Journal of Engineering Education Transformations,
Volume No. 37, January 2024 Special Issue, eISSN 2394-1707

Bridging the Gap in Elderly Care in Old Age Homes: An Automated Lighting and Handrail Solution

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***Abstract*— An old age home offers a place to live for the elderly and those in need who have either been abandoned by their families or require nursing care. They encounter numerous issues in old age homes because of inadequate funding, a lack of infrastructure, mental illness, a lack of emotional engagement between the elderly, a lack of societal support, etc. However, lacking adequate infrastructure amenities might result in numerous illnesses and accidents. Consequently, their independence and standard of living at home are limited. Building an automatic lighting system with handrails as part of our first-year course "Design Thinking For Social Innovation", allowed us to construct a modest prototype for a proper and simple lighting system to address this issue. We used the user-centered Design Thinking process to design this project, starting with accurate data collection and ending with developing a creative solution. This prototype has railings connected to infrared sensors, and numerous nearby ultrasonic sensors that can identify people and turn on the lights for any specified time when they are detected. The findings of this study show that the stakeholders' input on the solution was generally positive, and they even suggested several significant changes. Although this concept was not really implemented, it would be beneficial if it were in the future with more adjustments.**

***Keywords*—Accidents; Design thinking; Handrails; Infrastructure; Lighting system; Old age home.**

JEET Category—Practice.

I. INTRODUCTION

Old age homes are places where older or needy people are given shelter whom their family members have abandoned. This is a safe place for older people. They are given proper food and clothing. They also give proper medical facilities to the residents and ensure a healthy environment. However, there are many advantages, these homes often lack appropriate infrastructure facilities which may affect the residents' quality of life (Carter et al., 1997).

Addressing the infrastructure-related problems in old age homes is of vital importance. First and foremost, the safety of elderly people's lives is at risk. Slippery floors can lead to falls and severe injuries in the long term (Dionyssiotis, 2012). In addition, the lack of interaction and restricted mobility within the home can result in feelings of isolation and loneliness among the residents (Rotenberg & Hamel, 1988). Social interaction plays a vital role in maintaining mental well-being and overall quality of life (Bamford, 2005). Non-attendance of suitable infrastructure to facilitate mobility, such as support for climbing stairs, restricts older people's freedom and their opportunity to move around and engage in open-air exercises.

Tackling infrastructure-related issues requires a comprehensive approach. To begin with, safety measures must be prioritized. This incorporates executing non-slip flooring, handrails, and appropriate lighting to reduce falls' chances. Regular maintenance and checks should be conducted to guarantee the safety of the inhabitants (Phetsitong & Vapattanawong, 2022).

Lack of interaction is also an issue to be addressed (Rotenberg & Hamel, 1988). They can have communal spaces and activity areas within the home. These spaces can empower socialization, allowing older people to connect with other residents. Events, workshops, and outings ought to be organized to advance social engagement and combat loneliness.

Moreover, old age homes should provide the infrastructure that supports the mobility of the residents. This incorporates introducing inclines or lifts to simply get to distinctive levels, providing walking aids, and ensuring outdoor areas are accessible and safe for walks. Temperature control within homes should be observed to ensure a comfortable living environment for elderly residents (Yi et al., 2022).

The quality of life for elderly residents living in old age homes can be severely impacted by the infrastructure-related problems these facilities face. Tending to these issues is crucial for ensuring their safety, well-being, and social engagement. By implementing safety measures, promoting social interactions, and supporting mobility, old age homes can become nurturing

environments that enhance the overall quality of life for elderly residents (Xavier et al., 2003).

