



Transport Research Arena (TRA) Conference

# Acceptance Evaluation of Automated Logistics Services: Case Study in Rome

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## Abstract

EU member states face significantly higher sustainability awareness regarding safety, environmental and efficient mobility concerns of citizens. The paper aims to assess how to access the acceptance of automated logistics technology that is developed as a case study at the main campus of the Sapienza University of Rome, considering safety and service efficiency questions, willingness to use the service also in an urban environment. To achieve this, a user needs analysis was conducted to determine the target groups, followed by an acceptance questionnaire. The result is that the proposed automated service is expected to be used more by the younger age groups, although older respondents have also expressed an interest and do be accepted by transport sector employees and students. Regression analysis indicates a significant value for acceptance and automated logistics scenarios.

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## 1. Introduction

European Union member states have a significantly increased need for an unbreakable supply chain. It is required to have continuity even during emergency conditions and to respect greener and more efficient freight transportation. Regarding the European Green Deal targets, intelligent and sustainable transportation became a valuable point that is required to be also searched in terms of freight transportation and logistics services. For this objective, automated logistics services would be a problem-solver to reduce environmental impacts with increasing efficiency, service performance, and having more acceptance from citizens, users, and customers. This concept will be defined and tested regarding acceptance level considering safety and efficiency impact areas within a case study application.

On this basis, the case study has been designed to provide a potential implementation for automated vehicles within the concept of Logistics as a Service in an urban area such as at the Sapienza University of Rome's main campus in Rome (Italy). The mentioned case study can support the application of a guideline on automated logistics acceptance questionnaire in terms of its usefulness and effectiveness. The case study was defined as an example of evaluation of

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the automated logistics concept. In addition to that, a possible implementation of this concept has been tested to assess its acceptance by a questionnaire that has been developed using the defined reference guideline (Azarko and Capkin, 2022). Furthermore, this paper targets to emphasize how to proceed with an acceptance evaluation questionnaire for an automated logistics service. This questionnaire is assumed as an assessment tool or method to provide results for a case study execution in Rome. This tool is considering how performance of the concept of Automated Logistics as a Service would be evaluated by respecting relevant acceptance criteria such as user perceptions, safety, and efficiency.

The objective is to address the absence of an acceptance analysis tool for an Automated Logistics as Service by developing a case study and offer comments and recommendations for further research studies (Azarko and Capkin, 2022). The assumptions of study are summarized below:

- Logistics acceptance is directly related to users/customers' acceptance of service preferences.
- Automated Logistics concept covers automated vehicles for freight transport, IT-based tracking, processing with data digitalization.
- Preparation of an acceptance assessment questionnaire is assumed as general-aimed questionnaire concerning only logistics fields.

Based on the results of automated logistics acceptance questionnaire applied within the case study at Sapienza University, the behaviors of applicants (university students, academic staff, and private sector stakeholders) have been analyzed. The case study scenario was implemented to assess safety, efficiency, and overall acceptability in order to develop a strategy for automated logistics scenario characterization and its expected outcomes in further projects.

## 2. Literature Review

While performing a literature search, we faced a serious complication: there are not many studies dedicated to the assessment of automated logistics acceptance of users. There are a lot of studies of automated vehicles focusing on the attitudes from the users' perspective but for passenger transportation, namely privately-owned cars, taxi services, and public transport (Charness et al., 2018, Kyriakidis et al., 2015, Liljamo et al., 2018, Xu et al., 2018, Zhang et al., 2019). This is the reason why this literature study focuses on safety perception, willingness-to-use, and willingness-to-pay because these topics are also proper for automated logistics acceptance assessment (Neubauer and Schauer, 2018).

In terms of logistics, as stated by Bottalico (2021), acceptance by various stakeholders has been widely recognized as an overarching requirement for a successful and responsible introduction of automated road transport logistics.

However, the recent COVID-19 pandemic has accelerated the application of logistics technologies to some extent, and more consumers have experience in using logistics technologies. Consumer behaviour has a direct impact on the use of logistics service offers. Therefore, to maximize the utility of these innovations in logistics services, understanding consumers' motivations for technologies in logistics is vital (Wang et al., 2021).

