



DESIGNING ELDER-FRIENDLY PUBLIC TRANSPORT SYSTEMS: A CASE STUDY AT AIA RAILWAY AND METRO STATION

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Abstract

On the one hand, population ageing is growing and is expected to influence many aspects of everyday life including transportation. On the other hand, most public transport systems were designed on the basis of requirements and norms that today seem rather outdated. Consequently, there is a growing need to review and update the design parameters of public transport systems considering the needs of seniors as transport operators should provide safe, convenient, and reliable services to all users. The aim of this paper is to identify behavioural patterns, specific needs and challenges faced by the elderly in transportation hubs. In this purpose, field observations with videographic techniques were conducted at Athens International Airport (AIA) railway and metro station. Special emphasis was given on the ticketing service area and restroom areas. Regarding the ticketing service, a consistent trend of longer service durations for the elderly was observed. This observation is confirmed by a clustering analysis that indicates age to be a major classifier. The elders' cluster has service durations approximately 50% longer than the youngers' cluster. Regarding restroom areas, results indicate that seniors use them more frequently, but the duration of the usage is not substantially different to the one of younger populations. Findings are useful for both researchers and practitioners who can develop evidence-based station design protocols.

Keywords: elderly, gender, public transport, ticketing, modelling

1 Introduction

Ageing phenomenon is dramatically increasing worldwide [1]. Technological achievements, enhancements in well-being, advancements in health science, and fertility rate decline are contributing to accelerated progress in aging rates [2]. According to [3], the median age in the EU-27 is expected to reach 48.2 years, while the centenarians are projected to be half a million by 2050. By the year 2050, the proportion of individuals aged over 65 is projected to be approximately 30%, a notable increase from the current 20%. The transition to an older demographic poses significant challenges across various sectors of societies [4]. Among the various factors that affects, mobility holds a significant position. On one hand, the rise in well-being and the increase in the working-age ratio will influence transportation systems, with a growing number of older individuals anticipated to rely on them. On the other hand, looking ahead to 2050, the older population will have been brought up in progressive countries with reliable and convenient public transport systems, making it their preferred mode of transportation. Therefore, the needs and challenges faced by old people today, need to be addressed, understood, and solved for long-lasting reliable, easier, and safer commutes. Public transport systems have beneficial environmental impacts and are efficiently contributing to traffic congestion reduction and sustainable living.

In that end, societies and public transport authorities are making efforts in order pedestrians turn to public transportation systems for their daily commutes, in terms of their reliability and infrastructure. The American Public Transportation Association [5] reported that 7% of Public Transport passengers are aged 65 and more, while many elders are opting for public transport due to the cost-effectiveness [6]. OECD research on ageing phenomenon influence on the working and retirement plans suggest radical changes on work incentives and opportunities for older people as older inactive people will reach 40% by 2050 [7]. Consequently, the proportions of elders within Public Transport systems will rise and the need to understand the interrelations and peculiarities of older people is emerged. Many researchers have contributed to this by analysing the factors that determine the quality of public transport services perceived by older people [8, 9] and identifying the utilization patterns and how public transport commuting services are related to the physical and mental health of elders [10] and the mobility behaviour of older people [6]. Travel time patterns, influential factors, and accessibility have been also thoroughly studied the recent years. Regarding travel time patterns and influential factors, the in-station travel time and the built environment characteristics, trip and station features are reported [11]. Lastly, the accessibility to public transport stations is a constantly under-study factor in order to identify inequities and evaluate the performance of public transport system [12-14]. Notably, considerations of availability, affordability, and accessibility emerge as fundamental pillars influencing equity, comfort, convenience, independence, well-being, and social inclusion within Public Transport systems. The aging phenomenon is rapidly increasing, presenting numerous challenges across various societal perspectives, as mentioned earlier. Mobility impairment and physical and cognitive limitations are inevitable with the age increase. In the context of Public Transport systems, the impact is twofold. On one hand, the needs and challenges faced by elder require attention to ensure more reliable, safe, and convenient commutes. On the other hand, addressing these needs not only enhances the quality of service for seniors but also contributes to an overall improvement in service for all passengers, which is crucial in terms of crowd dynamics, as it can contribute to a system more resilient to emergencies, ensuring the safety and well-being of everyone. The objective of this paper is to contribute to the abovementioned, focusing on the ticket service and restroom areas. Eleftherios Venizelos Airport metro/railway station was selected to analyse the behaviour of older passengers when utilizing public transport facilities. Differences on their habits, needs, and moving behaviour regarding the overall population are expected to be determined, aiming to minimize the influence of elderly while meeting their needs. The structure of the paper is as follows: (2) Material and Methods, (3) Results, and (4) Discussion and future work.

