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Enhancing Walkability for Older Adults: The Role of Government Policies and Urban Design

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Abstract: This research examines the impact of government policy initiatives, community engagement programs, and age-friendly urban design policies on the built environment, with a specific focus on the walkability of older adults. The walkability of older adults in the built environment is essential because it promotes physical activity, social connectedness, and independence, thereby enhancing the overall quality of life and supporting healthy aging. This study employs a quantitative approach and cross-sectional design with convenience sampling in Udupi district, one of the urbanizing districts in India. The sample includes 333 older adults from diverse sociodemographic backgrounds who actively use the built environment. Structural equation modeling was used to test the hypotheses. The findings indicate that community engagement programs are the strongest enabler of safety and security perceptions related to walkability. Safety and security positively correlate with increased physical activity level, increased socialization level, and improved quality of life in older adults. Security also mediates the relationship between community engagement programs and all three outcomes associated with walkability. It highlights priority urban design features such as strategic lighting, sheltered walkways, traffic calming measures, barrier-free access, rest areas, and inclusive design elements as critical components of adaptive urban spaces that promote safety, accessibility, and social inclusion for older adults.

Keywords: urban design; community engagement; policy initiatives; quality of life; socialization; older adults; walkability

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1. Introduction

The population of older adults has been growing at an unprecedented rate due to advancements in medical science over the past decade. By 2050, it is estimated that 22% of the world's population will be older adults, aged 60 years and above [1]. As emphasized by [2], there is an urgent need of creating built environments for walkability globally for older adults through 117,259 global positioning system (GPS)-based data. This underscores the necessity to design age-friendly urban environments that can support the quality of life for older adults. Urban policymakers and designers around the globe have realized the need for safe and comfortable built environments for walkability for older adults to support their physical activities, socialization, and quality of life [3]. In this context, research on the impact of government policy initiatives, community engagement programs, and age-friendly urban design policies contributing to the overall wellbeing of older adults has become a topic of international importance.

The built environment for walkability encompasses the physical design, infrastructure, and urban planning features that ensure safe, accessible, and comfortable walking experiences for people in a specific area [4]. This includes well-maintained sidewalks, pedestrian crossings, sufficient lighting, traffic calming measures, and access to essential services within walking distance. For older adults, walkability must also consider additional needs such as barrier-free access, resting areas, handrails, shaded paths, and minimal trip hazards to accommodate mobility limitations [5]. Unlike general walkability, which focuses on active transportation and urban connectivity for all age groups, walkability for older adults prioritizes safety, comfort, and social engagement to support independence and quality of life. It also incorporates age-friendly urban policies that enhance security, ease of navigation, and proximity to healthcare, recreational areas, and community spaces. Thus, walkability in the built environment for older adults is a multifaceted concept that goes beyond accessibility, ensuring that physical, social, and psychological needs are met within the urban landscape.

While developed nations have established clear-cut policies and frameworks for the design and development of built environments for walkability for older adults, and have implemented these plans to an appreciable degree, developing countries have experienced limited progress owing to the shortage of resources in their various forms. In the case of India, one of the world's rapidly expanding economies, the development of built environments for walkability for older adults is an important aspect, alongside progress in the development of different dimensions. With the aging population growing in India, the rate of urbanization is also increasing [6]. Thus, the demand for effective planning policies and monitoring their implementation is greater than ever. As the built environment for walkability is an important aspect of urban design, the government has initiated policies and support infrastructure aimed at inclusive growth, addressing the needs of older adults. Through the Smart Cities Project, the government has initiated projects on improved infrastructure such as accessible pedestrian streets, public transport, and community engagement programs [7]. In addition, smart cities integrate digital technologies like IoT and AI to improve urban infrastructure and services, leading to enhanced efficiency and quality of life [6]. These cities leverage data analytics for optimized resource management and sustainability, reducing the environmental impact and fostering resilient urban environments. By reducing the environmental impact and fostering resilience, these cities enhance pedestrian-friendly environments with features like real-time traffic monitoring, air quality management, and adaptive urban planning, which collectively support safer, more comfortable, and sustainable walkability for older adults. The digital solutions like smart crosswalks, AI-based traffic monitoring, and community engagement platforms are used to foster inclusivity and ensure age-friendly urban environments [8].

The literature shows that studies on concepts such as the '15-minute city' emphasize accessible infrastructure and pedestrian-friendly environments, focusing on inclusive urban design to meet the walkability needs of all age groups. As highlighted by [9], the '15-minute city concept', emphasizing the need for accessible infrastructure and pedestrian-friendly environments to ensure equitable access to essential services such as grocery store accessibility in Vancouver, and underscored the importance of prioritizing pedestrian infrastructure and urban planning interventions to support aging populations and promote inclusive urban mobility. Drawing from this concept, [10] have emphasized the need to account for temporal and seasonal variations in walking accessibility, particularly for vulnerable populations such as older adults. By analyzing walking speeds in Helsinki's metropolitan area in Finland across different seasons and integrating data on diurnal activity hours and service locations, the study revealed that accessibility fluctuates significantly, with older adults experiencing a drastic reduction in access to essential services. The findings underscore the importance of integrating mobility constraints, seasonal factors, and service availability into urban planning to create more inclusive and accessible cities for all age groups. In another study, a quantitative methodological framework was developed to assess the compliance of the cities with the 15-minute city concept [11]. By applying this concept to the city Thessaloniki, Greece, the framework demonstrated the strong alignment of the city with the concept, with a high score of 0.85, suggesting that even more ambitious targets, such as 10- or 5-minute thresholds, could be feasible in dense urban areas.

Research indicates that mobility declines with age, and older adults in developing countries tend to limit their outdoor activities due to safety concerns, accessibility barriers, and health-related issues [12,13]. Having realized it, resources have been allocated to make public spaces, buildings, and road transport accessible to people with disabilities and older adults [14,15]. Measures are in place to promote the safety, comfort, and wellbeing of older adults through age-friendly public spaces [16]. However, several shortcomings have been observed by a group of researchers in the built environment for walkability for older adults, such as a lack of well-maintained sidewalks, ramps, and road crossings [17]; a lack of provisions such as ramps, handrails, and elevators in key public areas [18]; and lack of sufficient green spaces, parks, and resting areas such as seatings for older adults [12], in India.

