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Investigating the Public Acceptance of Autonomous Delivery Vehicles in Hungary

The technological advancement of autonomous vehicles has accelerated in recent days: the number of street tests conducted in the daily traffic of cities is increasing dynamically, and so are the numbers of cities involved, participating developers, and tested vehicles. It can also be observed that not only self-driving cars are being tested on the street now; self-driving buses and trucks are also appearing on public roads, and on the pavements a lesser-known type of vehicle can be found, the so-called autonomous city delivery robots. There are several international studies on the social acceptance of self-driving vehicles, but the vast majority of them focus on self-driving cars. We have little information about how the urban population relates to autonomous delivery robots, which travel on the pavement and can come into much more direct contact with residents than their counterparts that travel on the road or in the air. Our study, by means of netnography and questionnaire research, as well as motion picture sentiment research, analyses Hungarian society's attitude towards self-driving transport vehicles.
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1.Introduction

Emerging technologies can have a major impact on the development of cities (Szendi et al., 2022; Gábor, 2022). A dynamically increasing number of autonomous vehicles are present on the streets of more and more cities under the banner of more and more development companies worldwide: in California in 2022, the vehicles travelled 9.2 million kilometers miles, which was 1.6 million kilometers more compared to the base period (2021), in autonomous mode with 28% more test vehicles with a decreasing need for human intervention (DMV, 2023). Nevertheless, making self-driving technology widespread not only requires the maturity of the technology, but also, among others, the acceptance of society (KPMG, 2021).
The results of several social science research studies show how the population relates to self-driving vehicles: the public is characterized by a positive anticipation towards the emergence of self-driving cars; however, this is surrounded by considerable anxiety, concern and uncertainty (Moták et al., 2017; Koul and Eydgahi, 2018; Müller, 2019; Baccarella et al., 2020). Hutchins and Hook (2017) found that the majority of respondents expressed concerns about autonomous vehicles; furthermore, they questioned the safety of the vehicles and viewed the issue of legal and regulatory responsibility with mistrust. Liljamo et al. (2018) and Havlíčková et al. (2019) identified groups with more negative opinions: women, the elderly, inhabitants of rural regions and people having lower levels of education.
An increasing quantity of research results are being presented in social science issues regarding self-driving vehicles in Hungary, as well. Hungarian researchers have studied self-driving cars in terms of moral questions (Miskolczi et al., 2021), legal questions (Ambrus, 2019; Kecskés, 2020), relationship with responsible innovation (Lukovics et al., 2018), effect on government budget and employment (Gyimesi, 2019), effect on lifestyle and economy (Banyár, 2019), relationship with cities (Lados and Tóth, 2019; Smahó, 2021), and social impact and acceptance (Madarász and

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Szikora, 2018; Majó-Petri and Huszár, 2020; Csizmadia, 2021; Páhy, 2021; Kovács and Lukovics, 2022; Nagy et al., 2022; Palatinus et al., 2022; Prónay et al., 2022,; Hőgye-Nagy et al., 2023).
It can be observed that the vast majority of research either addresses the subject of autonomous vehicles in general without vehicle type specification or focuses exclusively on self-driving cars. At the same time, information is scarce on how the public relates to autonomous trucks, buses, drones or small-sized (about 1 meter sqare) autonomous delivery robots. The latter case is special because certain types travel on the pavement, thus they can come into much more direct contact with people than versions travelling in the air or on the road, and therefore, their technology acceptance may differ as well.
Based on the above, our research aims to assess the attitude of the Hungarian population towards autonomous delivery robots and to identify the factors influencing technology acceptance. Due to the specialty of the topic, we followed a multi-stage research design: first we conducted netnography research, which provided a direct picture about the emerging attitudes. Based on this we searched for group-level connections between individual attitudes. It was followed by a questionnaire survey, which aimed to examine the relationship between a person's demographic and lifestyle characteristics and attitudes. The effect of stimuli on acceptance was studied in motion picture sentiment research, where the subjects watched a video about robots in various situations, followed by an interview about the experience material and its effect on their opinion about delivery robots.

