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Determinants of Public Transportation Utilization among Older Adults toward Inclusive Urban Mobility in Surakarta City

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ABSTRACT

The increasing proportion of older people in urban areas highlights the importance of developing an inclusive transportation system that ensures accessibility, independence, and social participation. Although age-friendly city concepts and programs have been widely promoted, public transportation use among older people has not yet been adequately studied in Surakarta City. This study has two objectives: (1) to identify the level of public transportation utilization among older people in Surakarta City, and (2) to examine the associated factors. A quantitative approach was used, with data collected through a questionnaire survey of 100 older adult residents of Surakarta City. This study used stratified proportional random sampling. Descriptive statistical analysis, the Chi-Square test, and Spearman Rank correlation were used to analyze the data. The results indicate that public transportation utilization among the older adults in Surakarta City remains relatively low. This pattern may be linked to several factors with significant correlations, such as age, distance to public transport stops, waiting time, health conditions, and private vehicle ownership. These factors indicate that barriers to elderly mobility are not only physical but also related to demographic aspects, physical condition, perceived comfort, spatial accessibility, and preferences for transportation modes. This study highlights the need for efforts to realize inclusive mobility in Surakarta City by considering the characteristics and specific needs of elderly as public transportation users.

Keywords: Age-Friendly City, Mobility Barrier, Older Adult, Public Transportation, & Transport Accessibility

1. Introduction

The increasing proportion of the elderly population is a global demographic phenomenon that has occurred consistently over the past few decades (Fallahi et al., 2024; United Nations, 2023). This condition is projected to grow most significantly in low-income countries (Ariyanti et al., 2025). United Nations (UN) reports and various studies indicate that the elderly population continues to increase due to rising life expectancy and declining birth rates. Globally, the proportion of the population aged 60 years and over is projected to reach approximately 22% by 2050, up from approximately 12% in 2015. In developing countries, including Indonesia, this trend is also very pronounced. Indonesia is projected to see the proportion of the elderly population rise to approximately 20% by 2045 (BPS, 2023a, 2023b). In major cities across Indonesia, including those on the island of Java, this increase in the older adult population is directly associated with growing demand for more adaptive public services, particularly in mobility and transportation.

As the population ages, global demand for more inclusive and age-friendly cities is increasing (Steels, 2015). The World Health Organization (WHO) concept of age-friendly cities emphasizes that cities must support the

quality of life of older adults through several key dimensions, including respect and social inclusion, transportation, civic participation and employment, open spaces and buildings, community support and health services, housing, communication and information, and social participation (Chung et al., 2021; WHO, 2007). These dimensions are interconnected and help ensure that older adults can live independently and safely while remaining socially engaged in urban life.

Within this framework, transportation is a key dimension that connects older adults to various urban services and activities. Public transportation is a crucial component of an inclusive city, as limited mobility can directly contribute to declines in independence, social participation, and quality of life for older adults (Jia et al., 2025). Inclusive public transportation can help improve the health, social participation, and subjective wellbeing of older adults (Sun & Musselwhite, 2025; Zhang & Yang, 2024). However, many older adults face challenges accessing public transportation due to limited accessibility and service availability (Jaydarifard et al., 2026). Therefore, understanding public transportation use among older adults is crucial for developing age-friendly public transportation systems and improving their mobility (Liu et al., 2021).

Within the WHO framework, transportation is a fundamental domain of an age-friendly city, as the availability, affordability, accessibility, safety, and reliability of transportation services determine older adults' ability to travel independently and participate in urban life (WHO, 2007). From the perspectives of transport disadvantage and social exclusion, inadequate transportation services or difficulties in accessing them can limit individuals' opportunities to reach essential destinations, participate in social activities, and maintain social networks, thereby increasing the risk of mobility-related social exclusion (Jahangir et al., 2024; Ward & Walsh, 2023). Accessibility serves as an important mechanism linking transportation conditions to mobility outcomes, as the ease of reaching public transportation stops or service points, service availability and coverage, travel time, and the comfort of transportation facilities can influence older adults' ability and willingness to use public transportation (Al-Rashid et al., 2022; Hong et al., 2024). These accessibility conditions then interact with individual characteristics and travel preferences, as emphasized in travel behavior frameworks, to shape decisions about whether, how often, and which modes of transportation older adults use.

Surakarta (Solo) is one of the Indonesian cities frequently cited as a reference for developing the age-friendly city concept. The Surakarta City Government has developed various inclusion-based policies, including the Age-Friendly Urban Village program initiated in 2021 in response to the city's growing elderly population and rising life expectancy. This program is implemented through various activities at the village level, such as the establishment of integrated health posts (Posyandu) for older people, the provision of routine health check-ups, elderly exercise activities, strengthening social groups for older people, and providing social interaction spaces at the community level (Kawuri & Haryanti, 2025; Suroto et al., 2024).