The study of the built environment for walkability for older adults has become an active area of research worldwide for the past decade. Among the other variables, safety and security aspects have gained special attention, as they are the primary requirements of a built environment for walkability in older adults. An investigation by [19] explored the relationship between the built environment for walkability for older adults and the subjective perceptions of walking considering different physical capabilities. The TrueSkill algorithm was used to capture the perceptions of street images, and deep learning was used to analyze and predict street view factors. The results indicated a significant variation in subjective perception based on safety, comfort, interest, and barrier-free access, depending on physical mobility. An examination of inequalities by [20] in the perceived built environment for walkability attributes among older adults and their impact on the outdoor walking levels through a mixed methods approach with 173 participants. Significant inequalities exist in perceived safety within pedestrian infrastructure, which could lead to differences in outdoor walking levels. As assessed by [20] associations between the built environment for walkability aspects and physical function in older adults, finding that pedestrian infrastructure and esthetics are associated with physical function. However, there was weaker evidence for safety, land use mix, and traffic impacts on physical function. A mixed methods approach used by [21] in a study conducted in Canada reported that the built environment for walkability for older adults and social elements significantly influences perceived safety, and they emphasized the need for a multidimensional approach to urban design. A meta-analysis of 100 research articles by [22] reported that the walkability of older adults is positively associated with safety from crime and accessibility to destinations, parks, greenery, and public transport. Ellis et al. [23] explored how the built environment for walkability features support age-friendly communities and can be translated into policies and practices. Their mixed methods approach revealed that the physical activity, safety, security, and social status of the older adults were inter-related.

Research has consistently shown that the perception of safety significantly influences the willingness to engage in physical activities in older adults, directly impacting their overall wellbeing [13,24]. Concerns about security against weather conditions, theft, and crime are major factors affecting the walking of older adults in their neighborhoods [25].

Even a very well-designed built environment for walkability may fail to achieve its intended outcomes in promoting the walkability among older adults if it does not adequately address safety and security issues. Moreover, safety features are considered to foster the social interactions of older adults in public spaces [26,27]. Thus, examining the mediating role of safety and security in built environments for walkability for older adults is essential for successful urban interventions in age-friendly environments.

The terms safety and security are used interchangeably in many of the literature on built environments, but they have distinct meanings in the context of walkability for older adults. Safety pertains to protection from accidental harm, such as falls, poor infrastructure, or hazardous environmental conditions [28]. This includes features like well-maintained sidewalks, adequate lighting, pedestrian-friendly crossings, and accessibility elements such as ramps and handrails that help reduce the risk of injuries. On the other hand, security involves protection from intentional harm or external threats, such as crime, harassment, or unsafe social environments [29]. Security measures include surveillance, police presence, controlled entry points, and community watch programs that enhance the perception of personal safety. While both factors are crucial for walkability, safety ensures that the physical environment minimizes risks, whereas security fosters a sense of trust and confidence in using public spaces.

Research has shown that the built environment for walkability helps to achieve increased physical activity, increased socialization, and improved quality of life in older adults [24,30,31]. However, the main research gap lies in examining the collective impact of government policy initiatives, community engagement programs, and age-friendly urban design policies on the safety and security of older adults, even though this understanding is necessary for ensuring their engagement in both the development and utilization of the built environment for walkability.

With this background, the aim of this research is to empirically investigate the antecedents of safety and comfort of the built environment for walkability for older adults. The specific objectives of this study are (a) to assess the impact of community engagement programs, government policy initiatives, and age-friendly urban design policies on the comfort and safety of older adults in the built environment for walkability; (b) to explore the role of these variables in improving physical activity levels, socialization, and quality of life; and (c) to provide recommendations for urban designers and policymakers on how to increase the walkability and livability of Indian cities for aging populations. By addressing the gap in the literature, this research aims to contribute to the development of more inclusive, age-friendly cities in developing countries.

2. Hypothetical Model

The hypothetical model is developed based on earlier research concerning the dimensions of research interest in the context of the built environment for walkability for older adults. The relationships between these dimensions, as conceptualized by earlier researchers, are discussed in the following sections, leading to the development of the hypothetical model.

2.1. Relationship of the Government's Policy Initiatives with Safety and Security

This research takes a multidisciplinary approach to conceptualize a theoretical model representing the perceptions of walkability and the overall wellbeing of older adults in the context of the built environment in urban settings. The government's policy initiatives set the foundation for urban development and influence multiple aspects of the built environment. In a study conducted in Singapore, [32] reported that effective government policy initiatives ensure the construction and maintenance of safe pathways, crossings, and public spaces, reducing accidents and hazards. A review of studies conducted by [33] in the UK and US, reported that government policy initiatives may include provisions for adequate lighting, surveillance, and law enforcement to enhance security in urban areas. As reported by [34] that government policy initiatives influence comfort, and [35] emphasized that government policy initiatives have a significant role in providing comfort in the built environment for walkability for older adults. Thus, considering the relationships between government policy initiatives and safety and security from these studies, the following hypotheses have been developed to seek empirical evidence for these relationships.

H1. *there is a positive and significant relationship between government support for infrastructure and the safety aspects of walkability.*

H2. *there is a positive and significant relationship between government support for infrastructure and the security aspects of walkability.*

2.2. Relationship Between Community Engagement Programs and Safety and Security

As suggested by [36], community engagement programs involve residents in the planning and maintenance of their neighborhoods, ensuring their needs and preferences are incorporated into urban design. As reported by [37], approximately 50% of studies on community engagement programs related to older adults have focused on addressing safety and security concerns. A study in Lagos Metropolis by [38], reported that community watch programs and neighborhood associations enhance security by fostering vigilance and collaboration among residents. Thus, considering the relationships between community engagement programs and safety and between community engagement programs and security, the following hypotheses have been developed to seek empirical evidence for these relationships.

H3. *there is a positive and significant relationship between community engagement programs and the safety aspects of walkability.*

H4. *there is a positive and significant relationship between community engagement programs and the security aspects of walkability.*

2.3. Relationship Between Age-Friendly Urban Design Policies and Safety and Security

The primary purpose of an age-friendly urban design policy is to create built environments that cater to the needs of older adults by facilitating mobility and overall wellbeing. A study by [39] reported that age-friendly designs include restrooms, accessible seating, and temperature-controlled environments. Age-friendly policies prioritize accessible green spaces and public transportation, proximity to basic amenities, and well-marked routes, as shown in a qualitative meta-analysis by [40]. A study by [41] emphasized that a design incorporating esthetically pleasing elements such as clear signage, appropriate color contracts, and attractive landscaping, making it easy for older adults to navigate. Building on these findings, the relationships between age-friendly urban design policies and the comfort, convenience, and esthetics are explored in this research, with the following hypotheses developed to empirically test these relationships.

H5. *there is a positive and significant relationship between age-friendly urban design policies and the comfort aspects of walkability.*

H6. *there is a positive and significant relationship between age-friendly urban design policies and the convenience aspects of walkability.*

2.4. Relationship Between Safety and Increased Socialization, Increased Socialization, and Improved Quality of Life

It has been observed that the five perceptions of older adults regarding the built environment on walkability impact increased socialization through direct and indirect effects. A safe environment reduces the risk of accidents, encouraging more frequent and confident outdoor activities [42]. Although many researchers have conceptualized this relationship, empirical evidence remains limited, prompting the formulation of the following hypothesis. A longitudinal study conducted in the U.S. from 2014 to 2021 suggested that walkable neighborhoods, characterized by pedestrian-friendly infrastructure, well-maintained sidewalks, and low crime rates promote physical activity [43]. Walkable neighborhoods also foster social interactions; when people feel safe walking, they are more likely to engage in outdoor activities, meet neighbors, and participate in community programs [44]. Furthermore, walkability contributes to the overall quality of life, with accessible sidewalks, green spaces, and amenities enhancing residents' wellbeing [45]. Despite these findings, the empirical evidence directly linking these variables remains insufficient, necessitating the development of the following hypotheses.

