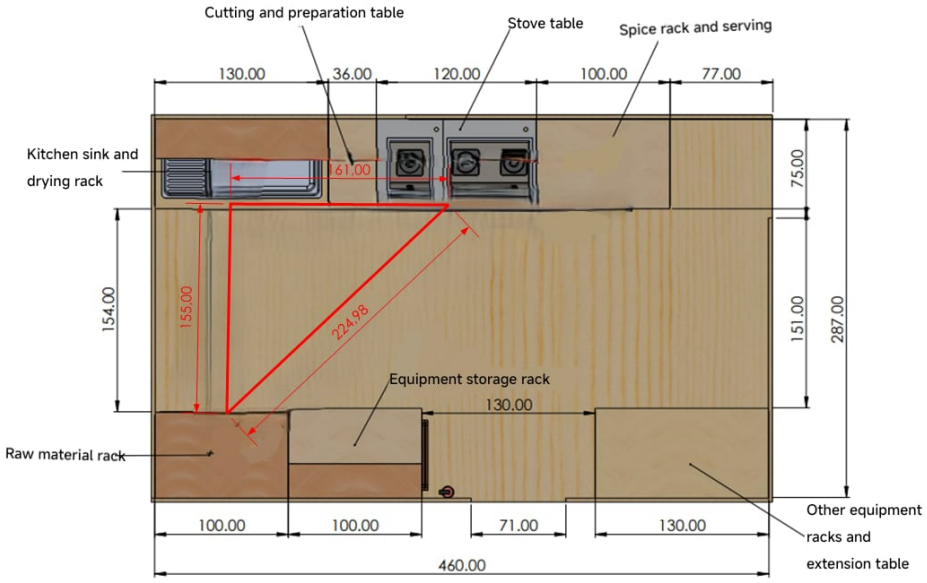

Figure 2 - Alternative Layout 1

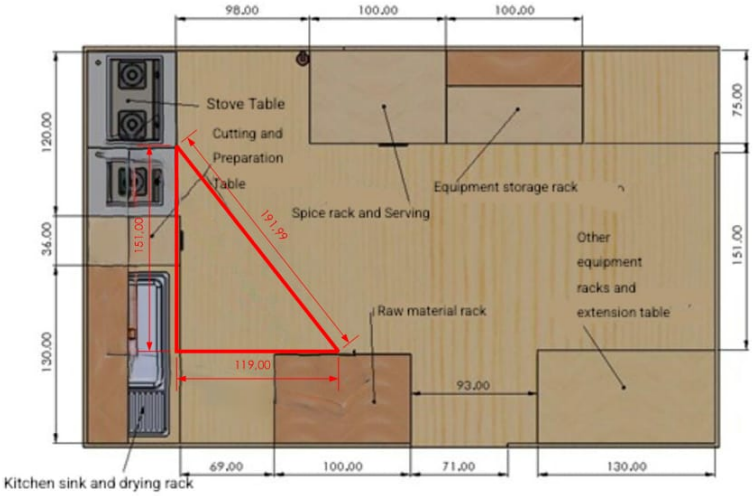

Figure 3. Alternative Layout 2

In kitchen design, this activity is known as the "work triangle" concept, which is used as a reference in general kitchen standards[33]. The arrangement of the kitchen form and the three main zones aims to optimize user activities in the kitchen [34]. The three main areas in the kitchen - the washing area, stove, and refrigerator - should be arranged in a triangular shape to achieve optimal efficiency [35]. Optimal kitchen design requires proper sizing, strategic placement of appliances, and application of movement efficiency principles, with the ideal distance between key elements such as the stove, refrigerator, and sink ranging from 4-8 meters [36].

Industry standard guidelines, such as those from the National Kitchen & Bath Association (NKBA), provide useful insights and measurements for kitchen design: for kitchens with three work centers, the total distance traveled should be no more than 790 centimeters, with each side of the triangle having no less than 120 centimeters between the point of the sink area and the ingredient storage area; and no more than 270 centimeters between the point of the sink and the ingredient preparation area[37].