Recently, a growing variety of innovative last-mile delivery options have appeared, including buy-online-and-pickup-in-store, smart lockers, auto-delivery robots, and drone delivery. These technological applications allow consumers to actively participate in the logistics process, which improves the logistics efficiency and service standard of logistics (Wang et al., 2019). At present, different logistics technologies have been extensively used in parcel collection. For example, smart lockers have been implemented in many areas, such as in communities, office blocks, supermarkets, and campuses in urban areas. Buy-online-and-pickup-in-store has also been applied by several large retailers. Meanwhile, the robot and drone deliveries are currently in the pilot phase and have not been commercialized (Gasparin et al., 2019).

## 3. Methodology

The purpose of this paper is to implement an acceptance evaluation questionnaire for automated logistics service facilities in the urban area of Rome around the Main Campus of the Sapienza University of Rome. The methodology proposed for this study is composed of following steps. Preceding an acceptance analysis, the target groups are to be determined. Potential customers' needs for goods transfers and their willingness to use such a logistics service should be identified through user needs analysis.

So, as User Needs Analysis is conducted and target user cluster are determined, an automated logistics service scenario is designed. Based on this, an Acceptance Questionnaire is developed and implemented. Then, the acceptance questionnaire responses are statistically analyzed in terms of the correlation and regression to highlight which parameters are more valuable for an automated logistics service to have more integration in society. The statistical analysis is to be done (using IBM SPSS and MS Excel) respecting that acceptance is the dependent variable; and characteristics, scenario specifications, and overall (city-wide) opinions are the independent variables. Correlation analysis is utilized to emphasize associations between acceptance level and quantitative variables. Moreover, it's an approach to measure how acceptance and chosen variables are linked.

#### 4. Case Study: Sapienza University of Rome

Based on the reference project (Azarko and Capkin, TraVision2022), the case study is developed and a recommendation for an acceptance evaluation scenario is provided for further studies. During the Final Project of TraVision2022 Young Researcher Competition namely Surveys of the future's transport concept: a guideline for the questionnaires on the Automated Logistics as a Service concept uptake from a test in Rome by "RomAnKa Group" (Azarko and Capkin, 2022), a guideline for preparation of the questionnaire on logistics automation acceptance was produced. Based on that, this paper aims to test a case study for an acceptance assessment of automated logistics scenario.



Fig. 1. Example of a robot-rider and its route in Sapienza Main Campus

A Case Study Scenario was designed to be located at the Main Campus of the Sapienza University of Rome to offer an automated logistics service - a driverless- automated vehicle (robot rider) - going around the faculty buildings providing goods' flows (such as papers, documents and other bureaucratic folders, food delivery, cleaning materials, and personal goods; see Figure 1). A logistics vehicle (fully automated) operates along a route with predefined stops (with possible modifications of them) to provide the customer with a variety of pick-up/delivery services. This logistics service provides the expected time of delivery and constantly shows the location of the robot rider.

A questionnaire hypothesis has been developed, according to which a fully automated logistics service would be assessed in terms of the acceptance level considering safety and efficiency perspectives. Based on this, and according to determined guideline from the mentioned project (Azarko and Capkin, 2022), the logistics questionnaire has been created and disseminated to target users to collect their characteristics, opinions, and concerns about such service.

Preliminary to the acceptance questionnaire, a user needs analysis was performed to determine the target user groups to assess if their needs can be met by using the automated logistics service. We have defined potential user clusters that are academic staff, students, university technical and administrative staff, and non-academic personnel such as bank employees, Poste Italiane staff, transport sector, etc. The pre-assessment results for user needs and requirements are highlighted in the further chapter (see chapter 5.1).

#### 4.1. Automated Logistics Questionnaire as an acceptance evaluation method

##### 4.1.1. Pre-assessment: User Needs Analysis

As previously noted, the goal of user needs analysis is to identify the target user groups and assess if the demands of those groups can be satisfied by an automated logistics service developed for a case study.

The user needs analysis questionnaire was done face-to-face and in total 28 responses were collected. An assessment of the user needs and requirements is summarized in the following graphs (see Figure 2).