H7. *there is a positive and significant relationship between safety and increased physical activity levels through walkability.*

H8. *there is a positive and significant relationship between safety and increased socialization through walkability.*

H9. *there is a positive and significant relationship between safety and improved quality of life through walkability.*

2.5. Relationship Between Security and Increased Socialization, Increased Socialization, and Improved Quality of Life

Increased security enhances the sense of safety, thus encouraging physical activity in older adults [46]. Research has demonstrated that the presence of security features in the built environment is essential for encouraging older adults to engage in physical activity [47]. Moreover, safe public spaces encourage people to spend time outdoors, thereby increasing opportunities for socialization (e.g., [48]. Additionally, a safe environment makes neighborhoods more welcoming and accessible, which enhances the overall quality of life (e.g., [49]. While many studies have established connections between these factors, empirical evidence remains lacking, prompting the formulation of the following hypotheses.

H10. *there is a positive and significant relationship between security and increased physical activity levels through walkability.*

H11. *there is a positive and significant relationship between security and increased socialization through walkability.*

H12. *there is a positive and significant relationship between security and improved quality of life through walkability.*

The hypothetical model developed is thus shown in Figure 1.

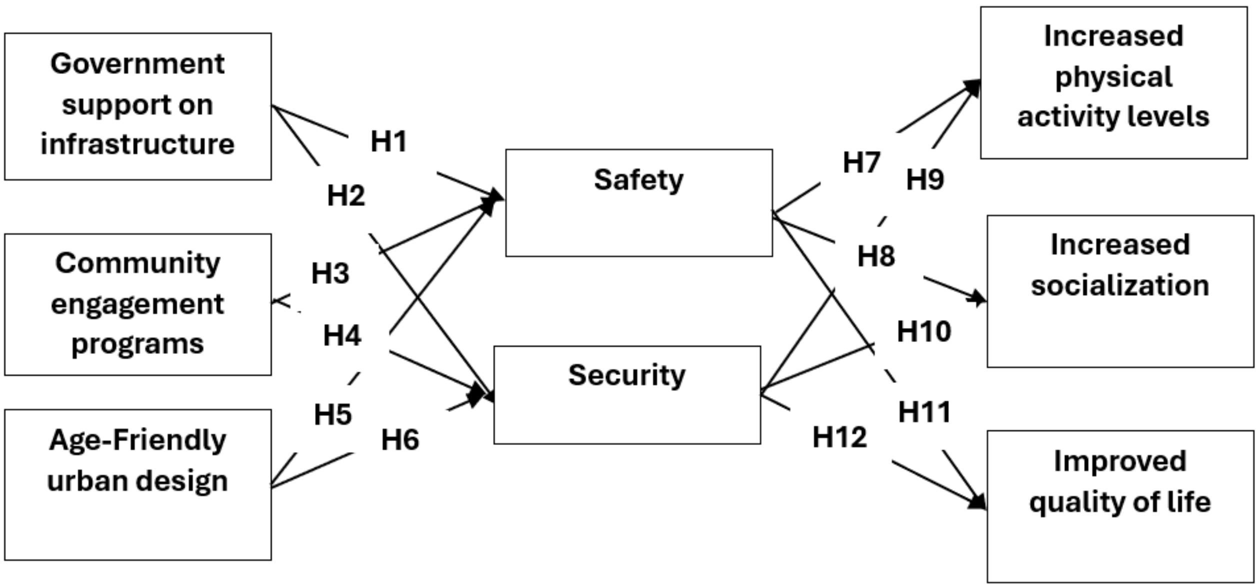

Figure 1. Hypothetical Model.

3. Research Methodology

3.1. Research Philosophy

This research adopts a quantitative approach using a survey strategy. The data were collected through a self-administered questionnaire in both manual and electronic forms. Convenience sampling was used for data collection, as random selection through unique identifiers from a population size of 170,000 older adults in the seven subdivisions of Udupi district under consideration is not practicable, as demanded by probability sampling. Moreover, the suitability of convenience sampling, particularly in the context of SEM analysis, has been widely accepted by earlier researchers owing to the voluntary nature of the research and wider reachability to the respondents (e.g., [50]. The analysis includes both descriptive statistics via the through measurement model and inferential statistics through the structural model.

3.2. The Study Area

Udupi district in Karnataka, India, is the geographical location selected for this research, representing a typical urbanizing study area in a developing country; the destinations of older adults are in proximity to essential services, namely parks, shrines, and recreational areas surrounded by nature, with the Arabian Sea on one side and the Western Ghats of India on the other. Moreover, Udupi is also a popular tourist and pilgrimage destination and is known for its temples, beaches, and historical monuments [51]. With a population of approximately 170,000 older adults, representing 14% of the total population of Udupi district, it is an ideal setting for studying walkability in the built environment for older adult [52].

The district has experienced rapid urbanization, with an urban population growth rate of 18.3% over the past decade, driven by infrastructural development, educational institutions, and healthcare facilities [53]. Additionally, Udupi's literacy rate stands at 86.24%, among the highest in Karnataka, indicating a well-informed population that is more likely to engage with urban planning and mobility initiatives [54]. With a higher life expectancy and an increasing number of nuclear families, there is a growing demand for age-friendly public infrastructure, including walkable environments and accessible transportation systems [55]. Furthermore, Udupi's dependency ratio is rising, putting pressure on urban development policies to cater to the needs of older adults, particularly in terms of mobility, healthcare, and social engagement [56]. These demographic factors make Udupi an ideal case for studying walkability and urban policies for aging populations in a rapidly developing region.

In addition, Karnataka, particularly southern India, has a higher proportion of older adults and a faster aging population growth rate compared to the national average, making it a critical region for studying age-friendly urban policies [52,55]. Moreover, Karnataka has pioneered several urban policy reforms aimed at enhancing mobility and accessibility for older adults, making it an ideal setting for assessing the effectiveness of government initiatives [54]. Udupi, a rapidly urbanizing district, reflects the broader challenges and opportunities in balancing modernization with age-inclusive infrastructure, aligning with India's Smart Cities Mission [52].

3.3. Research Design

This research is grounded in a positive paradigm, making it a correlational study, a cross-sectional design conducted on a temporal basis. Therefore, quantitative data were collected from older adults using a self-administered questionnaire built on a 5-point Likert scale and analyzed through SEM to determine the statistical significance of the relationships between the study variables. To ensure data reliability and validity in this type of research design, measures such as Cronbach's alpha, composite reliability, discriminant validity, and Rho-A were employed. This methodological approach offers a robust research design for exploring how community engagement programs, government policy initiatives, and age-friendly urban design policies impact the mediation of safety and security issues related to walkability for older adults in the built environment. The workflow of this research is shown in Figure 2, which indicates the sequential flow of the work, starting from the study design and identification to the implications and policy recommendations.