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The importance of maintaining the size of the work triangle is not only for efficiency, but also for user comfort. If the triangle area is too small, it can result in limited space for users to move around and feel cramped for cooking work, especially if there is more than 1 user in the area. Conversely, if the triangular area is too large, it will result in premature fatigue for the user and inefficiency. Ergonomic kitchen layout and design can reduce the risk of musculoskeletal problems, such as back pain and repetitive motion injuries.

In the layout shown in Figures 2 and 3, the workflow starts from washing, mixing, cooking, to serving. In the communal kitchen of ST Village, a raw material storage rack is used instead of a refrigerator in the work triangle, thus still supporting efficient movement and workflow. In this study, alternative layout 1 (Figure 2) has a work triangle perimeter of 540.98 centimeters, with sides of 155 centimeters, 161 centimeters, and 224 centimeters, respectively. This principle emphasizes that arranging the raw material storage rack, the sink, and the stove in a triangular configuration helps reduce unnecessary movements and physical effort during cooking. The triangular layout supports smooth transitions between retrieving ingredients, washing and preparing food, and the actual cooking process. By minimizing back-and-forth steps, the design enhances workflow efficiency and reduces fatigue. Moreover, an effective work triangle contributes to better traffic flow within the kitchen. It allows users to move freely without encountering obstructions or bottlenecks, which is particularly important in public kitchens where multiple people may be active at the same time. A layout that is carefully arranged should not only improve efficiency but also support accessibility for users of different ages and physical abilities. This creates a safer and more inclusive kitchen environment by organizing key activity zones in a logical and user-friendly manner. This study also considers ergonomic aspects related to body posture, workload, movement, lighting, and air quality. The height of the stove and sink was analyzed using anthropometric data to ensure that users can work in a natural and upright position without frequent bending or overreaching. To support a more upright and relaxed working posture, work surfaces were positioned approximately 20 to 25 centimeters below elbow height, a range supported by recent findings showing reduced muscle effort and discomfort in the upper body during the cooking task [38]. Frequently used tools and surfaces were positioned within a comfortable reach envelope to encourage neutral posture and decrease shoulder strain. The layout also allows users to move between retrieving ingredients, washing, and cooking with minimal bending or twisting, which helps prevent the buildup of musculoskeletal strain. Clear space between zones permits simultaneous use by more than one person without interference, reducing muscle fatigue

The distance between the raw material storage rack and the sink is 155 centimeters, which is within the range that complies with the NKBA standard (≥120 centimeters). Meanwhile, alternative layout 2 (Figure 3) has a perimeter of 461.99 centimeters, with sides of 119 centimeters, 151 centimeters, and 191.99 centimeters. However, the distance between the raw material storage rack and sink is only 119 centimeters, slightly below the minimum standard of 120 centimeters recommended by NKBA. Both alternatives also meet the range of 4-8 meters recommended by Al-Qamadi. From these results, both alternatives are still within the perimeter of the efficient working triangle (≤790 centimeters), indicating that the design has considered the efficiency of movement in the kitchen. However, alternative 1 is more compliant with the NKBA standard as it meets all the minimum distance requirements between main zones. Alternative 2 has a smaller perimeter, but the distance between the raw material storage rack and sink is slightly less than the recommended standard, although the difference is not very significant (only 1 centimeter).

Furthermore, this study supports previous findings that ergonomic kitchen design should reduce unnecessary movements to improve work efficiency [39], [40]. In addition, ease of movement in the kitchen is a necessity [41]. Therefore, the proposed design has considered the anthropometric dimensions of the user, ensuring that the user has enough space to move around without hampering the cooking activity. Anthropometric data of the 5th percentile elbow length dimension (D33) of 67 centimeters can be used as a benchmark, because ideally, 1 person walking requires a minimum of 67 centimeters of space. Meanwhile, if we stand sideways when doing cooking work, it will require at least 48 centimeters of space, which is based on the calculation of the dimensions of the shoulder-hand grip length (D25) forward with the 5th percentile. So, the width required in the area is at least 115 centimeters wide (67 centimeters + 48 centimeters) without disturbing the activities that are cooking, but other people can still pass by freely. The width of the alternative aisle design layout in figures 2 and 3 of 151 centimeters has been considered this size so it can be concluded that the width of the aisle has met the ergonomic requirements, namely the breadth of space for movement. The anthropometric dimensions used refer to the anthropometric dimensions of Indonesian people aged 16-47 years[42].