2.About the nature and significance of autonomous delivery robots

Before we study the relationship of autonomous delivery robots and society, it is important to look at the environment that triggered the creation of the technology in question and in which it is applied (Pettigrew et al., 2018; Hajdú, 2020; Zhu et al., 2022). Delivery robots work in freight transport, more specifically, in the area of last-mile delivery, which refers to the last stage of the delivery chain, carrying the package to the customer (Boysen et al., 2020).
The question of why this segment needs urgent reforms can be answered if we look at online purchasing habits – the number of packages to be delivered has multiplied over a few years, thereby increasing the volume of the vehicle traffic needed for delivery. This is largely attributed to changed shopping habits due to the COVID pandemic (Lipták, 2022; Lipták and Musinszki, 2022). The emissions generated by the vehicles used for last-mile delivery enormously exceed the allowable value (Figliozzi et al., 2020).

2.1.The explosion of electronic commerce and last-mile freight traffic

Despite the fact that customers are offered increasingly convenient solutions and extending business opportunities affect logistics service providers positively, home delivery involves high social costs due to the growing number of transport vehicles (Kapser –andAbdelrahman, 2020). These negative effects appear both in the quality of life provided by urban regions and in the economic competitiveness of these areas, in addition to the deterioration of general road safety. Overall, current transport practices do not seem to be compatible with this extremely swiftly changing segment (Peppel et al., 2022).
Janebäck and Kristiansson (2019) claim that with the rapid advancement of products and services most sectors enter new territories, whether it is artificial intelligence, digitalization, mobilization, or the redistribution of the market. Logistics is a good example for this, both growing and developing. The swift expansion of electronic commerce forces the stakeholders in the above-mentioned market segment to provide quicker and simpler services in compliance with increasing demands and needs. Accordingly, many pick-up points have been set up in city centres and rural regions, and the network of parcel terminals offering a 24/7 collection option has also expanded. Nevertheless, last-mile delivery is still considered an unresolved issue. As in the case of restructuring the delivery system, both public service and private parties take advantage of the

successful targeting of customers, and in an ideal case, the public and the private sector may establish a cooperation, which could help maximize the benefit from new initiatives, emerging technologies and methods related to mobility and delivery (Caspersen and Navrud, 2021).

2.2.Autonomous delivery robots

The increased demand for just-in-time deliveries is a logistics challenge that service providers still cannot manage in a way that it meets the environmental and economic(al) expectations (Figliozzi et al., 2020). This gap can be filled by autonomous delivery robots, which are electric motor-driven self-driving vehicles able to transport and deliver parcels without the intervention of a human courier (Figliozzi, 2020). Autonomous delivery robots can be categorized into several different types. There are pedestrian-sized robots travelling on pavements, car-like models participating in road traffic and flying drones (Figliozzi ,2020, 2017).

Electric light trucks can already be considered well-established and tested tools when addressing delivery issues (Garus et al. 2022). The main related drawback is a high cost of capital, which is currently an obstacle for delivery companies. This kind of entry barrier may be eliminated by robot-based delivery, where besides lower power consumption, the investment cost is a fraction of the amount needed to invest in larger vehicles, while emissions are also reduced by this scenario. At the same time, robots entail limitations such decreasing the maximum size and weight of parcels and uncertainties in terms of traffic and technology.

Given that delivery robots can only be used for delivering smaller-sized parcels due to their size, Lemardelé and Estrada (2021) studied the idea of a dual delivery system applying both traditional vehicles and robots depending on the size of the parcel. Garus et al. (2022) would also combine the robot-based system with another technology to fully supply the demand, concluding that the system set up together with diesel vans seems efficient. Another possibility alongside robot-based delivery is to establish pick-up points for the parcels which are not compatible with the capacity of robots. A further dual delivery concept is a possible extension of the system of pedestrian delivery robots supported by a carrier van, where the van not only transports the robots, but also participates in parcel delivery, carrying the packages that are too bulky for the robots in the first place (Heimfarth et al., 2022).

Delivery systems via delivery robots can be beneficial for consumers, the owners of delivery companies and the community (Lyon-Hill et al. 2020). Consumers receive faster delivery for their money, business owners can be pleased with increasing sales and customer attainment, and for the society decreasing vehicle traffic, carbon dioxide emissions and greater access to products mean an improvement in the quality of life.