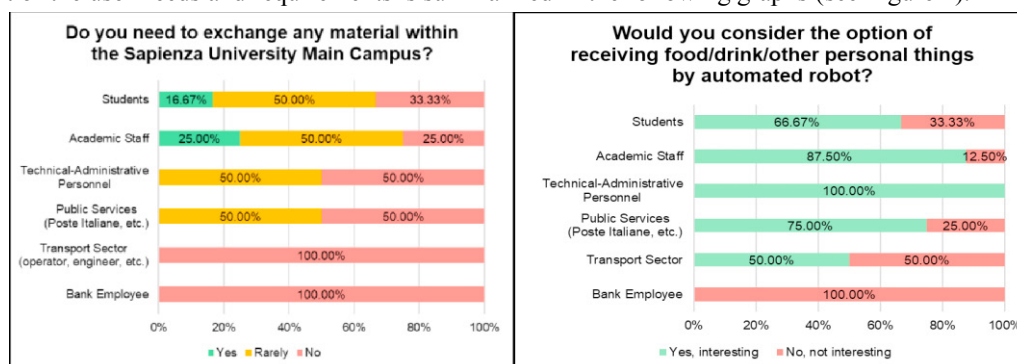


Fig. 2. Age clusters (a) need for material exchange; (b) consideration of new automated logistics option

As can be seen from the results, there is no need for the exchange of documents or other materials for Bank workers (as understood, this is due to the nature of the banks, where any operation requires personal presence and no packages are sent to clients), as well as to the transport sector employees.

In conclusion, the user needs analysis determined the user groups most interested in service, which will be further addressed in the acceptance questionnaire:

- The technical staff of the university has an interest and are in need of such a service (mainly for transportation of cleaning materials);
- The academic staff of the university has an interest and needs to have such a service;
- Students at the university have an interest in such a service.

##### 4.1.2. Preparation and Implementation of a Logistics Questionnaire

In this part, referring to the logistics questionnaire guideline (Azarko and Capkin, 2022), a questionnaire for acceptance assessment of a case study was created and disseminated online. The questionnaire has been prepared in two languages (English and Italian) to reach a wider number of potential users and collect their characteristics. Table 1 summarizes the questions of the implemented automated logistics questionnaire.

Firstly, it is aimed to address the relevant characteristics of participants (age, profession, frequency of attendance the study area), as well as their previous experience with automated logistics and preference to use new automated technology over traditional transportation. Secondly, focusing on the Case Study Scenario, the survey requests respondents to reflect on their opinions of the proposed service (ease-to-use, usefulness, safety concerns, efficiency, and effectiveness), concluding with the overall service acceptance and their perspectives about the use of such an automated logistics service on a city-wide scale.

In accordance with the identified questions, the questionnaire was implemented online by means of e-mailing to potential users of identified target groups: students, academic staff, and technical-administrative personnel.

Table 1. Automated logistics service acceptance questionnaire.

Question groups	Questions
Participants characteristics	<ol style="list-style-type: none"> <li>1. Age group clusters (sub-groups for 18-28; 29-39; 40-49; 50-64; 65-over)</li> <li>2. Profession of applicants (Student, Operator, Industry, Academy, Private Sector, Public Sector)</li> <li>3. Frequency of attendance of activities at university (one time in week, two times in a month, or more)</li> <li>4. Previous experience with automation technology in terms of logistics (yes or no)</li> <li>5. Preference for new technology use in logistics service over traditional transportation (level by 1-5 scale)</li> </ol>
Case Study: Scenario acceptance	<ol style="list-style-type: none"> <li>1. Easy-to-Use and automated technology in logistics (1-5 scale)</li> <li>2. Usefulness (1-5 scale)</li> <li>3. Effectiveness and Efficiency (1-5 scale)</li> <li>4. Safer than traditional logistics methods (1-5 scale)</li> <li>5. Automated Logistics Service will improve the environment (1-5 scale)</li> <li>6. Automated Logistics Service will be favoured by students and university staff (1-5 scale)</li> <li>7. Preference for the new automated logistics service use (1-10 scale)</li> </ol>
Safety concerns	<ol style="list-style-type: none"> <li>1. Trust on safety effectiveness (1-5 scale)</li> <li>2. Feeling safe to send materials (1-5 scale)</li> <li>3. Feeling more secure instead of traditional services (1-5 scale)</li> </ol>
Efficiency perspective	<ol style="list-style-type: none"> <li>1. Easier tracking of deliveries (1-5 scale)</li> <li>2. Processing Time-saving due to automated service availability (1-5 scale)</li> <li>3. Saving time so you do not spend it for delivery/ transfer (1-5 scale)</li> </ol>
Overall automated logistics service acceptance	<ol style="list-style-type: none"> <li>1. Economical acceptance perspectives of the automated logistics service (pay-for-service)</li> <li>2. Determination of the types of bonuses that would encourage and stimulate the customers to choose service instead of traditional services</li> <li>3. Opinion analysis about the defined automated logistics service would be well-accepted in society if that service is available within the whole city</li> <li>4. Customers' perspectives about the use of such an automated logistics service in the city frequently</li> <li>5. Analysis of customers' opinions about any problems or conflicts between traditional transportation and automated one (potentially more accidents, more delays, etc.)</li> </ol>