Analysis of the kitchen layout shows that the work triangle concept still plays an important role in improving efficiency and comfort when cooking. In the pre-improvement layout, the distance between the raw material storage area, sink, and stove is still too far, hindering the user's workflow. In addition, the less strategic placement of equipment makes the cooking process less efficient, especially when moving from taking ingredients, washing, to cooking. Obstacles such as unoptimized doors or table positions can also interfere with user movement in the kitchen.

After the layout improvement, the work triangle became more efficient with a shorter distance between the storage rack, sink, and stove. This allows users to pick up ingredients, wash, and cook more easily without having to move too far.

The more strategic placement of equipment also helps to reduce unnecessary movements, thus improving work efficiency. Thus, the application of the work triangle concept in kitchen design remains relevant even without a refrigerator, as it can save time, reduce fatigue, and create a more comfortable and functional cooking environment for public kitchen users in ST Village.

Safety is a top priority in kitchen design, not only for individuals with cognitive impairment who need to avoid distractions and hazardous products, but also to keep all users in the vicinity safe [43]. Kitchen design needs to be adapted to the environment while considering the needs of users, as cooking activities take place in it. Especially in the stove area, it is recommended to provide a free space of about 30-40 centimeters behind it to prevent excessive heat from hitting the wall. In addition, air circulation must also be considered. Based on actual data, the existing ventilation is still inadequate, as there is only a small window on the left and a door on the right. Therefore, it is recommended to add artificial ventilation above the cooking area, as shown in Figure 4 and Figure 5. To further enhance air circulation and minimize heat and smoke buildup during cooking, a simple exhaust fan installed directly above the stove may function as an effective ventilation solution. This approach is like the role of a range hood in modern kitchens, which captures airborne grease and improves indoor air quality by removing cooking fumes at the source. Studies have shown that combining mechanical ventilation with natural airflow, such as through windows, significantly improves thermal comfort and reduces respiratory discomfort during cooking activities[44].

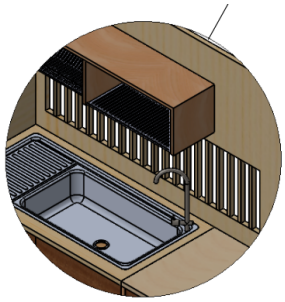

Figure 4. 1st ventilation in the sink area

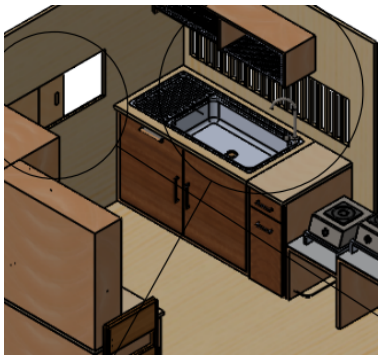

Figure 5. 2nd ventilation on the wall

Kitchen ergonomics requirements are related to only four factors: storage size and proportion, workflow organization, room lighting, and maintenance [45]. For lighting arrangements, it is arranged in such a way that lighting above the work area so that preparation and cooking activities safer and more comfortable. In contrast, indoor environmental comfort considers four aspects: thermal, visual, acoustic, and ergonomic [46]. Lighting and ventilation are important factors in providing optimal microclimate conditions to ensure comfort in work and dining areas [47].