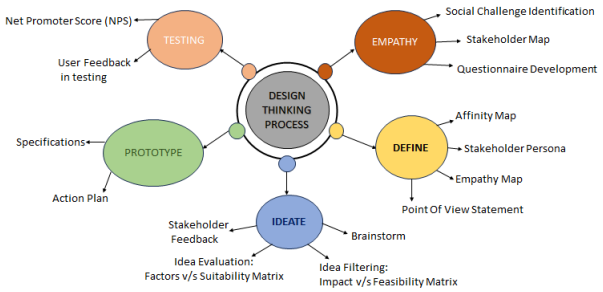

Fig. 1. Design Thinking Process

Therefore, the aim of this study is to design and develop a lighting system to support the infrastructure at the "Shine" old age home located in Hubli using the user-centered, design thinking approach. In the further sections, we have completed the literature survey in section II, the Methodology in section III, and the results and conclusions in further sections.

II. LITERATURE REVIEW

Yannis Dionyssiotis proposed a multifactional intervention program to address the safety issues due to falls and injury of older people (Dionyssiotis, 2012). Ruttana Phetsitong et al. concluded that having handrails in housing would improve seniors' capacity to cope with disability and disease, thereby lightening the physical care burden on caregivers. However, having the right quantity of handrails in seniors' homes should be taken into consideration (Phetsitong & Vapattanawong, 2022). MG Figueiro et al., cite the fact that falls are a leading cause of injuries in the elderly and raise the possibility that moderate lighting could help seniors maintain their postural balance. They conducted two experiments: Postural control and User acceptance. The outcomes demonstrated that it was preferable over traditional night lights for maintaining postural control during the crucial early stages of the sit-to-stand challenge (Figueiro et al., 2008). Saija Karinkanta et al., highlight the significance and difficulty of preventing falls and fractures among older individuals. The most effective approach is physical therapy, the implementation of canes and walkers, hip protectors, and anti-slip shoe devices (Karinkanta et al., 2010). Nielsen et al., aim to gain a deeper understanding of the culture, principles, and way of life of the elderly in light of how they use lighting in their homes. They gained knowledge through qualitative analysis, contributing to the design and use of lighting controls for the elderly (Nielsen & Mullins, 2018). Hyun Gu Kang, Ph.D. et al., have placed a focus on the use of technologies to track the health of elderly people and issues like stigma, the decline in social contact, and ethical considerations over privacy. The use of technology by seniors is one of these problems. The author focuses on how recent technological advancements are being used to address difficulties including abrupt falls, dementia, and heart problems (Kang et al., 2010). Kanya Tanaka et.al concluded that a safety confirmation system, which detects when an elderly person tries to get out of bed or leave a room and sends an alarm to the control room or a caregiver in another room, can be installed in small senior citizen welfare facilities without a nurse call and in ordinary homes. Additionally, power line communication makes it simple and affordable to set up a safety confirmation system (Tanaka et al., 2007). Muhammad Shoaib et.al concluded that they demonstrate Altcare, an ambient assistant living system based on stationary network cameras that can recognize emergencies involving senior citizens through a masked video patch. Altcare automatically picks up on common events and their locations (Shoaib et al., 2010). Yung-Chin Chen concluded that the design of an RFID-based home emergency and notification system for elder failures and any other home accidents has the purpose of providing emergency services that shorten the response time of carers for early treatment of the patients and save their lives, as well as reduce the costs of healthcare (Chen & Wang, 2007).

III. METHODOLOGY

This section describes the method used to address the identified social challenge. The method used here is the design thinking process that involves five critical phases. These phases include empathy, defining the problem, ideating potential solutions, prototyping the best idea, and finally, testing the prototype to ensure it meets the desired goals. These five phases are described as follows and shown in Fig.1:

A. EMPATHY

Empathy is the ability to see the world through people's eyes and step in their shoes to feel what they feel. It is an intentional effort to avoid preconceived notions and uncover the users'

TABLE I
QUESTIONNAIRE DEVELOPMENT

Sl	Questions for Primary Stakeholders
1	What measures are in place to prevent and manage chronic conditions such as diabetes, hypertension, and blood pressure?
2	How do you feel about the lighting & temperature control in the old age home?
3	Can you describe the outdoor spaces available to residents, including gardens or walking areas?
4	What kind of facilities & care are available for the elderly in the old age home & how are they addressed?
5	Have you ever raised concerns about the condition of an old age home's structure to staff or management? If so, what was their response?
6	How did you adjust to this old age home environment when you came here without knowing anything?
7	Where does your family live? Do they visit you often? How many children & grandchildren do you have? Are you happy with the treatment here? What's your most challenging part?
8	How do you feel about the old-age home infrastructure?
9	How do you feel about the food served here?