2 Materials and methods

The measurements were conducted during the period of July 24th to 27th, 2023, focusing on the Airport railway and metro station. This particular station was strategically chosen to assess the ticketing and restroom area zones. The significance of this station lies in its capability to facilitate not only the personnel of the airport or nearby areas but also the tourists arriving and departing from Athens. AIA is the largest international airport in Greece and the 19th busiest airport in Europe (https://en.wikipedia.org/wiki/Athens_International_Airport). Interestingly, in 2022 the passenger traffic flow exceeded 22 million. This station primarily serves tourists, consequently, selecting an unfamiliar station for pedestrians aged 65 years old and over will allow us to assess the effectiveness of the infrastructure and the overall quality of service. The station's passengers flow heterogeneity and extensive facility usage make it an ideal location for thoroughly study to achieve research's objectives. In Figures 1-2 the station's layout is illustrated.

The main hall of this station accommodates coffee and retail shops, 6 physical ticketing offices, 12 automated ticket machines, and 3 entries/exits points to the platforms of suburban railway and metro, as well as access to the main airport parking lot. There are three physical ticketing offices for metro services and three for the railway. Throughout the field observation period, five of these offices were accessible, although not all concurrently served passengers.

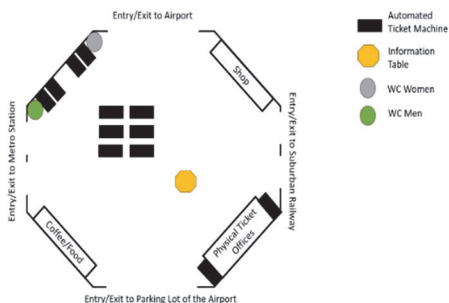


Figure 1 Layout of the main hall of the station



Figure 2 Main hall of the station

To comprehensively understand the impact of elderly individuals on metro station dynamics and identify their specific needs, field observations were employed. This technique ensured a representation of elderly passengers across different times and days. The primary instruments for data collection were a combination of structured observations and field notes. Observations were focused on key areas of passenger interaction, specifically the ticketing area and facilities related to WC usage. The aim was to capture both quantitative metrics and qualitative insights. Field observations were held on July and data collected refer to the time each passenger approached the counters. The procedure included detailed documentation of elderly passengers' behaviours, movements, and interactions within the chosen areas. The measured variables encompassed the frequency and duration of interactions at ticketing counters and WC facilities. Sociodemographic characteristics, such as gender and age group (particularly focusing whether they were elder or not), were recorded, along with observations on whether individuals were walking in groups. Additionally, qualitative aspects, including challenges encountered and assistance requirements, were identified during the observations. Table 1 describes the variables collected within the dataset.

Table 1 Variables collected within dataset

Variable Name	Description	Type	Value
Duration	Service Duration	Continuous	Seconds
DurationMember	Service Duration per passenger	Continuous	Seconds
DurationApproaches	Time required to approach the counter	Continuous	Seconds
Group Members	Number of individuals in a group	Continuous	
Counter	Number of counters	Ordinal	
Elder	Identification of elderly individuals	Binary	0, if yes 1, if no
Gender	Gender	Binary	0, if female 1, if male
Group	If they are walking in a group	Binary	0, if yes 1, if no

3 Results

The service time of each counter was calculated, and the outliers were removed. Group formations significantly increased counter times due to delays incurred during distancing. Consequently, the average duration per member was computed by dividing each passenger's service duration by the number of group members. The total number of passengers is 801, 25% out of which are elder. First preliminary results indicate differences in service times among the elderly population. Passengers under the age of 65 years old had 45% lower service time. The average service duration is 49 seconds while the average service duration for elder populations is 63 seconds (Table 2). This highlights a marked impact of age on service duration.

Table 2 Descriptive statistics of ticketing service

	Service duration [sec]		
	Elder	Non-Elder	Total
Average	63	44	49
Max	368	262	368
Min	3	3	3
Median	47	36	5
1stQ	32	22	3
3rdQ	79	54	15

Data were aggregated into 10-minute intervals to analyze temporal patterns and trends. Figure 1 illustrates the total number of passengers (blue) and elderly individuals (red) who approached the counters. In Figure 2, the mean ticket service duration is presented. Interestingly, elders' presence is significant over the day.