To ensure that the improved kitchen layout met appropriate lighting standards, the number of luminaires was calculated using the lumen method[48]. According to the Indonesian Ministry of Health regulation, the minimum required illuminance for food preparation areas is 500 lux [49]. In this study, the target illuminance was set at 500 lux. The kitchen space measured 4.6 meters by 2.87 meters, resulting in a total area of 13.20 square meters. A 36-watt linear fluorescent lamp was selected, provided through a dual-tube fixture (2 × 36 W), with a total power consumption of 72 watts. Based on the manufacturer's specification, the fixture produces a total luminous flux of 5,400 lumens, which corresponds to a luminous efficacy of approximately 75 lumens per watt. This value reflects the efficiency of the lamp in converting electrical energy into visible light and is commonly used in lighting calculations. The calculation applied a utilization factor (UF) of 0.8, a maintenance factor (MF) of 0.8, and assumed one lamp per luminaire. The number of luminaires (N) was calculated using the formula, as in (1).

$$N = \frac{E(F)\ x\ A}{UF(F)\ x\ n\ x\phi x MF} = \frac{500x13.2}{0.8x1x5400x0.8} = 2 \quad (1)$$

Where E is the target illuminance (500 lux), A is the area (13.20 m²), UF is the utilization factor, n is the number of lamps per luminaire, Φ is the luminous flux, and MF is the maintenance factor. Based on this formula, the required number of luminaires was approximately two units, which is sufficient to meet the recommended lighting level in the improved ST Village kitchen layout.

Air conditioning in the kitchen space needs to be well considered because, in general, various activities in public kitchens are carried out by several users at once. The proposed artificial ventilation needs to be placed around the washing area, as shown in Figure 4. The ventilation in the cooking area is not parallel to the height of the stove to avoid the death of fire in the stove due to wind exposure. In addition, insulated vents can also be used. The actual ventilation is currently on the left side of the wall, which can be opened and closed manually as shown in Figure 5. After that, considering that the wall material used in ST Village still uses flammable bamboo booth material, a fire extinguisher should be provided near the kitchen door, as shown in Figure 6.

Figure 6. Fire extinguisher in the door area

Testing phase: In this research, testing was not done directly, but through interviews with users. Based on the two alternative layouts that have been made previously, a concept evaluation of the two layouts is carried out, and the best alternative layout is selected using the concept scoring method. The criteria used for this concept scoring method are space efficiency, ease of movement, occupational safety and health, and process flow.

Space efficiency in layout planning is very important and must be considered when we determine the location of equipment, supplies, and storage. Access is facilitated if equipment, supplies, and physical facilities are placed in appropriate locations and there is sufficient space for users to perform their activities unhindered. Ease of movement also needs to be considered. This is because the activities carried out require the movement of more than a few users in the use of this public kitchen space, so it requires sufficient space to move freely. Especially when carrying hot ingredients or equipment.
Accidents in the kitchen also need to be anticipated. When working in the kitchen, there is a risk of minor or serious injury. Hot, sharp, dangerous equipment, inadequate circulation, and dim lighting can jeopardize the safety of those working in the kitchen. Good process flow can also improve work efficiency; this can be analyzed from the work triangle generated when working in the kitchen.

Table 2 shows the results of the scoring concept that has been carried out on 2 alternative layouts that have been assessed by 10 active users.

Table 2. Results of scoring assessment of the Layout concept

No	Criteria	Layout	
		Alternative 1	**Alternative 2**
1	Space efficiency	1	2
2	Ease of movement	1	2
3	Occupational Safety and Health	1	2
4	Process Flow	2	1
	Total Score	**5**	**7**
	Ranking	**1**	**2**

Based on the results of the concept scoring, alternative layout 1 was selected as the most suitable design, receiving the lowest total score of 5, while alternative 2 scored 7. This layout outperformed the other in space efficiency, movement flow, and occupational safety, and was more aligned with ergonomic design principles. The work triangle perimeter was shortened to 540.98 centimeters, helping reduce unnecessary steps and optimize the task sequence. Users reported improved posture, fewer awkward movements, and the ability to work simultaneously without obstruction, supported by the 151-centimeter aisle width. Lighting was repositioned above key work zones, and ventilation was improved by placing airflow sources near the stove and sink. These enhancements contributed to thermal comfort, visual clarity, and overall satisfaction during cooking. While alternative layout 2 remained acceptable, it had minor compromises to the NKBA standard. Overall, the final design meets ergonomic and functional standards and is supported by both scoring results and user evaluation.