TABLE II
QUESTIONNAIRE DEVELOPMENT

Sl	Questions for Secondary Stakeholders
1	How is the cleanliness and overall upkeep of the home maintained?
2	Have any renovations or updates been made to the structure of the old age home recently? If so, what were they?
3	What are the challenges faced by you in caring for old age people?
4	Are there any areas of the old age home structure that are in need of improvement or renovation?
5	How do you feel while treating old age people?
6	What made you want to treat them in a better way? What motivates you to do it? For what purpose are you doing this?
7	How accessible are the common areas such as dining rooms, for the residents with physical disabilities?
8	What support and resources are available to staff members if they need to address residence behavioral or emotional needs?

TABLE III
QUESTIONNAIRE DEVELOPMENT

SL. NO.	Questions for Tertiary Stakeholders
1	What challenges did you face when starting this home?
2	How do you manage things like food, clothes, needs, salary for the staff, etc.?
3	How do caregivers in the home ensure the safety and security of the elderly while also promoting their independence and autonomy?
4	How do you feel about the infrastructure problem?
5	How are medical emergencies handled in the home and are staff members trained to respond effectively?
6	Have any renovations or updates been made to the structure of the old age home?

unspoken needs. During this phase, we visited an an Old age home which is a 2 floored home that consists of 10 old age people,5 staff members, and 1 manager maintaining the old age home. We have gone to that place 3 times to observe, identify, and engage with the users/stakeholders. During the first visit, we observed many social challenges. Among the four social challenges, that is, lack of entertainment, lack of proper infrastructure, lack of interactions between old people, and lack of mental health support, we chose the social challenge of "Lack of proper infrastructure" after reading the literature review and discussions with the stakeholders. This particular challenge holds great significance as old people need better safety, comfort, and independence to live a quality life. When we engaged with the users in the community, we found three main stakeholders: old people residing in old age home as primary stakeholders, caretakers as secondary stakeholders, and the manager as tertiary stakeholder. We conducted semi-structured interviews with stakeholders, using the questions listed.

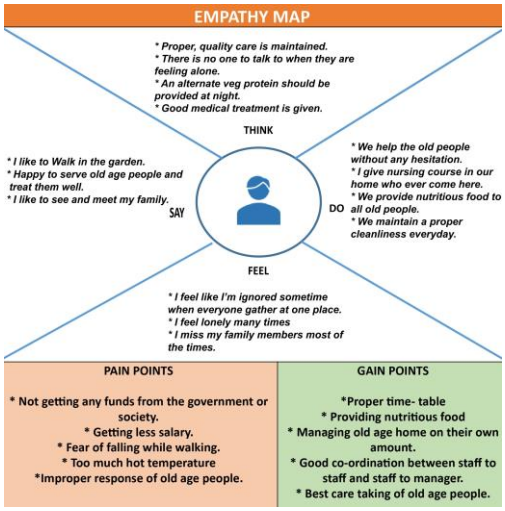

Fig. 3. Empathy Map

TABLE I for primary stakeholders, TABLE II for secondary stakeholders, and TABLE III for tertiary stakeholder. We met all the stakeholders initially and got to know about them, later to collect the proper information regarding personal life, old age home and other things. So We asked them Open ended questions which including how, when, what, where etc.in. We had in-depth conversations with the stakeholders to explore the infrastructure challenge and gather their perspectives. Personal

TABLE IV
AFFINITY MAP THEMES

SL. NO.	Affinity Map themes
1	Problems faced by old age people
2	Needs of the old age people
3	Facilities available in the old age home
4	Staff's perspective

information, including academic journeys, was gathered to understand their backgrounds and aspirations better. The interview was audio recorded and transcribed by listening to the recording and documenting the conversation for data analysis.