In the transportation sector, Surakarta has also developed several initiatives that support the development of an age-friendly city, particularly through improvements in public transportation services, such as Batik Solo Trans (BST), affordable fare policies, and the use of convenient digital payment systems. These conditions make Surakarta an interesting case study in examining the development of age-friendly urban environments, particularly from the perspective of public transportation. However, implementing the inclusive transportation concept for the elderly in Surakarta City still faces various challenges, including limited safety measures, insufficient driver awareness and courtesy, limited designated areas for the elderly, and limited route coverage (Suriastini et al., 2013). The existing transportation system has not yet fully addressed the mobility needs of the elderly population, particularly ensuring accessibility and travel comfort (Sugito et al., 2026). These limitations may stem from barriers related to infrastructure, transportation services, and technological factors (Karolemeas et al., 2026).

Previous studies in Surakarta have examined various issues related to older adults and transportation from different perspectives, including assessments of age-friendly cities, perceptions of age-friendly environments, program implementation, and evaluations of public transportation systems in general (Caesarita et al., 2022; Indah Dwi Pramesti, 2023; Kawuri & Haryanti, 2025; Suroto et al., 2024). Other studies have also examined inclusive transportation services such as Batik Solo Trans, particularly regarding accessibility and service coverage for people with disabilities (Ibrahim & Haryanti, 2025; Ulfaliya et al., 2024). However, the available research remains insufficient to quantitatively explain the frequency of public transportation use among older adults and the factors associated with its utilization based on older adults' own perceptions. Therefore, the research gap is the lack of a comprehensive quantitative examination of the factors associated with public transportation utilization from older adults' perspective.

More specifically, available empirical evidence remains limited in explaining how individual characteristics, health conditions, transportation accessibility, and socioeconomic and mobility-related factors are jointly associated with the frequency of public transportation use. Therefore, this study aims to identify the frequency of public transportation utilization among older adults in Surakarta City and examine the relationships between public transportation utilization and several individual, socioeconomic, and accessibility-related factors, including age, health condition, gender, employment status, household socioeconomic characteristics, vehicle ownership, distance to public transportation stops or service points, and waiting time.

2. Methods

This study was conducted in Surakarta City, Central Java, as presented in Fig. 1. This is a quantitative study. This study used a questionnaire survey as the data collection technique. The survey was conducted among older adults residing in Surakarta City. Eligible participants were residents aged 60 years or older who had lived in Surakarta City and could understand and communicate in Indonesian. Caregivers assisted participants who had difficulty communicating effectively in completing the questionnaire. The questionnaire was administered in Indonesian, and assistance was provided when necessary to participants who had difficulty reading, understanding, or completing the questionnaire. However, responses were based on participants' own perceptions, and caregivers were not permitted to determine or alter participants' responses.

Before participation, all respondents were informed about the purpose and procedures of the study, the voluntary nature of participation, and their right to withdraw at any time without consequences. For participants requiring caregiver assistance, the consent procedure was conducted in accordance with applicable ethical requirements, while ensuring that participation remained voluntary and that participants' responses and preferences were respected. The identities and personal information of respondents were kept confidential and were not included in the research database or publications. The data were used solely for research purposes and reported in aggregate form. Before the main survey, the questionnaire was pilot-tested to assess the clarity and comprehensibility of each question. The survey was conducted from March to April 2026.

According to data from Statistics Indonesia (BPS) in 2024, the population of elderly residents in Surakarta City reached 78,800 individuals. The study involved 100 respondents, with the minimum sample size determined using the Slovin formula with a 10% margin of error. A sample size of 100 respondents was considered a practical minimum based on practical considerations. This is acknowledged as one of the study's limitations. This study used a stratified proportional random sampling technique, as presented in Table 1. The study employed a proportional allocation approach to distribute the 100 respondents across sub-districts in Surakarta City, as presented in Table 1. Respondents were selected from the allocated areas based on the available eligible older-adult population. This distribution was intended to ensure geographical coverage across the study area. However, because only one respondent represented some sub-districts, the spatial distribution should be interpreted as nominal geographical coverage rather than as statistically representative estimates at the sub-district level.