3.Scientific literature background of the social acceptance of autonomous delivery robots

In order to investigate human relation to delivery robots, we need to scrutinize the circumstances of the human-robot encounter and identify the factors affecting our emerging feelings (Venkatesh et al., 2012; Hudik et al., 2022; Dimitropoulos and Panagiotopoulos, 2018; Kovács and Lukovics, 2022). The trust towards a robot depends on, among others, the physical distance between the individual and the vehicle, the level of convenience felt around the robot, and also the amount of prior knowledge and information about it (Matthews et al., 2017). A targeted communication system can be a solution for critical situations, facilitating pedestrian-robot interaction, thereby increasing comfort when encountering robots.

De Groot (2019) outlines three scenarios representing the three grades of the acceptance-rejection scale. Ideally, the attitude is so positive that human cooperation entails physical assistance if the robot needs it. In a less accepting environment, the robot can complete its task, but it may be faced with hostile individuals disturbing its operation. The worst-case scenario assumes total rejection, which makes the operation of the robot impossible and leads to a substantially more negative assessment of the operating company. In reality, a mixed appearance of the above-described

reactions is expected depending on the individual. The optimization of the robot needs to focus on making average attitude favourable.
Caspersen and Navrud (2021) examined the weight of need for sustainability in consumers' attitude compared to other factors. Their findings indicate that there is a group of customers preferring greener modes of transport and therefore willing to accept later delivery.
According to the research of Figliozzi et al. (2020), there is a great difference in the attitude of each customer type towards delivery robots, which indicates that consumers cannot be treated as a homogenous group. If we sought to draw conclusions collectively regarding social acceptance, it would lead to an incorrect interpretation of the obtained results leading to faulty decision making. Age appears to be one of the strongest influencing powers, showing an opposite strong relationship with acceptance. Certain factors only affect certain customer types more strongly, such as the positive relationship between the qualities of their place of residence in terms of shopping facilities and acceptance.
Kapser et al. (2021) defined autonomous delivery robots as a tool in the battle against COVID-19; thus, they attached an even greater value to them, and to pioneering delivery practices in a broader sense. Nevertheless, the study – which investigated the difference between the attitudes of men and women towards delivery robots – did not find markedly developed acceptance patterns. It seems that people know too little about the topic to form an opinion. At the same time, it is exactly a crisis, similar to the pandemic, which may lead to developing a wider-scale societal will towards a new practice offering a solution and finding a receptive environment.
Marsden et al. (2018) found that autonomous delivery robots are considered "environmentally friendly" and "innovative", whereas on the negative side they are considered to be "uncanny", "dangerous" or "not trustworthy".
According to the results of Yuen et al. (2022), attitude shows the largest effect on consumers' intention to use autonomous delivery vehicles, followed by perceived usefulness, perceived susceptibility, perceived severity, perceived ease of use, subjective norm, and perceived behavioural control. Joerss et al. (2016) investigate autonomous delivery robots, but their study is rather descriptive in nature and little emphasis is placed on the acceptance of them.

4.Social judgement of autonomous delivery robots in Hungary

As the next stage of our research, we intended to conduct an empirical survey. We considered it important to learn about the attitudes towards delivery robots based on a large sample (n>100), as well as a more profound examination of the connections and ideas behind the attitudes. We applied multiple methodologies to cover these criteria.

Table 1 Methodologies applied in the empirical research and their aim

Name of methodology	Sample size	Aim of research
Netnography research	320	To identify the attitude types of the local society regarding autonomous delivery robots based on online comments and then to categorise commenters based on attitude
Online questionnaire	131	To study the relationship between demographic and lifestyle characteristics and the level of acceptance, to identify rejecting groups, and to explore other connections related to acceptance
Motion picture sentiment research with interviews	16	To study the effect of visual situational experience material on attitude and to have a deeper understanding of emotions and ideas behind the attitude

Source: own construction

4.1.Netnography research

We conducted netnography research to learn about existing attitudes and to explore their distribution and influencing factors. Netnography is most frequently and most simply defined as online ethnography; in practice it is a methodology relying on data collection from the content of online communication channels (Dörnyei and Mitev 2010).