B. DEFINE

After gathering qualitative information from the stakeholders, we used the thematic analysis using an Affinity map (shown in Fig. 2), that is, grouping the ideas of similar themes into

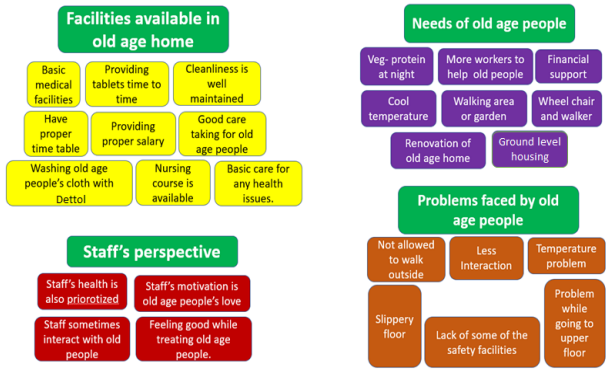

Fig. 2. Affinity Map

categories. The themes that formed the affinity map are shown in TABLE IV. We created stakeholder personas to understand better who our stakeholders and experiences, their motivations, frustrations, and goals in life. With the help of an affinity map and stakeholder persona, we further synthesized the data using

TABLE V
IDEA FILTERING: FEASIBILITY VERSUS IMPACT MATRIX

Degree of Impact	High Impact	1. Emergency call system in the bedroom or living room 2. Garden or walking area 3. Wheelchair and walker	1. Handrails 2. Matting facility 3. Wall corner proofing 4. Automatic window 5. Automatic lighting system 6. Automatic bed system
		High Impact & Low Feasibility	High Impact & High Feasibility
	Low Impact	1. Humidifier 2. Escalator facility 3. Automatic water detector on the floor	1. Keeping small plants 2. LED lighting system 3. Sitting bench outside 4. Conducting group activities
		Low Impact & Low Feasibility	Low Impact & High Feasibility
		Low Feasibility	High Feasibility
Feasibility			

an Empathy map in which the data is divided into four quadrants that refer to what our stakeholders say, think, feel, and do. This map helped us identify the pain points and the gain

TABLE VI
IDEA EVALUATION: FACTORS VERSUS SUITABILITY

Criteria	Rank (1 to 5)	Handrails		Matting facility		Wall corner proofing		Automatic bed		Automatic lighting system		Automatic window	
	A	Score B	C=A*B	Score D	C=A*D	Score E	C=A*E	Score F	C=A*F	Score G	C=A*G	Score H	C=A*H
Safety	5	5	25	4	20	4	20	4	20	4	20	4	20
Long term benefits	5	4	20	3	15	2	10	4	20	4	20	3	15
Impact	4	3	12	2	8	3	12	3	12	4	16	3	12
Cost	3	3	9	3	9	3	9	3	9	4	12	3	9
Ease of use	2	5	10	2	4	2	4	4	8	5	10	4	8
Time to implement	1	5	5	2	2	3	3	2	2	4	4	2	2
TOTAL		X	81	X	58	X	58	X	71	X	82	X	66
Selected Idea is: Automatic lighting system													

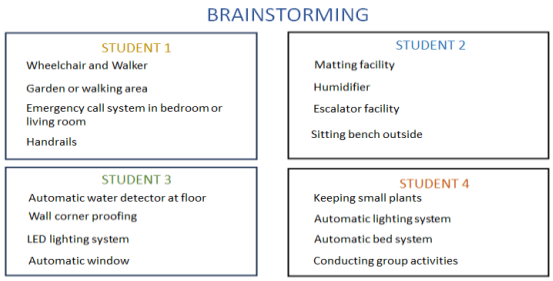

Fig. 4. Brainstorming Technique

points in the old age home so that we could discuss and prioritize their needs as shown in Fig. 3. We finally created a Point Of View statement that captures valuable information about the stakeholders, their needs, and our insights about them.

POV statement: Old Age People at Old Age Home which is situated in Hubli is in need of a support system for the infrastructure of the old age home because of the problems that are faced by old people such as their lack of safety issues, have less interaction, lack of support to climb stairs, not allowed to walk outside, temperature problem and slippery floors.