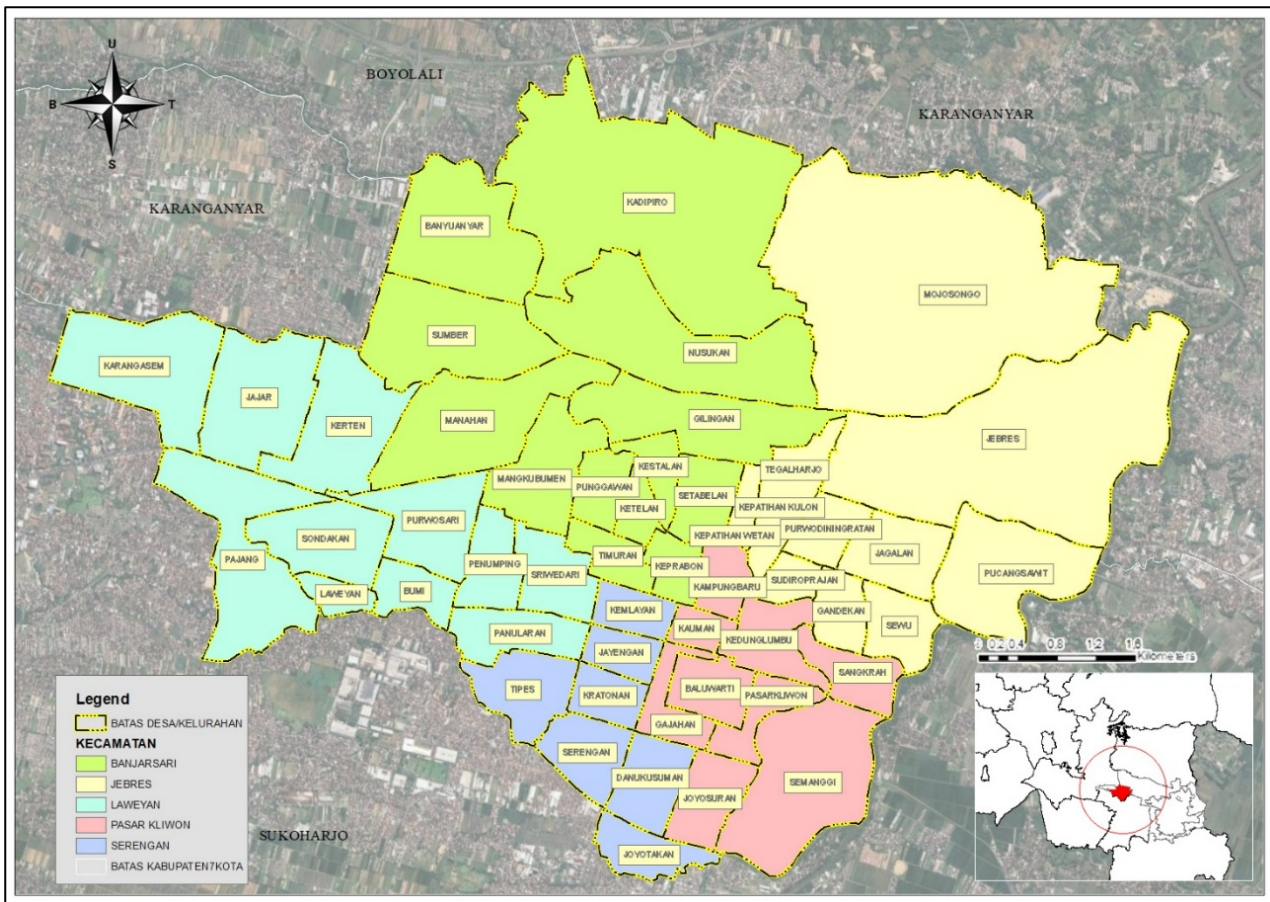


Figure1. Research Location Map

The analytical techniques used in this study consisted of descriptive and inferential statistical analyses. This analysis was conducted by presenting frequency distributions and percentages through graphs and diagrams for each research variable. Furthermore, inferential statistical analyses using the Chi-Square and Spearman Rank correlation tests were conducted to identify factors associated with the level of public transportation utilization by elderly residents in Surakarta City. Before the main data collection, the questionnaire was pilot-tested to assess the clarity, comprehensibility, and appropriateness of the questions. The pilot test involved 30 respondents who met the main study's eligibility criteria. The variables examined in this study were measured using single-item questions, with each question representing one observed variable.

Therefore, Cronbach's alpha and corrected item-total correlation were not applied, as these procedures are designed primarily to assess the internal consistency of multi-item constructs. Instead, the questionnaire's content validity was assessed based on the relevance and clarity of each question in representing the intended variable. The pilot test was also used to identify ambiguous or difficult-to-understand questions, and necessary revisions were made before the main survey. In addition, Cramér's V analysis was applied to determine the strength of the associations between factors related to the level of public transportation utilization among older people in Surakarta City. The magnitude of association was interpreted based on Cohen's effect-size thresholds, where values of approximately 0.10, 0.30, and 0.50 indicate small, medium, and large associations, respectively. The interpretation was made in conjunction with the degrees of freedom (df) and the dimensions of each contingency table. In this study, the term public transportation' refers to Batik Solo Trans (BST) services and other conventional public transportation modes available in Surakarta City.