3.4. Sampling Procedure

As previously mentioned, convenience sampling was employed in this research, as it provides the flexibility to select samples from all seven subdivisions of Udupi district, ensuring representativeness. A sample of 333 older adults aged 60 years and above living in Udupi District was selected. Sample size adequacy, via G-Power analysis with an effect size of 0.2 under the criterion of a small effect, bidirectional rejection, and a 0.05 confidence level, yielded 327 as the sample size; hence, the adequacy of the sample size was confirmed. The sample was drawn from various built environments for walkability areas within Udupi district, ensuring diverse representations of the age groups of older adults, genders, marital statuses, educational backgrounds, and socioeconomic statuses.

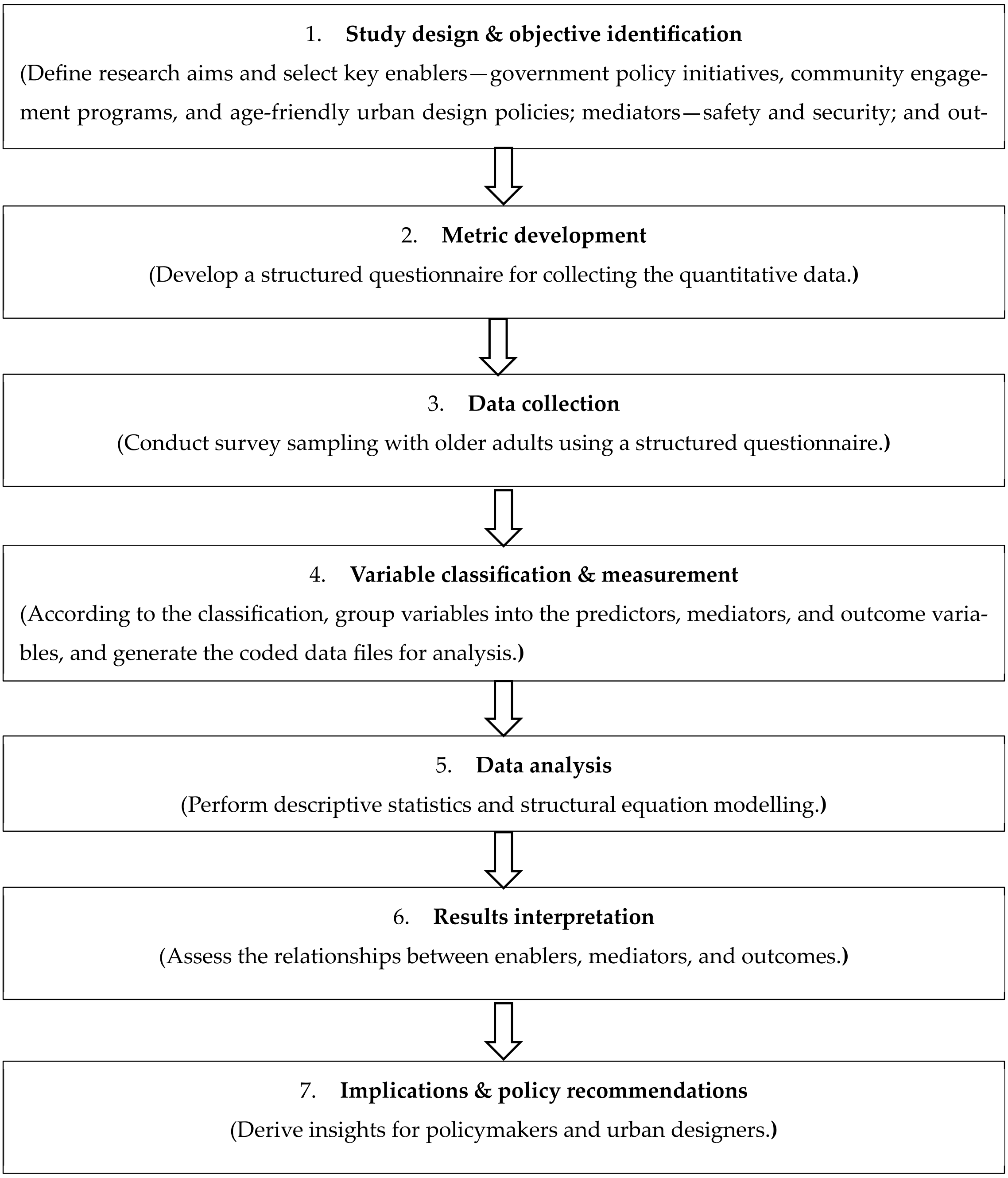

Figure 2. The workflow diagram.

3.5. Questionnaire Design

The questionnaire design followed the standard procedure of selecting items from standard scales designed by earlier researchers. Items from the Urban Accessibility Index (UAI), Infrastructure Quality Index (IQI), and Sustainable Infrastructure Index (SII) [57–59] were chosen for government policy initiatives; items from the Community Engagement Scale (CES), Community Participation Scale (CPS), and Citizen Participation Assessment Tool (CPAT) [60–62] were chosen for community engagement programs, and items from the WHO Age-Friendly Cities Questionnaire (WAFQ), Age-Friendly Communities Scale (AFCS), and Built Environment Assessment Tool (BEAT) [63–65] were chosen for the AUG. The items in the questionnaire were modified slightly to suit the local context; hence, reliability and validity were reassessed through Cronbach's alpha reliability measures.

The first section of the questionnaire was reserved for assimilating sociodemographic information, and the second section comprised 5-point Likert scale items to measure the perceptions of built environments for walkability by older adults of the research variables.

The original and the modified items are provided in Table 1, with the justification for the modifications made. Since confirmatory factor analysis (CFA) was conducted, ensuring that all factor loadings remained above the acceptable threshold ($\geq$0.7), the modifications made to the items did not compromise the construct validity of the questionnaire. Cronbach's alpha and composite reliability values, which ranged between 0.78 and 0.96 in the original study, indicate that the internal consistency of the modified items remained strong. These refinements preserved the original constructs by maintaining conceptual alignment while enhancing clarity for respondents. Additionally, the changes were guided by established scales such as the Government Support Policy for Infrastructure [57], Community Engagement Scale (CES) [60], and WHO Age-Friendly Cities Questionnaire (WAFQ) [63], ensuring content validity. Given that the modifications primarily improved readability without altering the meaning, they maintained the robustness of the measurement model. Thus, the refinements contributed to a more comprehensible survey instrument without affecting the reliability and validity of this study.

Table 1. The dimension, original item, modified item, and justification.