This study was conducted in the context of a single rural community kitchen with a limited number of participants. The study prioritized a user-centered qualitative approach, which enabled the creation of design ideas based on user experience. The evaluation of layout alternatives relied on concept assessment and user feedback, rather than on real-time task observation or motion analysis. As a result, reported functional improvements were based on perceived efficiency rather than objective performance data. Future studies could complement this approach with motion or time tracking, combined with postural measurements or specific tool usage, to assess not only layout efficiency but also its impact on physical workload and fatigue.

4. CONCLUSION

The study successfully applied the design thinking and work triangle concept to redesign a public kitchen, prioritizing ergonomic efficiency, safety, and user comfort. The size of the triangle area needs to be organized in such a way as to avoid space limitations that can result in less efficient cooking activities. Key improvements included a streamlined work triangle (540.98 cm perimeter), optimized lighting (two 36-watt luminaires meeting the 500 lux standard), and enhanced ventilation. The selected layout (Alternative 1) outperformed Alternative 2 in space efficiency, movement flow, and safety, aligning with NKBA standards. Attention to anthropometric dimensions: the use of anthropometric dimensions such as elbow length and shoulder-arm length dimensions, helps in determining the minimum width of the work area to ensure user comfort. Occupational safety and health were considered essential aspects in the kitchen design process. Proper planning of lighting and ventilation was emphasized to ensure that cooking activities could be carried out safely and comfortably. Through the combination of ergonomics, safety, and innovative design, it is hoped that the resulting public kitchen layout can provide a better user experience, increase efficiency, and create a safe and comfortable working environment.

Although the design thinking and work triangle are widely known, this study contributes a novel integration of the two within a real-world participatory context. By applying design thinking to gather user insights and align them with ergonomic layout principles, the research presents a practical approach to solving spatial and functional challenges in shared kitchen environments. The involvement of community members throughout the design process enabled solutions that are not only technically sound but also socially accepted and contextually appropriate. This research highlights the importance of combining user-centered design with ergonomic evaluation to achieve meaningful improvements in public spaces that are used every day. These findings highlight the importance of merging user-centered approaches with technical ergonomic principles to develop practical and sustainable solutions for shared kitchen spaces.

Disclosure statement

No potential conflict of interest was reported by the authors.

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REFERENCES

[1] R. Sundaram and S. Rukmangadhan, "Optimizing kitchen experience," in *ACM International Conference Proceeding Series*, Association for Computing Machinery, Dec. 2016, pp. 147–156. doi: 10.1145/3014362.3014380.

[2] F. H. Ismail, S. Osman, and F. B. A. Rahman, "Ergonomics Kitchen: A Better Place to Work," *International Journal of Academic Research in Business and Social Sciences*, vol. 11, no. 13, Dec. 2020, doi: 10.6007/ijarbss/v11-i13/8501.

[3] D. M. Eisenberg, L. S. Pacheco, A. C. McClure, J. W. McWhorter, K. Janisch, and J. Massa, "Perspective: Teaching Kitchens: Conceptual Origins, Applications and Potential for Impact within Food Is Medicine Research," *Nutrients*, vol. 15, no. 13, p. 2859, Jun. 2023, doi: 10.3390/nu15132859.

[4] A. J. H. M. Beurskens, U. Bültmann, Ij. Kant, J. H. M. M. Vercoulen, G. Bleijenberg, and G. M. H. Swaen, "Fatigue among working people: validity of a questionnaire measure," *Occup Environ Med*, vol. 57, no. 5, pp. 353–357, 2000, doi: https://doi.org/10.1136/oem.57.5.353.

[5] M. Nagai *et al.*, "Effects of fatigue on immune function in nurses performing shift work," *J Occup Health*, p. 1107180194, 2011, doi: https://doi.org/10.1539/joh.10-0072-OA.