Table 1. Distribution of Research Samples at the Sub-district Level

Sub-district	Number of Population by Age				Total Elderly Population	Number of Samples
	60–64	65–69	70–74	>75		
Laweyan District						
1) Penumping	221	173	110	107	611	1
2) Laweyan	98	81	63	66	308	1
3) Karangasem	540	393	268	203	1404	2
4) Jajar	511	394	235	211	1351	2
5) Pajang	1270	964	612	507	3353	4
6) Kerten	483	337	209	250	1279	2
7) Purwosari	556	378	268	251	1453	2
8) Sondakan	626	486	324	253	1689	2
9) Sriwedari	209	151	108	115	583	1
10) Bumi	332	244	141	135	852	1
11) Panularan	478	371	238	217	1304	2
Serengan District						
1) Serengan	581	424	311	279	1595	2
2) Kemlayan	192	158	102	126	578	1
3) Tipes	614	469	296	258	1637	2
4) Danukusuman	529	407	304	250	1490	2
5) Joyotakan	399	250	173	122	944	1
6) Kratonan	334	222	163	111	830	1
7) Jayengan	199	171	124	133	627	1
Pasar Kliwon District						
1) Kampung Baru	156	135	80	84	455	1
2) Mojo	618	471	260	214	1563	2
3) Gajahan	200	194	140	147	681	1
4) Semanggi	1034	824	502	469	2829	4
5) Kedung Lumbu	239	221	170	131	761	1
6) Kauman	158	112	66	72	408	1
7) Baluwarti	329	265	166	154	914	1
8) Pasar Kliwon	290	221	156	153	820	1
9) Joyosuran	531	433	288	224	1476	2
10) Sangkrah	593	457	294	223	1567	2
Jebres District						
1). Tegalharjo	287	257	140	166	850	1
2) Jagalan	651	461	351	273	1736	2
3) Gandekan	491	381	237	232	1341	2
4) Jebres	1701	1294	790	666	4451	6
5) Sewu	340	302	201	150	993	1
6) Kepatihan Kulon	133	108	88	99	428	1
7) Pucangsawit	691	523	347	249	1810	2
8) Mojosongo	2661	2045	1206	897	6809	8
9) Purwodiningratan	260	216	159	157	792	1
10) Kepatihan Wetan	148	115	95	103	461	1

Sub-district	Number of Population by Age				Total Elderly Population	Number of Samples
	60–64	65–69	70–74	>75		
11) Sudiroprajan	219	176	148	158	701	1
Banjarsari District						
1) Punggawan	246	187	127	124	684	1
2) Timuran	178	243	240	216	877	1
3) Gilingan	974	854	475	453	2756	3
4) Keprabon	196	126	87	102	511	1
5) Sumber	988	678	434	423	2523	3
6) Kadipiro	1223	854	484	524	3085	4
7) Joglo	663	481	295	234	1673	2
8) Mangkubumen	527	420	268	286	1501	2
9) Ketelan	195	143	83	75	496	1
10) Setabelan	240	170	117	139	666	1
11) Manahan	604	434	300	287	1625	2
12) Nusukan	1534	1212	758	720	4224	5
13) Kestalan	134	105	92	105	436	1
14) Banjarsari	946	630	342	225	2143	3
15) Banyuanyar	768	525	321	252	1866	2
Total					78800	100

3. Result and Discussion

3.1 Respondent Characteristics of Elderly in Surakarta City

Based on the characteristics presented in Table 2, the respondents in this study were predominantly young older adults aged 60-69 years, representing 66% of the total respondents. This dominance of the young elderly category indicates that most respondents generally still have relatively good mobility and independence in their activities, making them relevant to this study. In this context, this elderly group tends to have high travel potential to meet their social, economic, and daily activity needs. Based on gender characteristics, Table 2 indicates that male older adults were predominant (65%), compared to female older adults (35%). This indicates variations in mobility patterns based on individual characteristics, which may be associated with differences in public transportation utilization. In this context, male older adults may have more experience with independent travel and outdoor activities. In comparison, female older adults may rely more on family support or assistance for travel in certain situations.

Furthermore, in terms of employment status, respondent characteristics show balanced figures, with 50% still actively working and 50% no longer working. The relatively large proportion of older adults who remain economically active supports the relevance of this study, as this group continues to engage in productive activities that require regular mobility. Among the 50 respondents who were still employed, the largest occupational groups were laborers/casual workers (42.0%) and traders (38.0%), followed by pedicab drivers (6.0%), private-sector employees (4.0%), craftsmen (4.0%), tailors (4.0%), and religious leaders (2.0%). These occupational characteristics indicate that older adults' mobility needs in Surakarta are not limited to social and recreational activities but also include travel related to economic and livelihood activities. Therefore, affordable, accessible, and reliable public transportation is particularly important for supporting the mobility needs of older adults who remain economically active.

Table 2 also shows that the majority have resided in Surakarta City for more than 10 years, while only 5% have resided for 5–10 years. This finding indicates that most respondents are native residents of Surakarta City and have a high level of attachment to the Surakarta urban environment. This group is generally familiar with existing transportation services and can therefore provide relevant assessments in the context of this study.

Table 2. Respondent Characteristics of This Research

Respondent Characteristics	Category	Frequency (n)	Percentage (%)
Age	60–69 (years)	66	66,0
	70–79 (years)	25	25,0
	≥80 (years)	9	9,0
	TOTAL	100	100,0
Gender	Male	65	65,0
	Female	35	35,0
	TOTAL		
Employment status	Employed	50	50,0
	Unemployed /retired	50	50,0
	TOTAL	100	100,0
Occupation	Laborer/Casual worker	21	42,0
	Private-sector employee	2	4,0
	Trader	19	38,0
	Craftsman	2	4,0
	Tailor	2	4,0
	Religious Leader	1	2,0
	Pedicab Driver	3	6,0
	TOTAL	50	100,0
Length of Residence in Surakarta	< 5 (years)	0	0,0
	5 – 10 (years)	5	5,0
	> 10 (years)	95	95,0
	TOTAL	100	100,0

3.2 Level of Public Transportation Utilization by the Elderly in Surakarta City

Based on this research, the level of public transportation utilization among older adults in Surakarta City remains relatively low. According to Figure 2, only 8% of respondents frequently use public transportation, while 69% use it occasionally, and 23% stated they never use public transportation. This finding indicates that public transportation has not yet become the primary mode of travel among most older adults.