## 4.2. Results

Starting with the analysis of the first question group, the respondents' age clusters and professions were analyzed regarding case study acceptance (considering safety concerns and efficiency perceptions), willingness to use the automated logistics service and preference to use it over the traditional transportation way (see Figure 3).

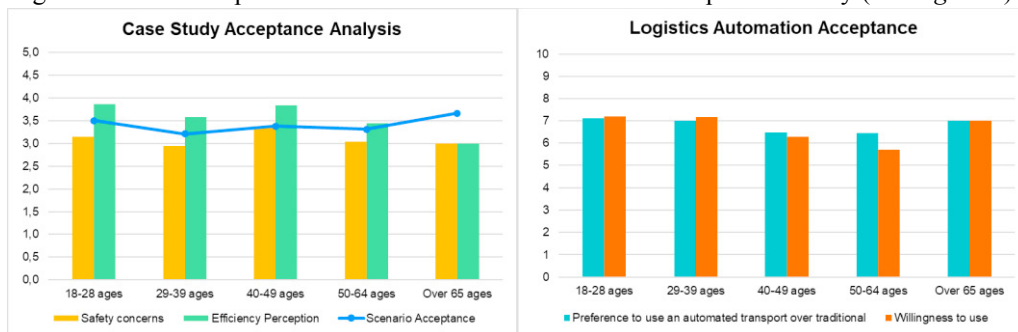


Fig. 3. Age clusters: (a) case study acceptance assessment; (b) automated logistics service acceptance assessment

Generally, all the respondents were quite positive about the safety (with a medium score of more than 3 out of 5). They feel generally safe (that no damage happens to deliveries), secure (no-theft/loss of deliveries) and trust the service (that delivery reaches the destination). Besides, all the respondents were more positive about the efficiency of the proposed automated service delivery, for younger clusters (from 18 to 50 years old) the score is more than 3.5/5, while it is slightly less for elder respondents. The figure shows a medium-high level of acceptance of the case study (around 3.5 out of 5) for all the clusters, which allows us to assume that there is no significant difference between age and acceptance: in general, respondents expect service to be safe, efficient and trustable.

The second graph (Figure 3b) shows a medium-high willingness to use the service, especially for the groups from 18 to 39 years. Surprisingly, the elder respondents have a higher willingness to use the service that middle-aged

respondents. The same trend can be observed for the users' preference to use a delivery robot over transitional transportation. Some of the respondents believe that *"It would be easier to trace the route"*, and *"It has reduced time compared to traditional methods, process automation"*. However, they express several concerns about possible accidents, damages, and thefts.

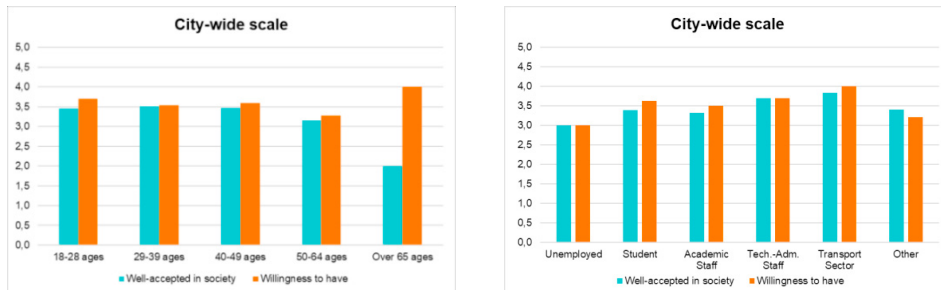


Fig. 4. Automated service implementation on a city-wide scale: (a) age; (b) profession

This preliminary analysis allows us to conclude that the service is expected to be used more by the younger age groups, although elder respondents have also expressed an interest.

After that, the analysis of opinions about possible expansion of an automated service implementation from a case study to an urban concept was performed (see Figure 4a). The younger groups believe that the automated service will be well-accepted in society whilst the elder respondents (50+) were more skeptical about it. However, surprisingly, they express more willingness to have such a service in the city-wide option.