Dimension	Original Item	Modified Item	Justification
Government Support Policy for Infrastructure	GPI1: the government's support for a walkable design in our urban infrastructure development is visible.	GPI1: the government actively integrates walkability features in urban infrastructure development projects.	This slight rewording was performed to enhance clarity while preserving the original intent and meaning.
Government Support Policy for Infrastructure	GPI2: the government takes inputs from local communities to ensure their input in walkable design decisions.	GPI2: the government incorporates community feedback into walkable design decisions for urban development.	We simplified the wording to maintain the measurement of community participation in policy-making.
Community Engagement Programs	CEP1: community engagement programs effectively involve residents in the decision-making process for walkable design initiatives.	CEP1: residents actively participate in community engagement programs that influence walkable design initiatives.	The modified version removed redundancy and maintained the focus on community involvement.
Age-Friendly Urban Design Policies	AUP2: crosswalks and pedestrian signals are designed in accordance with age-friendly policies, facilitating safe and comfortable crossing for elderly individuals.	AUP2: crosswalks and pedestrian signals follow age-friendly policies to enhance safety and accessibility for older adults.	The meaning was maintained while improving readability.
Safety	SFT1: the walking streets are free of broken slabs on the footpaths, stray dogs, electrical poles, stay wires, tied banners, open drains, tall and high footpaths, etc.	SFT1: walking streets are maintained free of hazards such as broken slabs, stray animals, obstructive poles, and open drains.	Shortened for better readability while preserving hazard-free street conditions.

Table 1. *Cont.*

Dimension	Original Item	Modified Item	Justification
Security	SCT1: the neighborhood has adequate lighting, providing a sense of security for walking at night.	SCT1: adequate street lighting in my neighborhood enhances security and nighttime walkability.	Retained the essence of security perception with a clearer structure.
Increased Physical Activity Level	IPL1: the presence of well-maintained sidewalks encourages me to walk more often.	IPL1: well-maintained sidewalks in my neighborhood encourage frequent walking.	Minor rewording was made for conciseness, and the original construct remained unchanged.
Improved Quality of Life	IQL1: the walkable design of my neighborhood contributes to an improved overall quality of life.	IQL1: the walkable neighborhood design positively impacts my overall quality of life.	The slight modification improved fluency while maintaining the measurement of walkability impact.

3.6. Data Collection Process

The data collection process was carried out between March and June 2024. The researcher personally collected hardcopies of the self-administered questionnaire filled out by participants in their homes, parks, and community centers across different locations in Udupi district. The items in the questionnaire were briefly presented by the researcher to the participants, highlighting their importance during the personal model of data collection, and a brief explanation of the research was provided in the Google Form with the contact details of the researcher to revert in case of any difficulty. Google forms were also distributed through contacts in community centers, old-age homes, healthcare centers, and recreation clubs. While 186 hard copies were collected through hardcopies of the completed questionnaire, the remaining 147 were obtained through Google Forms.

4. Analysis and Results

The results of the analysis are presented using a combination of textual explanations, tabular summaries, and graphical representations to ensure clarity and comprehensibility. The sociodemographic characteristics are tabulated, displaying both the numbers and percentages; the measurement model and the structural model of the structural equation modeling (SEM) have been displayed both in tabular and graphical forms for ease of understanding and have been described in the following sections.

4.1. Sociodemographic Characteristics of the Sample

Table 2 shows a nearly equal gender distribution, with 52.9% male and 47.1% female respondents observed in the sample selected for this research. The age distribution in this study aligns with the demographic trends in India, where life expectancy is lower (70.4 years) compared to many Western countries (80+ years), leading to fewer older adults actively engaging in public spaces [66]. Therefore, the representation of younger seniors in this study is consistent with prior findings, as the oldest age groups are less likely to be active in walkable public environments [42]. Most respondents were between the age groups of 60–65 years (45.0%), followed by the age group of 65–70 years (40.9%). A smaller proportion is in the older age groups, namely 7.2% (aged 70–75 years), 6.0% (aged 75–80 years), and 0.9% (above 85 years). In terms of marital status, 41.5% were married, 26.1% widowed, 16.8% unmarried, 6.9% divorced, 6.6% separated, and 2.1% in the "other" category, which includes cohabitation arrangements.

Table 2. Sociodemographic characteristics of the sample (N = 333).

Characteristics	Number	Percentage
Gender		
Male	176.0	52.9
Female	157.0	47.1
Age		
Above 60 up to 65 years	150	45.0
Above 65 up to 70 years	136	40.9
Above 70 up to 75 years	24	7.2
Above 75 up to 80 years	20	6.0
Above 85 years	3	0.9
Marital Status		
Unmarried	56	16.8
Married	138	41.5
Divorced	23	6.9
Widowed	87	26.1
Separated	22	6.6
Other	7	2.1
Socioeconomic Status		
Below Poverty Line	14	4.2
Lower Income Group	25	7.5
Middle Income Group-1	159	47.8
Middle Income Group-2	114	34.2
High Income Group	21	6.3

The SES distribution shows that 47.8% of participants belong to middle-income group 1 (7150–14,300 USD per annum), 34.2% to middle-income group 2 (14,300–21,450 USD per annum), 6.3% to the high-income group (>21,450 USD per annum), and 11.7% to the low-income group (3565–7150 USD per annum), with 4.2% below the poverty line (less than 350 USD per annum). Since 70% of Udupi district is classified as rural, there is a possibility that lower-income rural residents were relatively underrepresented in the sample or may not actively utilize the built environment for walkability, as their daily routines often involve physically demanding labor, reducing the need for additional walking to maintain good health.

4.2. SEM Analysis

SEM has two distinct parts: descriptive statistics in the form of a measurement model and inferential statistics in the form of a structural model. These two components of the analysis are discussed in the following sections.

4.2.1. The Measurement Model

Reliability and Validity

The standard procedure of testing the reliability and validity of the data and the questionnaire was performed, and the following are the salient features. The factor loadings of the various latent variables ranged between 0.78 and 0.97 (Table 3, Figure 3), demonstrating good to very high levels of convergent validity (cut-off = 0.7; [67]). Cronbach's alpha values ranged between 0.78 and 0.96, indicating that a moderate to high level of internal consistency exists in the data (cut-off of 0.7; [68]). Internal consistency is also measured through Rho_A values, which, in this research, range from 0.79 to 0.96, demonstrating a high to very high level of acceptability (cut-off = 0.7; [69]). Another measure of reliability, in the form of composite reliability, was also used to test the data, and the values ranged from 0.87 to 0.97, further confirming the reliability of the constructs. Finally, the average variance extracted (AVE) ranges from 0.69 to 0.92, indicating a high to very high level of acceptability in terms of variance due to measurement error (cut-off = 0.5; [70].

Table 3. Reliability and validity measures.

Construct	Items	Factor Loadings	Cronbach's Alpha	Rho_a	Composite Reliability	Average Variance Extracted (AVE)
AUP	AUP1	0.97	0.96	0.96	0.97	0.92
	AUP2	0.95				
	AUP3	0.96				
CEP	CEP1	0.90	0.88	0.88	0.92	0.81
	CEP2	0.89				
	CEP3	0.90				
GPI	GPI1	0.96	0.92	0.92	0.95	0.86
	GPI2	0.93				
	GPI3	0.89				
IPL	IPL1	0.90	0.86	0.86	0.91	0.77
	IPL2	0.88				
	IPL3	0.86				
IQL	IQL1	0.81	0.78	0.79	0.87	0.69
	IQL2	0.90				
	IQL3	0.78				
ISL	ISL1	0.90	0.91	0.91	0.94	0.86
	ISL2	0.95				
	ISL3	0.91				
SCT	SCT1	0.89	0.87	0.88	0.92	0.80
	SCT2	0.82				
	SCT3	0.96				
SFT	SFT1	0.89	0.92	0.92	0.95	0.87
	SFT2	0.97				
	SFT3	0.92				

Legend: AUP = age-friendly urban design policy; CEP = community engagement program; GPI = government policies for infrastructure; IPL = increased physical activity level; IQL = improved quality of life; ISL = increased socialization; SCT = security; SFT = safety.