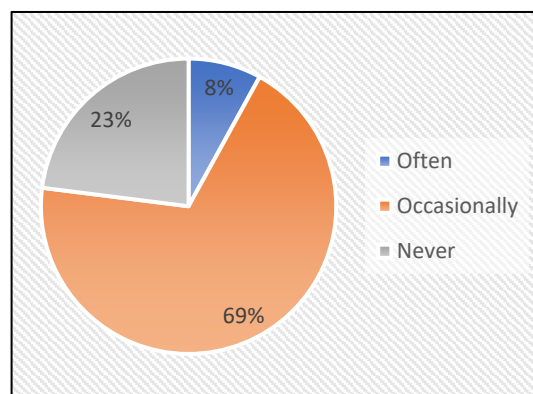


Figure 2. Level of Public Transportation Utilization among Older Adults in Surakarta City.

The low level of public transportation utilization among older people in Surakarta City is also related to the availability of public transportation near their residences. As presented in Figure 3, not all older adults have access to public transportation within their residential areas. Approximately 22% of older adult respondents live in areas where public transportation is not accessible. This condition may be attributed to changes in public transportation routes or the distance between residential areas and public transportation routes. This situation occurs among older people living in the Banjarsari and Joglo areas. Because of the flyover construction, public

transportation routes that previously passed near their residences were modified. Meanwhile, among the 78 respondents (78%) whose residences are accessible to public transportation, only 8 respondents (10.3%) reported using public transportation often for their daily activities.

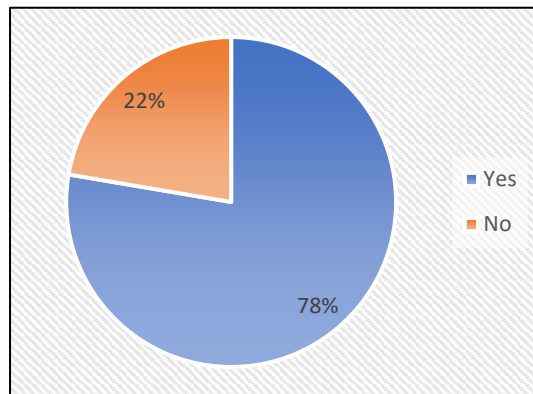


Figure 3. Older Adults' Perceptions Regarding the Availability of Public Transportation in Their Neighborhoods

For travel purposes, as shown in Figure 4, the analysis was based on 100 respondents ($n = 100$), with each respondent selecting only one primary travel purpose. Public transportation use among older adults was predominantly for getting around the city or for recreational activities or traveling around the city (40%), followed by accessing healthcare facilities (26%), visiting family or relatives (11%), and other activities such as visiting places of worship, shopping, and accessing other transportation services. This high level of recreational use indicates that public transportation plays an important role in supporting older adults' quality of life, not only for essential travel. Access to urban spaces allows older adults to reduce the risk of social isolation, maintain social interactions, and continue participating in urban life.

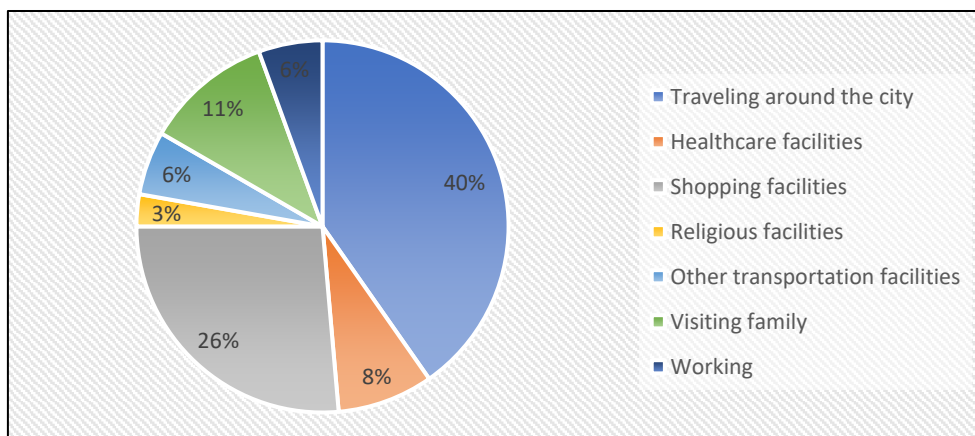


Figure 4. Travel Patterns of Older Adults Using Public Transportation in Surakarta City

Meanwhile, the use of public transportation to access healthcare facilities indicates its role in supporting access to essential services. However, as shown in Figure 3, the proportion of trips to healthcare facilities remains lower than recreational trips. This may reflect the characteristics of healthcare travel, which generally requires greater reliability, comfort, and safety. Older people traveling to healthcare facilities often need more dependable transportation modes because these trips are frequently associated with physical limitations or declining health. In this context, older adults often need assistance to access healthcare facilities.