4.1.1.The methodology of netnography research

In order to conduct the netnography research in line with the aim of the investigation, we needed relevant data in time and space, i.e., recent and Hungarian comments. For this we studied the comments under the writings about delivery robots in domestic media and the posts related to the topic in social media over a timeframe of one year, during the period between 20th October 2021 and 20th October 2022. Finally, the 623 comments forming the basis of the research came from the comment sections of Telex.hu (Tech column) and EMFIE – Innovations of your future pages, based on which 320 people were identified according to gender and attitude.

Reading the comments revealed that several ideas recur; many see the same debatable aspects of the concept of delivery robots. The common ground was the tone, the type (or, at all, existence) of arguments, the source of occasional concerns, the comment, and the intention of the commenter. Thus, these assumptions no longer seemed to be reflecting an individual but rather a communal attitude. The overall picture indicated that we basically examine a heterogeneous set, including markedly outlined subsets with strong internal cohesion. We hereinafter refer to these interconnected attitudes as attitude types.

4.1.2.The results of the netnography research

After studying the comments, we categorised the commenters into five attitude groups. These groups were formed based on the content of the comments, while certain groups were associated with a specific style of expression. The five attitude groups are the following[13]:

1. Problem-raising rejectionists (46.4%)**:** almost half of the commenters, 46.4% of them, can be categorised in this group. They are characterised by objecting to the introduction of delivery robots due to one or more perceived or real negative phenomena or impacts until the problem is unresolved: *"Similar robots have been tested at our place. A part of them were stolen, a part of them were damaged, and the rest couldn't "take the heat". This technology is still in its infancy".*
2. Total rejectionists (28.8%)**:** they totally, without compromises, object to the introduction of delivery robots; the reason for rejection often remains unrevealed, they frequently express their attitude towards the technology without any underlying arguments. In this group it is not uncommon to have emotional outbursts and offensive wording: "*There's no need for such bull[…]!!!! Those who made it up are […]!!!!!!*".
3. Realists (10.0%)**:** these commenters consider both the potential advantages and disadvantages of delivery robots. Their comments are often informative, they can be responses to other comments to confirm, refine, or confute the position they adopt, as well as to highlight the opposite side. They are open to new information and occasionally raise questions: *"Here the pavements are quite wide for them to have enough space. It's funny how they stop where the pavement ends and wait if a car or something comes and if not, they quickly rush across to the other side. Allegedly the energy they use during a delivery is the same energy needed for boiling a cup of water. I think after a while it can totally replace couriers, but they can't travel in every city, just where the pavements are wide".*

[13] We corrected the spelling mistakes in the quotations where necessary and we indicated the commenters' wordings which were formulated in an unprintable style with dots in square brackets.

4. Optimists (8.2%)**:** they support the introduction of delivery robots, they focus on the positive outcomes of the technology or on the problems related to the current delivery system which justify the use of the new technology; they often oppose the arguments of rejectionists, frequently reponding to the comments in an informative way with data or personal conclusions relying on data: *"I've seen quite a few here in England, it's not accident-prone, it's fully equipped with sensors and lights, and they're slow anyway, they travel at a maximum of 5 km/hour, it's a great help for the elderly".*
5. Conspiracy theory believers (6.6%)**:** they emerge from the total rejectionists; they do not hide that their rejecting attitude isnot only about the technology in question but they consider it as a part of a broader system (often world order) unsupported by facts which they envisioned and they reject this system: *"if robots become widespread, they want to introduce basic income in parallel, which will entail the confiscation of private property, it's been planned".*