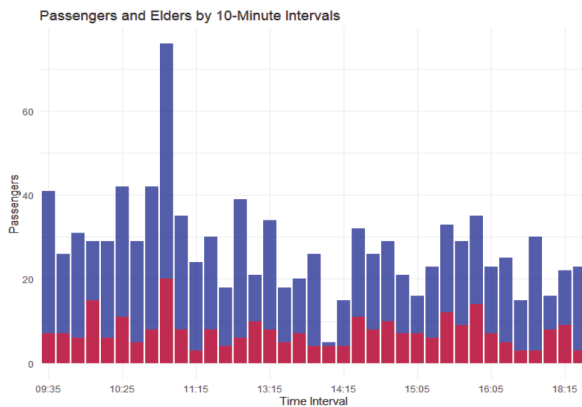


Figure 3 Total (blue) and elder (red) pedestrians flows in ticket service area per 10-min intervals

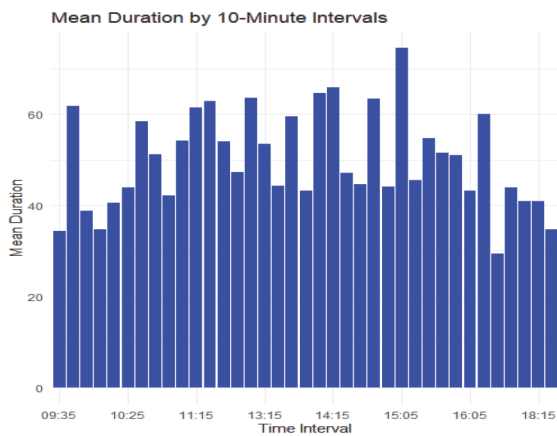


Figure 4 Average ticket service duration in ticket service area per 10-min intervals

A correlation and a clustering analysis were also conducted (Table 3 - Table 4). The correlation between elder parameter and average ticketing service duration was established, emphasizing the crucial role of age in influencing the dynamics of ticket service durations.

Table 3 Clustering analysis results

	Elders	Females	Males	Group	Duration [sec]
Cluster1	28	314	487	371	65.91
Cluster2	171	103	698	79	83.45
Total	199	417	384	450	70.31

Table 4 Correlation Analysis results

	Elder	Group
	Correlation Analysis	
Correlation Coefficient	-0.1886	0.27936
p-value	<0.001	<0.001
Confidence level	[-0.2490, -0.1267]	[0.2198488, 0.3367978]
t-statistic	-5.9317	8.9863
df	801	801

Regarding the restroom area, Figure 3 shows the flows of total and elder passengers over the day. However, there is no significant correlation between the zone utilization and the age group, the presence of elder pedestrians is strong.

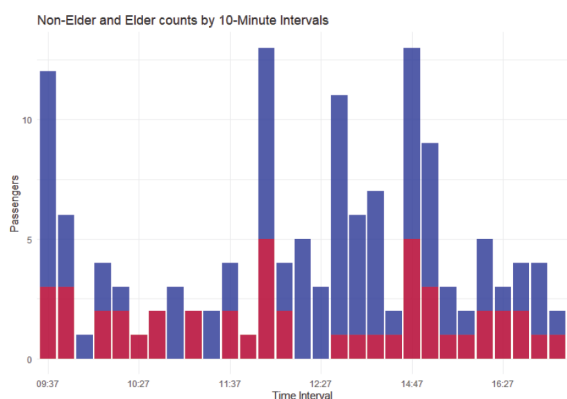


Figure 5 Total (blue) and elder (red) passenger flows in restroom area

4 Discussion and future work

The research conducted is a comprehensive examination of public transport dynamics, particularly focusing on the metro and railway station of Eleftherios Venizelos Airport in Athens, Greece. The study delved into the ticketing and restroom areas considering various factors such as age, gender, group membership, and counter service. The findings showed significant differences between elder and non-elder populations. In the ticketing area, the study uncovered that elder pedestrian experienced prolonged service durations, highlighting potential challenges they face. The correlation and clustering analysis confirmed the intricate relationships between service duration and older populations. In the restroom area, elder populations flow holds a significant proportion during the day, although there is no significant correlation. The abovementioned underscore the necessity for tailored considerations and improvements in service efficiency targeted specifically at elder passengers. Exploring the integration of technology, such as automated ticketing systems with friendly environment for elder populations or smart restroom facilities, may offer innovative solutions to enhance overall efficiency. In the future, it is imperative to examine the platform space and the dynamics of passenger flow to thoroughly understand the diverse needs and challenges encountered during commuting.

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