C. IDEATE

Ideation is a creative process that generates a lot of ideas in a facilitated, judgment-free environment to address a problem statement, which the team can then filter and narrow down into the best, most useful, or most creative ones to inspire fresh and improved design solutions and products. To find solutions to this problem, our team used the brainstorming technique as shown in Fig. 4, and gathered a list of spontaneous ideas. We filtered the ideas using a Feasibility versus Impact matrix as shown in TABLE V. "Impact" on the Y axis defines how much the action if implemented successfully, will help resolve the problem. "Feasibility" on the X axis defines the likelihood that you will be able to implement the action successfully. We found six solutions that had a high impact and high feasibility in the respective quadrant as shown in TABLE V. To decide the best solution among these, we evaluated the ideas using the Factors versus Suitability matrix as shown in TABLE VI. Factors are the variables that will produce or influence the results. Suitability enables you to evaluate, contrast, and rank filtered concepts according to how well they match the chosen and established criteria. We assessed each idea using criteria like safety, long-term benefits, impact, cost, ease of use, and time to implement and assigned every idea a score in accordance. After calculating the sum of weighted scores, we found the idea of an automatic lighting system with the highest score. The SCAMPER method was employed to address the identified problems, leading to several potential solutions. Using SCAMPER, you can challenge the status quo and explore new possibilities. It's a lateral thinking technique that helps teams explore ideas from different perspectives. We applied SCAMPER as *Combine*- Automatic lighting system + Handrails (In the bedroom and the walking path); *Modify*- 1) Modify the installation process of LED lights for more efficient brightness, reduce the usage of electricity, keep the room without causing any temperature-related issues, and be eco-friendly. 2) Modifying the handrails with the IR sensors, which turn on the lights after detecting the object; *Put into other use* - We can implement this system in the washrooms of offices, schools, colleges, and companies. So that whenever a person enters the washrooms, the lights should be turned on automatically. And if no one is there, the lights should be turned off automatically. And we can use the handrail system as the door handle. In the home, fix the ultrasonic sensors at the entrance of the door, so that after sensing the object or the person, the lights will turn on; *Eliminate* - 1) Eliminate the need for manual light switches by implementing a fully automated lighting system that responds to residents' movements and needs. 2)Eliminate the use of traditional bulbs and replace them entirely with energy-efficient LED lights. Ultimately, the decision was made to combine the ideas of an Automatic LED lighting system and Handrails.

TABLE VII
FINALIZED IDEA WITH SPECIFICATIONS

Finalized Idea	Specifications
Automatic lighting system with handrails	Material: Foam board of thickness 0.5 cm with dimensions of 30* 30 * 30 cm (length*base*height)
	Arduino: Arduino mega 2560
	LED: 5V (White color)
	Sensors: 2 Infrared sensors, 3 Ultrasonic sensors
	1st Ultrasonic sensor: Distance specified - 13 cm
	2nd Ultrasonic sensor: Distance specified - 35 cm
	3rd Ultrasonic sensor: Distance specified - 18 cm
	L - Clamp (Galvanized steel): 1 inch - 12 pcs
	Jumper cables: M-M: 10 pcs M-F: 15 pcs F-F:10 pcs
	Resistors of 100 ohm: 2 pcs

Fig. 5. The prototype's bedroom.

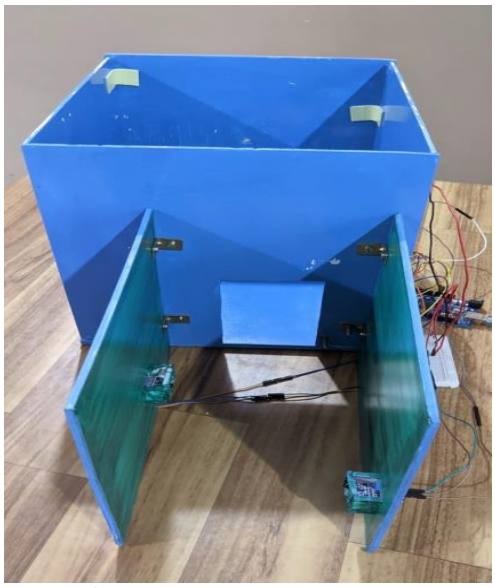

Fig. 6. The prototype's entrance.