In terms of users' occupation (see Figure 5), users in the transport sector feel more secure and safer about the service. They rate efficiency higher than others, therefore they have the highest level of acceptance of robotic delivery. Technical-administrative, academic staff and students express quite high acceptance as well, rating their safety perception more than 3.0/5 and the expected efficiency of the automated vehicles more than 3.5/5.

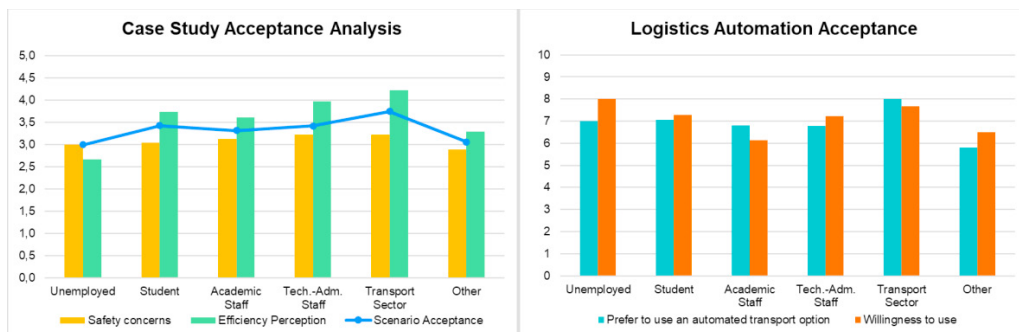


Fig. 5. Occupancy clusters: (a) case study acceptance assessment; (b) automated logistics service acceptance assessment

Likewise, users involved in the transportation prefer more than the other groups to use an automated service over traditional transportation methods. The transport employees and unemployed citizens express the highest willingness to use automated service in general. The main concerns are related to the loss of jobs (reduction of job positions), that the robotic service *"is an extra item that may not work"*, *"the curiosity of the people with this new service (automated) would cause some delays"*, and *"as it is without supervision (no human onboard) there is a risk of damage and vandalism"*. Interestingly, the results have shown that unemployed citizens have a higher willingness to use such a service; however, they do not want to have such a service on city-scale (because of job-loss concerns).

Speaking of a possible expansion of an automated service implementation from a case study to an urban concept (see Figure 4b), as previously, the transport sector is the most positive about the service acceptance on society and express willingness to use. The citizens have several opinions and concerns that are mentioned below:

- robot causes problems for citizens since the roads in the city are narrow;
- such services require "ease-to-use" smartphones and applications; otherwise, is not convenient for all generations;
- less negative environmental impact, improved life quality.

Furthermore, the responses were analyzed using MS Excel and IBM SPSS program for regression between “acceptance” as the dependent variable, and respondents’ characteristics, scenario characteristics, and safety-efficiency impact area as independent variables. The results of statistical analysis of responses are grouped in the following Table 2.

Table 2. Response statistical analysis results.

Clusters	Variables	Coefficients	Standard Error	Stat t	Lower 95%	Higher 95%
Characteristics	Acceptance (dependent)	6,2853	0,6949	9,0448	4,9101	7,6605
	Age	-0,1752	0,1912	-0,9166	-0,5536	0,2031
	Automation Experience	0,7486	0,3576	2,0935	-0,0410	1,4562
	<b>R-Square (characteristics)</b>	0,044177162				
Scenario	Acceptance (dependent)	0,3367	0,7981	0,4219	-1,2442	1,9177
	Easy-to-use	0,2285	0,2459	0,9291	-0,2587	0,7157
	Useful	-0,2684	0,3055	-0,8786	-0,8737	0,3368
	Effective and efficient	-0,1066	0,3150	-0,3383	-0,7306	0,5175
	Safer	0,3679	0,2076	1,7726	-0,0432	0,7791
	Improve environment	0,2004	0,2063	0,9714	-0,2082	0,6090
	Will be favored	0,1685	0,2826	0,5963	-0,3913	0,7283
	Like to use this service	0,5839	0,1073	5,4436	0,3714	0,7963
	Safety - trust the service	0,1905	0,3197	0,5957	-0,4428	0,8238
	Safety - feel safe	-0,3326	0,3377	-0,9850	-1,0015	0,3363
	Safety - more secure	-0,0654	0,2416	-0,2707	-0,5441	0,4132
	Efficiency - easier tracking	-0,1823	0,2416	-0,7545	-0,6607	0,2962
	Efficiency - less process-time	0,3293	0,2881	1,1432	-0,2413	0,8999
	Efficiency - less transfer-time	0,2181	0,2954	0,7384	-0,3670	0,8032
<b>R-Square (scenario)</b>	0,518342928					
Overall	Acceptance (dependent)	1,5089	0,6553	2,3026	0,2121	2,8058
	Well-accepted in society	-0,0603	0,2077	-0,2903	-0,4714	0,3508
	Use in the city frequently	1,5639	0,2100	7,4461	1,1482	1,9795
<b>R-Square (overall)</b>	0,407077698					