[6] D. M. Rose *et al.*, "Associations of fatigue to work-related stress, mental and physical health in an employed community sample," *BMC Psychiatry*, vol. 17, no. 1, pp. 1–8, 2017, doi: 10.1186/s12888-017-1237-y.

[7] M. Sirajudeen, P. Pillai, and G. Vali, "Assessment of Knowledge of Ergonomics among Information Technology Professionals in India," *International Journal of Health and Rehabilitation Sciences (IJHRS)*, vol. 2, no. 4, p. 192, 2013, doi: 10.5455/ijhrs.0000000170.

[8] A. Bhatia and S. Singla, "Ergonomic evaluation and customized design of kitchen," *International Journal of Innovative Technology and Exploring Engineering*, vol. 8, no. 9 Special Issue, pp. 1033–1039, Jul. 2019, doi: 10.35940/ijitee.I1166.0789S19.

[9] E. Rachmawati, T. Sulistyani, and L. Mufidah, "Studi Desain Ergonomi Dapur Ditinjau dari Efektivitas Kerja," vol. 9, no. 1, pp. 39–44, 2023.

[10] B. T. Özalp, "Determination of Domestic Kitchen Characteristics for Elderly Turkish Women: A Comprehensive Ergonomics Approach," *Open Journal of Safety Science and Technology*, vol. 10, no. 02, pp. 53–67, 2020, doi: 10.4236/ojsst.2020.102005.

[11] O. A. Mihalache *et al.*, "Kitchen layouts and consumers' food hygiene practices: Ergonomics versus safety," *Food Control*, vol. 131, p. 108433, 2022.

[12] A. R. Othman, N. I. Muhamad Razib, and W. Zahrah, "Ergonomic Kitchen Design in Malaysian Low-Cost Housing," *Environment-Behaviour Proceedings Journal*, vol. 7, no. 20, pp. 111–120, Jun. 2022, doi: 10.21834/ebpj.v7i20.3424.

[13] S. Mahajan and S. Patwardhan, "A study of ergonomic approach to kitchen work centers," *Asian Journal of Home Science*, vol. 10, no. 2, pp. 371–374, 2015.

[14] T. P. Kiran, A. Verma, and S. Atreya, "A Smart Compact Kitchen Layout to Optimize Space Utilization," in *International Conference of the Indian Society of Ergonomics*, Springer, 2021, pp. 537–548.

[15] A. Bonenberg, "Designing a Functional Layout of a Kitchen for Persons with Disabilities – Concept of Optimal Access Points," *Procedia Manuf*, vol. 3, pp. 1668–1675, 2015, doi: 10.1016/j.promfg.2015.07.490.

[16] A. Rohimah and S. Sulistyo, "Perbaikan Layout Kantin Kampus UNIMAR Menggunakan Analisis Ergonomi (The Work Triangle)," in *Prosiding Konferensi Nasional Penelitian Dan Pengabdian Universitas Buana Perjuangan Karawang*, 2023, pp. 44–54.

[17] A. F. Hidayanto and A. Rulia, "Desain Rancang Bangun Dapur Umum Portable Dalam Penanggulangan Bencana Alam," *Panggung*, vol. 26, no. 2, pp. 108–116, 2016.

[18] A. K. B. Aparece, M. G. T. Ayop, A. T. Ruz, and A. P. Lazaro, "Kitchen Layout Design and Individual Work Performance of Eatery in Davao Del Norte, Philippines," *South Asian Journal of Social Studies and Economics*, vol. 21, no. 7, pp. 41–54, Jun. 2024, doi: 10.9734/sajsse/2024/v21i7843.

[19] S. Dareker, "'A Study of importance of kitchen designing in standalone restaurants,'" 2024. [Online]. Available: http://www.euroasiapub.orghttp://www.euroasiapub.org

[20] D. Kelley and T. Brown, "An introduction to Design Thinking," *Institute of Design at Stanford*, vol. 7, 2018.