The procedure for testing the validity of the measurement in SEM is through discriminant validity, which involves comparing the square root of the AVE for each latent variable with the interitem correlation of that variable with the rest of the variables. In this research, the square roots of the AVEs of all the variables, represented on the diagonal cells (shown in bold) of the table, are greater than the interitem correlation values shown below that cell (Table 4); hence, the variance shared by the variable with its own indicators is greater than that shared with the rest of the variables, confirming strong discriminant validity.

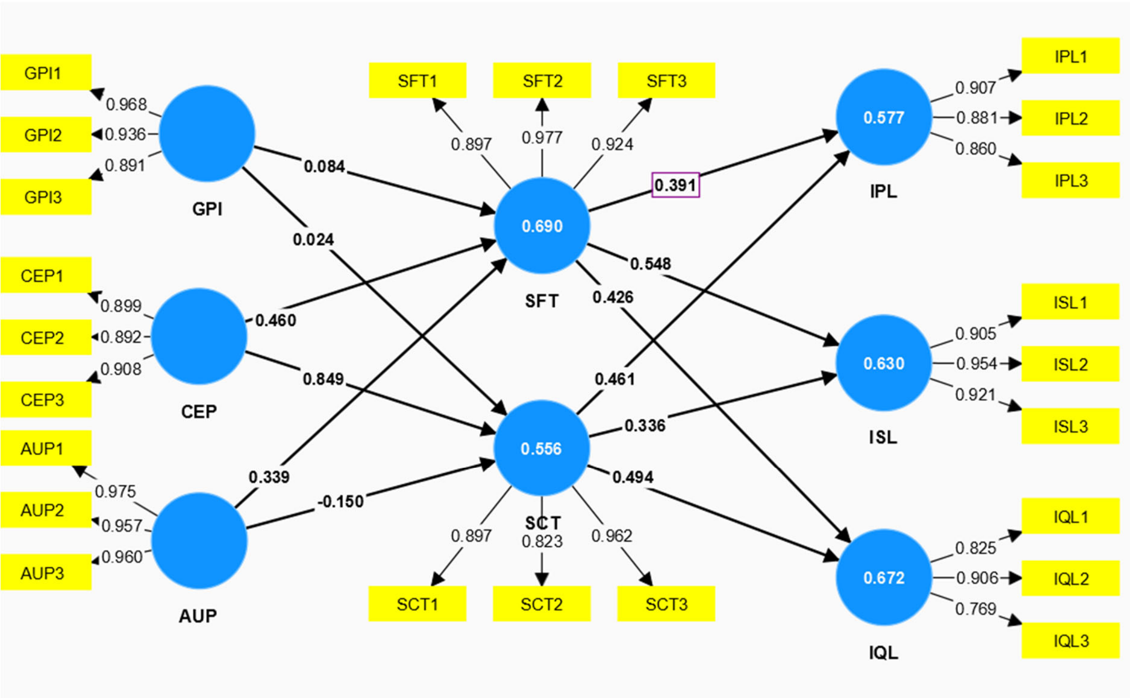

Figure 3. The measurement model. Legend: AUP = age-friendly urban design policy; CEP = community engagement program; GPI = government policies for infrastructure; IPL = increased physical activity level; IQL = improved quality of life; ISL = increased socialization; SCT = security; SFT = safety.

Table 4. Discriminant validity.

	AUP	CEP	GPI	IPL	IQL	ISL	SCT	SFT
AUP	**0.96**							
CEP	0.83	**0.90**						
GPI	0.71	0.72	**0.93**					
IPL	0.50	0.66	0.37	**0.88**				
IQL	0.66	0.72	0.61	0.72	**0.83**			
ISL	0.55	0.72	0.50	0.89	0.69	**0.92**		
SCT	0.57	0.74	0.53	0.69	0.74	0.65	**0.89**	
SFT	0.78	0.80	0.65	0.66	0.71	0.74	0.58	**0.93**

Legend: AUPs = age-friendly urban design policies; CEPs = community engagement programs; GPI = government policies for infrastructure; IPL = increased physical activity level; IQL = improved quality of life; ISL = increased socialization; SCT = security; SFT = safety.

Thus, the questionnaire measured what it was intended to measure, confirming its validity, and the data are reliable, making them suitable for structural analysis.

In addition to these measures, the measurement model also provides path coefficients and R-square values. Path coefficients offer descriptive statistics and cannot be the basis for decision-making, as evidenced through inferential statistics. However, it can be used to gain a general understanding of the situation in terms of the relationships between the variables being studied. The weakest path coefficient exists between government policy initiatives and security (0.02), indicating a positive but very weak relationship between the two variables. This means that the government's policies on infrastructure may not have been successful in providing security perceptions among older adults in built environments for walkability. On the other hand, the strongest relationship is observed between community engagement programs and security (0.849), which indicates that a positive and very strong relationship exists between these two variables, implying that community engagement programs have great potential in increasing the security perception of older adults in the built environment for walkability. The effect is only negative and weak (−0.15) between age-friendly urban design policies and security, which indicates that an age-friendly urban design policy may not be the only factor that can improve the perception of older adults regarding the security of the built environment for walkability. The relationships between the remaining variables are depicted in the measurement model.

The R-square values are a measure of how good the model fit is, and it reflects the influence of exogenous variables on the endogenous variables being studied. The R-square value of 0.69 (safety) indicates that 69% of the variance in safety is explained by the exogenous variables used in this research (age-friendly urban design policies, community engagement programs, and government policy initiatives). A high value indicates a strong ability of the exogenous variables to predict the perceptions of safety of older adults on the built environment for walkability (cut-off = 0.1; [71]). Similarly, the other endogenous variables also demonstrated a strong model fit, with values of security (0.556), increased socialization (0.577), increased socialization (0.630), and improved quality of life (0.672).

4.2.2. The Structural Model

The structural model provides the results of hypothesis testing. The following direct hypotheses are supported (Table 5, Figure 4).