The statistical analysis indicates that the coefficients have both positive and negative effects on service acceptance. For example, the analysis of acceptance with independent variables of Characteristics suggests that acceptance would be negatively affected by age (the older is the user, the less acceptance s/he expresses, vice versa); on contrary, it is positively affected by previous automation experience (more experience, more acceptance). Another case is that acceptance would be positively affected when respondents think that service is easy-to-use (more favorable than being against); on contrary, it is negatively affected when respondents have a negative opinion that tracking of proposed robot rider would be easier than tracking the traditional way of delivery (the responses have a negative average that means they have more concerns than feeling safe). For a better explanation, the average of responses for acceptance by society is closer to *the service would be not well-accepted than being accepted*; based on that, the variable has a negative effect on automated logistics acceptance. In conclusion, the results indicate that variables related to safety and security have a slightly negative effect on acceptance (the more people feel safe and secure, the more they tend to accept the service). The results show that respondents tend to accept the service if they trust in such a service. On the contrary, variables related to efficiency have a positive effect: if they think such a service would have less process and transfer time, it increases acceptance. Interestingly, users having concerns about ease-to-track the fully automated logistics vehicle, express a higher acceptance. Surprisingly, the respondents have a willingness to use such service frequently; however, they do not think that society would accept it in city-scale.

In the end, according to the regression statistical analysis, for a cluster of “characteristics and acceptance” regression, with  $R\text{-square}=0.04$ , does not indicate significance. On the contrary, the regression statistics of clusters “scenario and acceptance”, with  $R\text{-square}=0.52$ , and “overall acceptance”, with  $R\text{-square}=0.41$ , indicate the significant regression values.

## 5. Conclusion and Recommendation

The study concludes that the acceptance assessment of automated logistics services is not well represented in the previous studies. The analysis of questionnaire responses shows that respondents generally have a medium-high level



of acceptance of an automated logistics service; however, expressing some significant concerns about the safety and security, wondering about job loss, vandalism and theft risk, and collision-accident risks while operating in the city. Respondents express their willingness to use such an automated logistics service, demonstrating high-efficiency expectations. It has been shown that the differences between age clusters have also an effect on the acceptance level of such a service, in particular younger ages have more interest and expectation for automation in transportation. The same can be said about the users involved in transportation: they expect higher social acceptance and willingness to use automated delivery systems. Interestingly, the unemployed citizens have a higher willingness to use such a service; however, they do not want to have such a service on city-scale (because of job-loss concerns).

In conclusion, surprisingly, the citizens generally have a higher level of trust in automated service and its efficiency; however, they do not feel safe without human on board. In the same succession, such service would have less process work and travel time thanks to automation; nevertheless, the respondents think that tracking the automated logistics vehicle would be not easy. Remarkably, almost all citizen clusters have a higher willingness to use and have mentioned automated logistics services; nonetheless, they do not presume that the society would accept it on a city scale.

After that, regression analysis indicates that acceptance is significantly influenced by characteristics of the case study scenario, age group of users, profession, and their knowledge and previous experience of automated transport.

Regarding the comments of respondents on improving the quality of the automated logistics service, the following points are mentioned: difficulty to apply such service because of poor quality of infrastructure and architectural design problems; potential increase in number of accidents (both for vehicles and pedestrians); exposure risks. On the contrary, it is expected to increase delivery service efficiency and reduce negative environmental impacts.

As a result, the recommendation is to have a roadmap that mentions a preliminary assessment of the users' needs and requirements for guidelines on logistics acceptance assessment. Furthermore, the automated logistics service acceptance depends on safety-security concerns with a marginally negatively dependency (due to the precaution of theft and collision risks), and significantly positively depending on efficiency and sustainability.

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