[21] T. Brown, "Design Thinking Harvard business review, 86(6), 84.," 2008. [Online]. Available: www.hbr.org

[22] N. F. Ardian and H. Werdhaningsih, "Penggunaan Design Thinking Dalam Pengembangan Produk Kerajinan IKM (Studi Kasus: Sentra Kerajinan Patung Kayu, Subang," *Jurnal Dimensi Seni Rupa Dan Desain* , vol. 15, no. 1, pp. 1–16, 2018, doi: https://doi.org/10.25105/dim.v15i1.4193.

[23] D. I. Levine, A. M. Agogino, and M. A. Lesniewski, "Design thinking in development engineering," *International Journal of Engineering Education*, vol. 32, no. 3, pp. 1396–1406, 2016.

[24] S. Panke, "Design thinking in education: Perspectives, opportunities and challenges," *Open Education Studies*, vol. 1, no. 1, pp. 281–306, 2019.

[25] J. R. Batmetan, T. Komansilan, and A. Parera, "Model Design Thinking Pada Perancangan Aplikasi Mobile Learning," *Ismart Edu: Jurnal Pendidikan Teknologi Informasi*, vol. 1, no. 02, Feb. 2021, doi: 10.53682/ise.v1i02.719.

[26] M. L. Lazuardi and I. Sukoco, "Design Thinking David Kelley & Tim Brown: Otak Dibalik Penciptaan Aplikasi Gojek," *Organum: Jurnal Saintifik Manajemen dan Akuntansi*, vol. 2, no. 01, pp. 1–11, 2019, doi: 10.35138/organu.

[27] Syahrul Yasermi, "Penerapan Design Thinking Pada Media Komunikasi Visual Pengenalan Kehidupan Kampus Bagi Mahasiswa Baru STMIK PALCOMTECH dan POLITEKNIK PALCOMTECH," *Jurnal Bahasa Rupa* , vol. 2, no. 2, pp. 109–117, 2019, [Online]. Available: http://jurnal.stiki-indonesia.ac.id/index.php/jurnalbahasarupa

[28] R. H. Da Silva, P. C. Kaminski, and F. Armellini, "Improving new product development innovation effectiveness by using problem solving tools during the conceptual development phase: Integrating Design Thinking and TRIZ," *Creativity and Innovation Management*, vol. 29, no. 4, pp. 685–700, Dec. 2020, doi: 10.1111/caim.12399.

[29] R. C. Redante, J. F. de Medeiros, G. Vidor, C. M. L. Cruz, and J. L. D. Ribeiro, "Creative approaches and green product development: Using design thinking to promote stakeholders' engagement," *Sustain Prod Consum*, vol. 19, pp. 247–256, 2019.

[30] A. Md Hashim, S. Ruzaina Syed Aris, and C. Yuen Fook, "Promoting Empathy Using Design Thinking In Project-Based Learning And As A Classroom Culture," 2019.

[31] M. Eriyadi and I. F. Fauzian, "Desain Prototipe Mesin Sortir Barang Otomatis," *JTERA (Jurnal Teknologi Rekayasa)*, vol. 4, no. 2, pp. 147–156, 2019, doi: 10.31544/jtera.v4.i2.2019.147-156.

[32] A. Sal Moslehian, E. Warner, and F. Andrews, "The impacts of kitchen and dining spatial design on cooking and eating experience in residential buildings: a scoping review," *Journal of Housing and the Built Environment*, vol. 38, no. 3, pp. 1983–2003, Sep. 2023, doi: 10.1007/s10901-023-10027-z.

[33] A. Rahmatia, S. Ds, P. Dwimirnani, and S. Ds, *Menata dapur minimalis*. PT Niaga Swadaya, 2010.

[34] M. J. Waisnawa, N. L. K. R. Kerdiati, and P. A. Darmastuti, "Desain Ruang Dapur Berdasarkan Tiga Zona Utama (Studi Kasus Proyek Desain Ruang Dapur di Studio Interior Jayadi-Sign)," *Jurnal Patra*, vol. 5, no. 1, May 2023, Accessed: Oct. 27, 2023. [Online]. Available: jurnal.idbbali.ac.id/index.php/patra

[35] A. Ollár, K. Granath, P. Femenías, and U. Rahe, "Is there a need for new kitchen design? Assessing the adaptative capacity of space to enable circularity in multiresidential buildings," *Frontiers of Architectural Research*, vol. 11, no. 5, pp. 891–916, Oct. 2022, doi: 10.1016/j.foar.2022.03.009.