Beyond usage patterns, barriers to public transportation use also indicate factors that limit older adults' mobility. As shown in Figure 5, the analysis was also based on 100 respondents ($n = 100$), with each respondent identifying one primary reason for not using public transportation. The most common reason is the availability of alternative transportation modes perceived as more convenient (31%), such as online transportation. Other barriers include long waiting times (27%), physical limitations in accessing transportation services (13%), bus

stops located too far from residences (12%), and difficulties with route information and digital payment systems. Many older adults report that the current public transportation system, which requires app-based payment, is difficult for them to use. This is particularly relevant considering that older adults were previously among the main users of public transportation services.

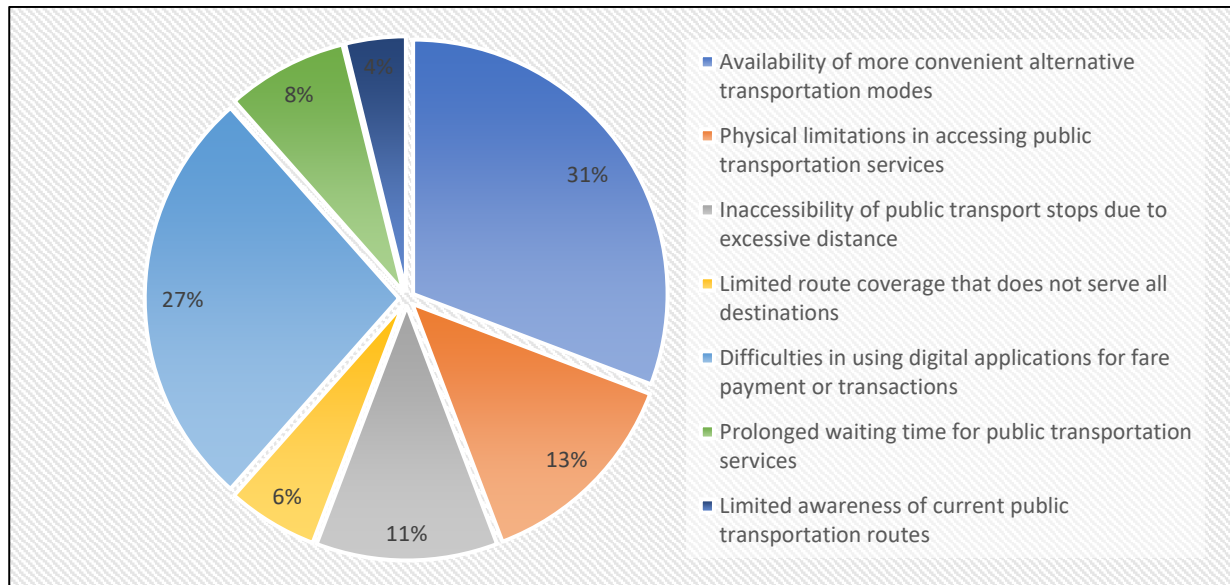


Figure 5. Barriers to Public Transportation Use among Older Adults in Surakarta City

Furthermore, the high level of private vehicle use may also explain the low utilization of public transportation among older adults in Surakarta City. As shown in Figure 6, private vehicles are the dominant mode for accessing basic facilities such as community healthcare centers, hospitals, shopping centers, and green open spaces. For each destination, respondents selected only one transportation mode that they most frequently used. Thus, the analysis was based on $n = 100$ respondents for each destination, with the distribution of transportation modes totaling 100% for each destination. This preference may be related to destination characteristics and travel distance, particularly for healthcare-related trips that require more comfortable, reliable, and safer transportation modes. Therefore, public transportation is considered unable to meet older people's mobility needs optimally, particularly for urgent trips or travel undertaken when experiencing health-related limitations.