D. RESULTS

1) PROTOTYPE:

We made a prototype to depict our finalized idea. Basically, we demonstrated a room as shown in Fig. 5, and a pathway as shown in Fig. 6 using a high-density foam board. On the pathway, we build handrails on both sides that are connected to or linked to the Infrared sensors. When the elderly, who need more support to walk, can hold either of the handrails and move, the Infrared sensors linked to it detect movement and switch on the light in the bedroom after a delay of 10 seconds. The delay can be customized accordingly. When elderly people move near the door, there is an Ultrasonic sensor opposite the door in the wall of the bedroom, which has a range of 1 meter before the door, so if they enter this range, it switches on the light for 10 seconds. If that didn't help, we have added another Ultrasonic sensor to the side of the door in the wall of the bedroom, which again detects and switches on the light for 10 seconds. If the old people are in bed at night and want to go somewhere, when they sit upright, there is another ultrasonic sensor near the bed that senses and turns on the light for 10 seconds. This is the actual working of the model. TABLE VII explains the material characteristics used in this prototype. Estimated cost of this prototype is rupees1350.We have differentiated as these systems is new and it was actually a manually operated but now we have went according to these technology and made it automatic as we have introduced sensors and better support system to the old people by these we could track their activities and also this product is new in the market and in the field of technology as per our records it's not been successful implemented in old age home.

2) FEEDBACK

Feedback is a tool that can assist people in evaluating their work as well as how others perceive their work. Feedback is used in the Design Thinking process since it advises you on what is and is not working, as well as how things might be improved. To gather feedback, we had offline interaction with all of our stakeholders. We demonstrated and discussed our prototype with them. They seemed pleased with our solution. We have also exhibited in one of the exhibition where we could exhibit our prototype there we got good impression from the teacher, students, parents and other guest where they motivated us to take these prototype further for the implementation in real life scenario. Our tertiary stakeholder, the Manager, advised us on several significant changes to be implemented in our project, stating, "You would have used a zero bulb for the night because the elderly are afraid of being alone at night, of dying, of dementia, or of being paranoid, so when the automatic lights are turned off after their set time, the zero bulb should switch on automatically. It is a wise financial decision to use LED lights, which are environmentally friendly and save electricity. Since the elderly wake up throughout the night to drink water or use the restroom, this system can help them turn on the lights automatically without the assistance of staff, reducing the workload for staff members who are sleeping. We don't have any problems during the day, but there are numerous problems at night, so when the elderly wake up and sit or get out of bed, there should be a siren or anything to alert them (staff). The notification should state that a person from this room has awoken and requires assistance, as well as the room number or bed number, or some other specific information. In hospitals, night duty is similar to day duty, which is quite stressful for the employees who sleep there, therefore I think this will be very useful in hospitals and all old age homes, perhaps saving many lives." We have kept this model till the model level but this prototype can be further implemented in real life scenario.

IV. CONCLUSION

This study proposed an automatic lighting system with handrails that may be put in small-sized nursing homes without the usage of a nurse call system, as well as in ordinary residences. Our country's senior population will continue to grow in the future. Then, regular houses and small and medium-sized facilities are expected to become the hub of nursing care for senior residents. As a result, it is anticipated that the planned automatic lighting system will serve as an excellent support system for nursing care for senior adults. We built a small-scale

prototype of the bedroom and the route leading to it. Due to the cost-effectiveness of LED, we may adopt this across the entire house for further research. Along with the automatic lighting system, we may also develop an automatic bed system with an alert system to alert caregivers. Using this method, the safety, comfort, and independence of vulnerable elders are significantly enhanced, potentially saving more lives from falls or accidents and lowering healthcare expenses.

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