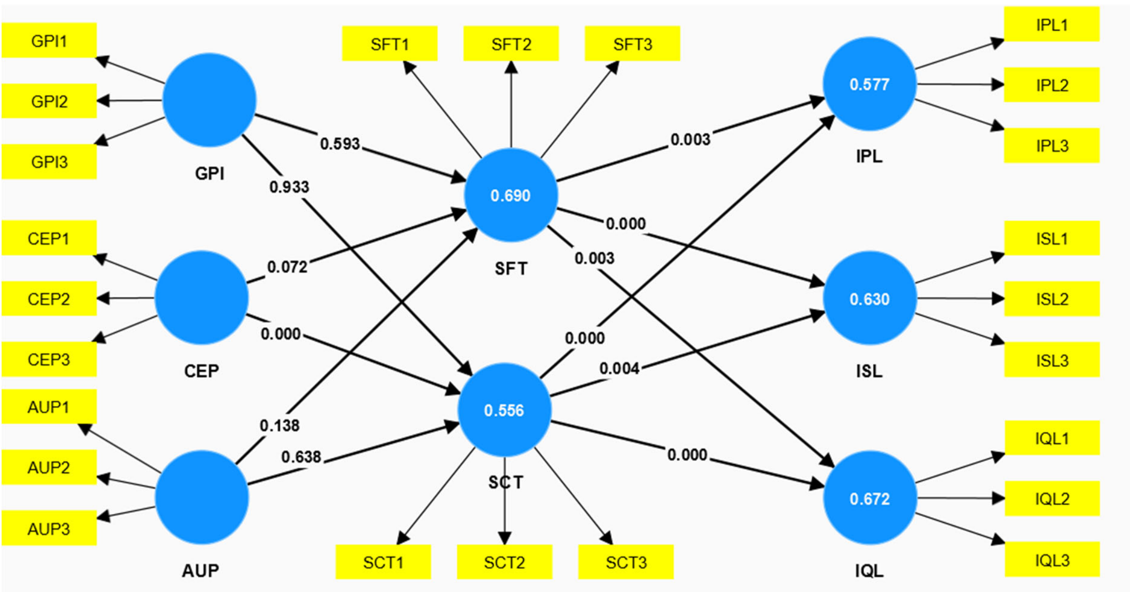

Figure 4. The structural model. Legend: AUP = age-friendly urban design policy; CEP = community engagement program; GPI = government policies for infrastructure; IPL = increased physical activity level; IQL = improved quality of life; ISL = increased socialization; SCT = security; SFT = safety.

H3. *there is a positive and significant relationship between community engagement programs and the safety aspects of walkability.*

H4. *there is a positive and significant relationship between community engagement programs and the security aspects of walkability.*

H7. *there is a positive and significant relationship between safety and increased physical activity levels through walkability.*

H8. *there is a positive and significant relationship between safety and increased socialization through walkability.*

H9. *there is a positive and significant relationship between safety and improved quality of life through walkability.*

H10. *there is a positive and significant relationship between security and increased physical activity levels through walkability.*

H11. *there is a positive and significant relationship between security and increased socialization through walkability.*

H12. *there is a positive and significant relationship between security and improved quality of life through walkability.*

Table 5. Hypothesis testing.

Paths	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	*t*-Statistics	*p*-Values	Null Hypothesis
AUP→SCT	−0.15	−0.12	0.32	0.47	0.638	Failed to reject
AUP→SFT	0.34	0.37	0.23	1.48	0.138	Failed to reject
CEP→SCT	0.85	0.84	0.19	4.57	**0.000 ****	**Rejected**
CEP→SFT	0.46	0.40	0.25	1.80	**0.072 ***	**Rejected**
GPI→SCT	0.02	0.00	0.28	0.08	0.933	Failed to reject
GPI→SFT	0.08	0.11	0.16	0.53	0.593	Failed to reject
SCT→IPL	0.46	0.48	0.13	3.55	**0.000 ****	**Rejected**
SCT→IQL	0.49	0.51	0.10	4.69	**0.000 ****	**Rejected**
SCT→ISL	0.34	0.35	0.12	2.86	**0.004 ****	**Rejected**
SFT→IPL	0.39	0.36	0.13	2.94	**0.003 ****	**Rejected**
SFT→IQL	0.43	0.40	0.14	2.94	**0.003 ****	**Rejected**
SFT→ISL	0.55	0.53	0.11	5.11	**0.000 ****	**Rejected**

*—significant at the 10% significance level; **—significant at the 5% significance level. Legend: AUP = age-friendly urban design policy; CEP = community engagement program; GPI = government policies for infrastructure; IPL = increased physical activity level; IQL = improved quality of life; ISL = increased socialization; SCT = security; SFT = safety.

Furthermore, through the indirect effects analysis, the following conclusions can be drawn (Table 6).

Table 6. Specific indirect effects.

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	*t*-Statistics	*p* Values	Null Hypothesis
GPI→SCT→ISL	0.00	0.00	0.09	0.08	0.935	Failed to reject
AUP→SFT→IPL	0.13	0.14	0.10	1.28	0.201	Failed to reject
AUP→SCT→IPL	−0.07	−0.04	0.15	0.45	0.651	Failed to reject
AUP→SFT→IQL	0.14	0.15	0.11	1.31	0.189	Failed to reject
CEP→SFT→IPL	0.18	0.15	0.11	1.56	0.120	Failed to reject
AUP→SCT→IQL	−0.07	−0.05	0.16	0.45	0.649	Failed to reject
AUP→SFT→ISL	0.19	0.20	0.13	1.39	0.165	Failed to reject

Table 6. *Cont.*

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	*t*-Statistics	*p* Values	Null Hypothesis
CEP→SCT→IPL	0.39	0.41	0.15	2.63	**0.009**	**Rejected**
CEP→SFT→IQL	0.20	0.17	0.12	1.53	0.125	Failed to reject
GPI→SFT→IPL	0.03	0.04	0.06	0.57	0.571	Failed to reject
AUP→SCT→ISL	−0.05	−0.05	0.11	0.44	0.660	Failed to reject
CEP→SCT→IQL	0.42	0.43	0.13	3.31	**0.001**	**Rejected**
CEP→SFT→ISL	0.25	0.21	0.14	1.76	0.078	Failed to reject
GPI→SCT→IPL	0.01	−0.01	0.14	0.08	0.937	Failed to reject
GPI→SFT→IQL	0.04	0.05	0.07	0.53	0.598	Failed to reject
CEP→SCT→ISL	0.28	0.30	0.13	2.15	**0.032**	**Rejected**
GPI→SCT→IQL	0.01	−0.00	0.15	0.08	0.937	Failed to reject
GPI→SFT→ISL	0.05	0.06	0.09	0.52	0.603	Failed to reject

Legend: AUP = age-friendly urban design policy; CEP = community engagement program; GPI = government policies for infrastructure; IPL = increased physical activity level; IQL = improved quality of life; ISL = increased socialization; SCT = security; SFT = safety.

Security is a positive and significant mediator of community engagement programs with increased socialization, increased socialization, and improved quality of life.

5. Discussion

The hypothesis testing has led to important revelations that could be very useful in policy design and implementation in the context of the built environment for walkability in developing countries like India, where evidence-based outcomes are limited in supporting decision-making.

This research revealed that community engagement programs have a significant relationship with both safety and security aspects of walkability (H3, H4), consistent with earlier findings by [37,38]. Engaging communities in urban design fosters trust, enhances social cohesion, and creates a safer and secure environment. As reported by [72], age-friendly initiatives incorporated into policies through community engagement programs improved the safety of the built environment for walkability for older adults.