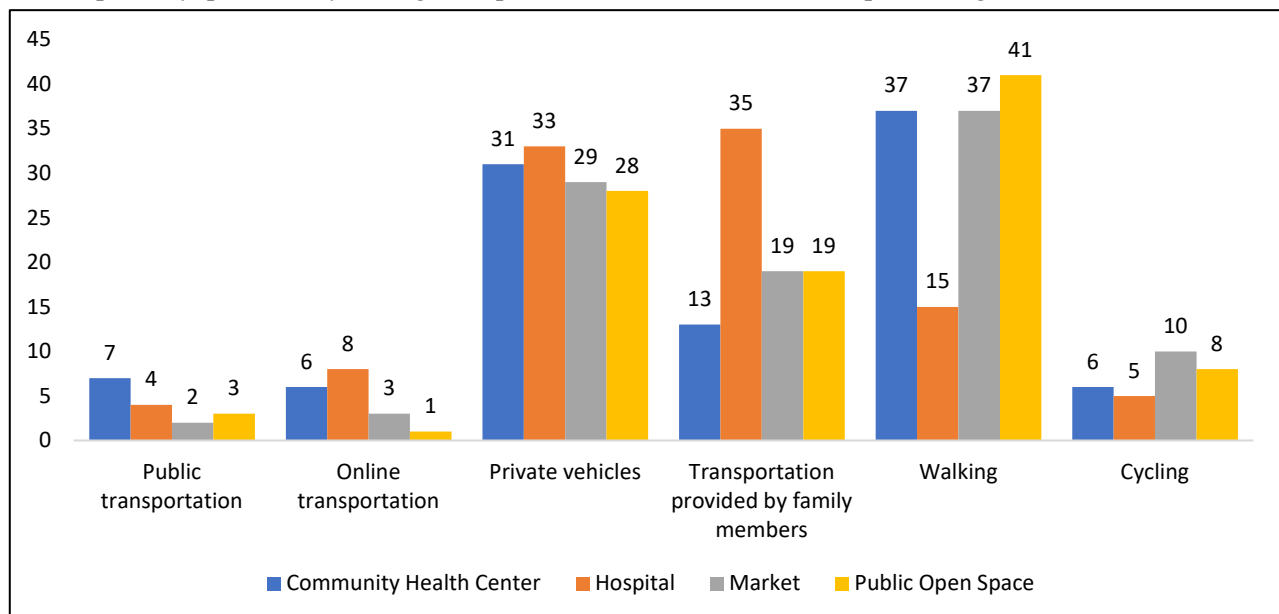


Figure 6. Modes of Transportation Used by the Elderly to Access Healthcare Facilities, Shopping, and Public Open Spaces in Surakarta City

However, the high dependence on private vehicles also presents challenges in achieving inclusive urban mobility. This dependence can increase mobility inequality, especially for older people who do not own private vehicles or lack family support. This group of older adults will be more dependent on public transportation to access basic facilities. In this context, the quality and affordability of transportation services are crucial factors in maintaining mobility independence among older people.

3.3 Factors Associated with Public Transportation Utilization by the Elderly in Surakarta City

Based on statistical tests conducted in this study, several factors were found to be significantly related to the level of public transportation utilization among older people in Surakarta City. These factors include age, health condition, private vehicle ownership, distance to bus stops or other stopping facilities, and waiting time for public transportation. The first factor is age. Age was analyzed as a continuous variable based on the respondents' chronological age in years, without categorization, and was entered directly into the Spearman rank correlation analysis. The Spearman correlation test results, as shown in Table 3, indicate a correlation coefficient of -0.532 with a significance level of 0.000 ($p < 0.05$). This result indicates a significant correlation between age and public transportation utilization among older people. The correlation is negative, meaning that as the elderly age, their public transportation utilization tends to decrease. Conversely, younger elderly tend to use public transportation more frequently.

Table 3. Relationship between Age and Level of Public Transportation Utilization

Variable	Correlation Coefficient (ρ)	Sig. (p-value)	Interpretation
Age – Public Transportation Utilization	-0.532	<0.001	Moderate negative correlation

These findings suggest that declines in physical ability, mobility, and endurance may be associated with aging in older adults. This condition can make it difficult for older adults to access public transportation because they may have difficulty walking long distances to bus stops, boarding vehicles, or waiting for extended periods. These results are consistent with the subsequent factors that also show a significant correlation, as shown in Table 4. This table also shows a moderate correlation between distance to bus stops/terminals and public transportation utilization among older people in Surakarta City. For older people, long distances to bus stops or terminals represent a significant barrier. Greater distances may lead to physical fatigue and increase safety risks when walking in public spaces. In this regard, distance to stops and ease of access are important factors in older adults' decisions to use public transportation, as noted by Ravensbergen et al. (2022). This finding aligns with previous research, which confirmed that inclusive transportation is strongly associated with accessibility (Zhang & Yang, 2024).

Table 4. Relationship between Distance to Stops and Public Transportation Utilization

Variable	X ²	df	p-value	Cramér's V	Result
Distance to stops - Public transportation utilization	22.756	4	<0.001	0.332	Significant with moderate association

Similarly, waiting time also shows a moderate correlation with public transportation utilization among older people in Surakarta City. These results are presented in Table 5. Older adults tend to have a lower tolerance for uncertainty about travel times. Longer waiting times may contribute to negative perceptions of public transportation, reduce comfort, and even pose health risks, especially for older adults with physical disabilities, as revealed in previous research (Wijaya & Putranto, 2022). Therefore, although public transportation services are available, access to bus stops and service reliability remain important factors in whether older adults use public transportation. These two factors are not only technical but also psychological and relate to older adults' perceptions of public transportation services in Surakarta City. This aligns with previous research explaining that barriers to mobility among older people in developing urban contexts are shaped not only by the availability of transportation modes but also by service-related factors such as uncertain waiting times, which can reduce independent mobility (Ariyanti et al., 2025; Caesarita et al., 2022).