[36] M. A. Al-Qamadi, "Optimizing Kitchen Design: Principles, Layouts, And Movement Efficiency In Modern Homes," *Nanotechnol Percept*, vol. 20, no. 5, pp. 640–666, 2024, [Online]. Available: www.nano-ntp.com

[37] National Kitchen and Bath Association, *NKBA Kitchen and Bathroom Planning Guidelines with Access Standards*. John Wiley & Sons,Incorporated. , 2016.

[38] Y. Li, L. Chang, and F. Zhang, "Effects of Kitchen Cooking Height on Upper Limb Muscle Activation, Posture, and Perceived Discomfort of Chinese Older and Young Women," *Sensors*, vol. 24, no. 21, Nov. 2024, doi: 10.3390/s24217056.

[39] S. D. Ramsamy-Iranah, M. Maguire, S. Peace, and V. Pooneeth, "Older Adults' Perspectives on Transitions in the Kitchen," *Journal of Aging and Environment*, vol. 35, no. 2, pp. 207–224, Apr. 2021, doi: 10.1080/26892618.2020.1834052.

[40] S. Hagejärd, A. Ollár, P. Femenías, and U. Rahe, "Designing for Circularity—Addressing Product Design, Consumption Practices and Resource Flows in Domestic Kitchens," *Sustainability*, vol. 12, no. 3, p. 1006, Jan. 2020, doi: 10.3390/su12031006.
[41] K. Shete, H. T. Pandve, and T. Puntambekar, "Role of ergonomics in kitchen related back problems," *Journal of ergonomics*, vol. 5, no. 3, 2015.
[42] https://antropometriindonesia.org, "Data Anthropometri Indonesia," Data Anthropometri Wanita Dewasa berumur 1 tahun samapi 47 tahun .
[43] K. Johansson, S. Lundberg, and L. Borell, "'The Cognitive Kitchen'-Key principles and suggestions for design that includes older adults with cognitive impairments as kitchen users," *Technol Disabil*, vol. 23, no. 1, pp. 29–40, 2011, doi: 10.3233/TAD-2011-0310.
[44] S. Sung, E. Ham, W.-T. Kwon, M.-Y. Kim, and H.-Y. Park, "Effect of Ventilation Method on Indoor Air Quality when Cooking at Home1," *Journal of Wellbeing Management and Applied Psychology*, vol. 7, no. 5, pp. 39–51, 2024, doi: 10.13106/jwmap.2024.Vol7.no5.39.
[45] P. Nowakowski, "Kitchen chores ergonomics: Research and its application," in *Advances in Intelligent Systems and Computing*, Springer Verlag, 2018, pp. 43–52. doi: 10.1007/978-3-319-60450-3_5.
[46] Q. Kwong, M. A. Nor, and S. Tang, "Effect of environmental comfort factors in enclosed transitional space toward work productivity.," *Am J Environ Sci*, vol. 5, no. 3, pp. 315–324, 2009.
[47] P. Nowakowski, "Designing kitchens for small domestic spaces," in *Universal Access in Human-Computer Interaction. Access to the Human Environment and Culture: 9th International Conference, UAHCI 2015, Held as Part of HCI International 2015, Los Angeles, CA, USA, August 2-7, 2015, Proceedings, Part IV 9*, Springer, 2015, pp. 340–351.
[48] M. A. Laughton and M. G. Say, *Electrical engineer's reference book*. Elsevier, 2013.
[49] Peraturan Menteri Kesehatan Republik Indonesia, "Peraturan Menteri Kesehatan Republik Indonesia Nomor 70 Tahun 2016 tentang Standar dan Persyaratan Kesehatan Lingkungan Kerja Industri. Kementerian Kesehatan Republik Indonesia.," 2016.