The results of the attitude test carry various information and the conclusions drawn cover several areas. Unstructured data collection enabled taking account of the individual aspects of the commenters. The most frequently emerging critical point is public safety, the physical safety of the delivery robots, furthermore, many have doubts about transport infrastructure, especially the condition of public roads, for example: "*on these pavements, roads? There is no straight or smooth surface within 2 metres".*
It is implied that if delivery robots arrived in a rejecting environment, it would have adverse effects not only in terms of business. The reactions of the total rejectionist group go far beyond the mere unwillingness to use the robots. There were several commenters who basically used a threatening tone when writing about what would happen if they encountered delivery robots; besides an intention to cause damage to them, some commenters also threatened the developers and policymakers linked to the scheme, for instance: *"Just set up the system...we'll hunt for them…then you.".*
It is important to see that besides the obstruction for obtaining material gain, which is frequently mentioned by problem-raising rejectionists, jeopardizing because of mere hostility without any financial motivations can also pose a serious threat to the delivery robot system. It is also shown that attitude, or at least its development, is not detachable from time. The comments of conspiracy theory believers often associated the introduction of delivery robots with the vaccination against the coronavirus, which obviously could not have been possible three years ago: *"then they can sit confined within four walls waiting for the robot or drone. Meanwhile they can be just tapping their mobile phone, after getting the umpteenth shot. Nice future! Right?"*. Therefore, it is also possible that attitude research conducted in two or three years from now would find a connection between the acceptance of delivery robots and phenomena which we know nothing about at the moment.
Rejecting or partly rejecting groups often related their doubts to factors which do not necessarily refer to real difficulties (e.g., delivering to higher floors is considered an unsolvable task for a robot by many, even though certain types are suitable to climb stairs).

4.2.Questionnaire survey

Our questionnaire survey relied on literature findings, international methodologies, and our netnography results. We studied the relationship between nominal and ordinal measurement level variables in the questionnaire survey, which we carried out via crosstab analysis.

4.2.1.The methodology of the questionnaire survey

The questionnaire, entitled *Social acceptance of autonomous delivery robots in Hungary*, was compiled based on the series of questions used for Kapser's attitude test in Germany in 2019, taking account of the results of the netnography research. The original questions were specifically

restricted to autonomous delivery robots travelling on the pavement, while the present research also focuses on road and drone delivery robots, thus we surveyed the attitudes towards each delivery robot type respectively in the case of the questions related to such situations (typically to traffic situations).

The questionnaire was available online between 27th September and 1st November 2022 in social media. It is to be noted that the questionnaire was available in the form of an advertisement targeted at the entire Hungarian population. The results of the survey are based on the responses given by 131 persons. The demographic composition of the respondents is the following: 61.1% female, 39.9% male. The median of the age of respondents is 25–34 years, its modus is 18–24 years. The largest portion of the subjects, 49.04%, have a university degree or higher qualifications, while 4.58% reported their highest level of education as lower than a secondary school leaving certificate.

4.2.2.The result of the questionnaire survey

Although self-driving technology is becoming less of a novelty for the general public, the segment of delivery robots is a much lesser-known area, whether in terms of the number of scientific publications or the number of economic and public press articles; nevertheless, the majority of respondents (68.70%) had heard about the scheme and 3.1% had already used a delivery robot.

In the framework of testing the relationship of the responses, first we look at the relationship between demographic characteristics and acceptance. Several attitude tests conducted in the topic of autonomous technology have identified excessively rejecting groups (e.g., the elderly, women), however, the observations of the present research did not indicate that the respondents' gender, age, or highest level of education had a significant relationship with their level of information on autonomous delivery robots (gender: χ^2=3.676 and sig=0.055; age: χ^2=2.921 and sig=0.232; level of education: χ^2=2.848 and sig=0.091), their support for the introduction of the technology (gender: χ^2=2.173 and sig=0.337; age: χ^2=4.145 and sig=0.387; level of education: χ^2=0.178 and sig=0.915), and their trust in delivery robots (gender: χ^2=1.657 and sig=0.437; age: χ^2=1.420 and sig=0.841; level of education: χ^2=0.159 and sig=0.924).

Among previous research studies, besides the rejecting groups identified based on demography, we found papers which focused on the lifestyle of the subjects, connecting its characteristics with acceptance (Figliozzi et al., 2020; NMHH, 2019). Relying on this, we looked at whether rejecting groups can be identified based on the responses given to questions surveying lifestyle habits and the responses related to attitude in the first section of the questionnaire.

Of the respondents who use five or fewer mobile applications on a daily basis (including the respondents who do not use any apps) 38.2%, would support the introduction of autonomous delivery robots, while almost the same proportion (36.8%) expressly opposes it. By contrast, more than two-thirds, 69.2% of the respondents using at least six mobile applications on a daily basis would support the availability of robot-based delivery, and only 7.7% oppose the emergence of the technology. This difference can be considered significant with values of χ^2=16.411 and sig=0.000; the daily users of a higher number of mobile applications showed a substantially higher level of support towards delivery robots compared to those who run a lower number of apps on a daily basis. Given the value of C=0.358, the strength of the relationship can be regarded as medium.