Table 5. Relationship between Waiting Time and Public Transportation Utilization

Variable	X ²	df	p-value	Cramér's V	Result
Waiting Time - Public Transportation Utilization	23.566	4	<0.001	0.338	Significant with moderate association

The next factor is the health condition of older people. Based on the Chi-Square test shown in Table 6, the correlation between health conditions and the level of public transportation utilization among older people is significant. This is indicated by a significance value of 0.000 ($p < 0.05$) and the Cramér's V value of 0.424, which reflects a moderate association. These results suggest that older adults in better health tend to have higher levels of public transportation utilization compared to those with poorer health conditions.

Table 6. Relationship between Health Conditions and Public Transportation Utilization

Variable	X ²	df	p-value	Cramér's V	Result
Health Conditions - Public Transportation Utilization	37.119	4	<0.001	0.424	Significant with moderate association

Good health enables older people to move around more easily and independently. Conversely, older adults with health conditions such as joint pain, chronic diseases, or balance disorders tend to face mobility barriers, resulting in lower public transportation usage. These findings align with the current state of the public transportation system, which is not yet fully age-friendly. These findings support previous research indicating that older individuals' mobility on public transportation is significantly associated with their physical condition (Jaydarifard et al., 2026; Karolemeas et al., 2026).

However, this relationship should not be interpreted as unidirectional. The observed association may also reflect reverse selection and self-selection. Older adults with better health and greater functional ability may be more likely to select public transportation because they are better able to manage the physical demands of using the service. At the same time, greater mobility through public transportation may give older adults opportunities to access social activities, services, and destinations outside the home, potentially supporting continued social participation and an active lifestyle. Thus, the observed relationship between health condition and public transportation utilization may reflect a reciprocal relationship in which health status affects transportation use. At the same time, mobility opportunities may also help maintain activity and social participation. Because this study employs a cross-sectional design, the direction of this relationship cannot be established and should therefore be interpreted as an association rather than a causal effect.

In the context of Surakarta City, these results highlight the need to develop age-friendly transportation systems that account for users' health conditions. This effort can be achieved by providing accessible bus stops, adequate seating facilities, safe pedestrian infrastructure, and assistance services for elderly passengers. This aligns with transportation, a key dimension of an age-friendly city, which supports older adults' independence and social participation. (Chung et al., 2021; WHO, 2007).

The final factor is private vehicle ownership. Statistical tests revealed a statistically significant association between private vehicle ownership and public transportation utilization. Table 7 presents these results. This factor shows the strongest association with public transportation utilization, as indicated by the Cramér's V value of 0.595. Among the factors examined using bivariate analysis, private vehicle ownership showed the largest association with public transportation utilization. However, this result should be interpreted as a bivariate association rather than evidence that private vehicle ownership is an independent determinant of public transportation utilization, as vehicle ownership may also be associated with other individual and household characteristics, such as income, gender, health condition, household support, and employment status.

Table 7. Relationship between Private Vehicle Ownership and Public Transportation Utilization

Variable	X ²	df	p-value	Cramér's V	Result
Private Vehicle Ownership - Public Transportation Utilization	36.472	2	<0.001	0.595	Significant with large association

The strong association observed in the bivariate analysis may reflect differences in mobility options and travel preferences between older adults who own private vehicles and those who do not. Older adults with access to private vehicles may have greater flexibility in choosing travel times, routes, and destinations, as well as greater control over the overall journey. In contrast, those without private vehicles may rely more heavily on public transportation or other available mobility options to meet their daily travel needs. Private vehicle ownership may therefore be associated with the frequency of public transportation use because it provides an alternative mode that offers greater flexibility and convenience for some older adults. This interpretation is consistent with previous research suggesting that older adults' travel mode choices are associated with their perceived independence, comfort preferences, and ability to control their journeys (Sun & Musselwhite, 2025).

4. Conclusion

This study concludes that public transportation utilization among older adults in Surakarta City remains relatively low despite the relatively broad availability of public transportation services. The findings indicate a gap between service availability and actual utilization. Several associated factors were identified, including age, distance to public transportation stops, waiting time, health conditions, and private vehicle ownership. These findings suggest that public transportation availability alone is insufficient to ensure use among older adults, particularly when accessibility, physical conditions, and travel convenience are important considerations. From a practical perspective, improving age-friendly mobility in Surakarta requires policies that address the identified mobility barriers. Priority should be given to improving the accessibility and spatial proximity of public transportation stops, reducing waiting times, and strengthening connections between public transportation services and essential destinations, particularly healthcare facilities. Transportation planning should also consider older adults' mobility limitations and their continued reliance on private vehicles. These measures should complement, rather than expand, the existing public transportation network. This study has several limitations. The 10% margin of error may limit the precision and representativeness of the findings. Although proportional stratified sampling was applied to ensure representation across strata, the relatively limited sample size may still affect the generalizability of the results. In addition, the cross-sectional design limits the ability to establish causal relationships, while the bivariate analytical approach does not account for potential interactions or confounding factors among variables. Therefore, future research should use larger, more representative samples; longitudinal or multivariate approaches; and spatial accessibility analysis to provide stronger, more location-specific evidence to support age-friendly transportation planning.

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6. Conflict of Interest

The authors declare no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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