The aspects of safety in the built environment for walkability are positively and strongly related to increased socialization (H7), increased socialization (H8), and improved quality of life (H9), underscoring the importance of prioritizing safety in achieving the outcome of the built environment for walkability for older adults. These findings highlight how improved safety can encourage outdoor physical activities and social interactions in older adults [73]. The perception of safety in the built environment for walkability encourages outdoor activities and social engagement, contributing to the overall wellbeing in older adults.

Security also shows a significant relationship with increased physical activity levels (H10), increased socialization (H11), and improved quality of life (H12). This finding suggests that the overall wellbeing of older adults is linked to security, as evidenced by previous researchers [46–48]. Security features promote physical activity, support independence, improve mental health, and result in increased use of public spaces by older adults, contributing to their overall wellbeing.

The security perception of older adults has proven to be a significant mediator between community engagement programs and increased socialization, increased socialization, and improved quality of life. These findings suggest that community engagement programs can indirectly enhance physical activity, socialization, and quality of life by enhancing the perceptions of safety. This is a very important finding in this perception-based research.

6. Conclusions

In a developing country like India, where urban infrastructure is expanding and the population of older adults is growing, research on the built environment for walkability for older adults is increasingly vital. This study specifically examined the role of three enablers—government policy initiatives, community engagement programs, and age-friendly urban design policies—of walkability for older adults in shaping urban design aspects of safety and security, ultimately leading to the enhancement of well-being. The importance of this research lies in its support for inclusive and sustainable urban design, which ensures improved mobility, independence, social interaction, and quality of life in older adults.

The findings revealed positive and significant relationships between community engagement programs and both safety and security in the built environment through hypothesis testing. Additionally, both safety and security were found to have strong positive effects on increased socialization, increased socialization, and improved quality of life. Thus, the results indicate that while community engagement programs can enhance the perceptions of safety and security among older adults regarding the built environment for walkability, the perception of safety and security can, in turn, improve the wellbeing of older adults, as represented by outcome achievements through increased socialization, increased socialization, and improved quality of life.

These results have critical implications for policymakers and urban designers. Involving older adults in urban planning and designing through community engagement program initiatives has the potential to develop a built environment for walkability that can ensure the safety and security of older adults. Research has shown that community engagement program initiatives lead to a better built environment for walkability through suggestions on reducing fall risk, such as making walking easier, providing easy access to amenities, developing comprehensive transportation networks, providing adequate housing spaces near shopping centers, improving urban design in response to the needs of older adults, providing intergenerational spaces, etc. (e.g., [74,75].

Policymakers and urban planners may consider integrating urban design features identified by older adults in this research as the most crucial for enhancing safety and walkability, aligning with findings from similar studies conducted by other researchers. According to the survey results, strategic lighting emerged as the top priority, significantly enhancing nighttime visibility and perceived security (e.g., [76]. Sheltered walkways were the second most critical feature, providing protection against adverse weather and promoting year-round walkability (e.g., [77]. Traffic calming measures ranked third, as they help to reduce vehicle speed and improve pedestrian safety [76]. Other key features included natural surveillance strategies such as open sightlines and community watch programs (e.g., [78]), the implementation of fencing and boundaries to delineate pedestrian zones (e.g., [79]), and the incorporation of age-friendly urban design elements like barrier-free access, resting areas, and inclusive facilities to enhance overall accessibility (e.g., [80]). This prioritization, based on the perceptions of older adults, provides urban planners with clear directives for creating safer and more inclusive walkable environments.

Policymakers may consider focusing on crime prevention through environmental design (CPTED) principles, which are not commonly observed in developing countries such as India. Active monitoring, controlled entry points, ownership signaling, functional zoning, and spatial optimization are essential features of CPTED that are not widely implemented and must be considered in the design of the built environment for walkability.

Urban designers must incorporate 'safety-conscious design elements' as an integral part of the built environment for walkability, as they can indirectly control the overall wellbeing of older adults. This includes a number of architectural elements, such as adequate lighting for late-night walks, benches and rest areas to stay outdoors for longer times, wide and even sidewalks to prevent tripping hazards, spaces for walking aids, clear pedestrian crossings to prevent confusion while navigating, barrier-free access with appropriate ramps and curb cuts, clear signage and wayfinding to navigate with no anxiety of getting lost, greenery and natural buffers to offer shade, and most importantly, inclusive design features such as universal accessibility ramps, hearing loops, automatic doors, tactile paving, visual and audible alerts, and contrasting colors and textures.

Designers should develop mechanisms to integrate community feedback into the process, particularly when shaping the layouts of parks, public spaces, accessible playgrounds, water fountains, hydration stations, fitness zones, sensory gardens, multiuse paths, interactive public art, and recreational facilities. As community engagement has been linked to increased perceptions of safety, involving older adults in safety audits or decision-making processes can further reinforce their perceptions and their connection to the built environment.

Community engagement programs, identified as the key enabler influencing both safety and security, play a vital role in fostering trust and promoting active participation among older adults. Institutionalizing these programs within urban planning frameworks ensures long-term sustainability and strengthens community networks that encourage physical activity and social interaction. To maximize their impact, community engagement programs should be integrated at the earliest stages of urban planning and design rather than as post-implementation feedback mechanisms. Engaging older adults in initial site selection, infrastructure planning, and accessibility assessments ensures that walkability features are purposefully embedded into urban spaces from the outset. Studies suggest that cities that incorporate early-stage participatory planning experience fewer design failures, lower retrofit costs, and stronger public adoption of urban spaces (e.g., [74,75]. Hence, the proactive inclusion of older adults in preliminary phases of urban design, rather than in later stages or policy reviews, can result in more functional and widely accepted walkable environments.

Future researchers may build on this study by adopting a longitudinal design to establish causal relationships between the variables, moving beyond the correlational findings of this cross-sectional analysis. Expanding the sample size and including diverse geographic regions would enhance the generalizability of the findings, particularly when employing random sampling instead of convenience sampling. Additionally, future studies could explore the mediating roles of variables such as environmental esthetics, comfort, convenience, and access to services to gain deeper insights into the impact of the built environment on walkability for older adults. This would contribute to a more comprehensive understanding of adaptive urban design and its influence on the mobility, safety, and wellbeing of the older adults.

The findings of this study have broader international relevance to some extent, as the challenges of walkability, age-friendly urban design, and policy implementation extend beyond India to other developing countries. While India serves as a case study, the insights gained can inform global urban planning strategies, particularly in rapidly urbanizing regions with aging populations. Future research should consider cross-country comparisons to assess how government policies, community engagement, and built environment interventions influence the walkability of older adults in diverse socio-economic and geographical contexts.

Finally, this research strongly advocates for the significance of community engagement in strengthening the safety and security of older adults, thereby improving their walkability and wellbeing. It highlights that community engagement programs have an indirect influence on the wellbeing of older adults. Therefore, policymakers and urban designers are encouraged to incorporate the insights from this research to create inclusive and age-friendly environments that support active aging and enhance the life satisfaction of older adults, particularly in developing countries.

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