There is also a significant relationship between the general openness to technology and the financial sacrifice for a good delivery option. 41.7% of the respondents who claim to be seeking technological novelties believe that a really favourable delivery system would be worth a higher price, while 78.8% of the opponents of tech reforms claim that this alternative would not be valuable for them (χ^2=24.454 and sig=0.000).

In the next step, we compared the attitudes towards delivery robots, i.e., we explored whether there is a significant difference in the relation to a delivery robot depending on whether it is a pavement, road, or drone delivery robot. As the difference between the robot types is primarily

manifested in what form they participate in traffic, the risk assumed about the appearance of each type in traffic is the focus of investigation. For this, we studied the delivery robot types via crosstab analysis and the proportion of the respondents claiming that the appearance of each type in traffic would be risky. The results show that there is a significant relationship (χ^2=16.124; sig=0.003) between the type of the delivery robot and the risk felt about its participation in traffic, and its strength is weak (C=0.145). Road delivery robots are considered to be a potential risk in traffic by the respondents in the highest percentage (66.4%) and they feel the lowest risk regarding drone delivery robots in this respect (44.1%), while pavement robots were considered risky by 55.8%.
Overall, the survey showed that based on demographic characteristics we cannot clearly delineate a group which expresses remarkable rejection or acceptance towards autonomous delivery robots, while in the case of examining daily habits we can define differing acceptance for groups having a certain routine (see the relationship between the number of daily used mobile applications and the level of acceptance). The most important connection which the survey highlighted is the relationship between the type of the delivery robot and the social attitude expressed towards it. We can therefore conclude that delivery robots cannot be treated as a homogenous set when we look at them in connection with acceptance. Thus, we must make a distinction regarding the level of social preparedness depending on whether we study flying or rolling delivery robots and we must take this difference into account when faced with a live testing situation of a specific robot type.

4.3.Motion picture sentiment research with interviews

The motion picture sentiment research may be one of the data collection processes which is the most easily transformable to real aspects, since we showed situations to the participants which were recorded in real life, technically it may as well have happened with them, and such cases can happen in general (Siedlecka and Denson 2019). In the framework of the motion picture sentiment research, a video was designed in which every frame was searched and pieced together based on the international literature. This video was watched by the subjects while they were asked about their experiences, feelings, thoughts, and expectations.

4.3.1.The methodology of the motion picture sentiment research

The video contained several short scenes where delivery robots can be seen in various traffic and functional situations and had to cope with different difficulties. The research aimed to assess how each situation affects the individual's sense of safety when (1) they are travelling as a pedestrian and delivery robots are travelling around them, when (2) they are travelling as a car driver and delivery robots are travelling around them, and when (3) they are waiting for their parcel which is delivered by a delivery robot. As the video progressed, the robots could be seen in increasingly complex situations, they had to cope with their own limitations and challenges posed by the other participants in traffic on an increasingly high level. The presented situations were the following (Figure 1):

1. the delivery robot travels on the street, without other traffic participants and disturbances;
2. a customer opens the load compartment of the robot with a code received in a mobile application and collects their parcel;
3. the delivery robot travels in a busier environment compared to earlier, passers-by come from both directions, the robot reacts to everything properly (e.g., brakes when a cyclist comes from the opposite direction);
4. the delivery robot should go across a pavement section narrowing because of tree roots and gets stuck on the roots;
5. a car hits the delivery robot coming on the pavement;
6. the delivery robot cannot take a turn because of the narrow pavement and a simultaneously close wall and curb, it gets confused and climbs the wall in the end.

Figure 1 Situations shown during the motion picture sentiment research

1. Delivery robot travelling without disturbances

2. Successful delivery

3. Delivery robot in heavier traffic

4. Delivery robot getting stuck

5. Delivery robot having an accident

6. Delivery robot getting confused

Source: own construction

At the end of each scene, the subjects were asked to evaluate their sense of safety in the above-mentioned three roles on a scale of 1 to 10, where 10 refers to the highest degree of safety and 1 indicates the highest level of danger. 16 persons participated in the series of interviews, 10 women and 6 men.

4.3.2.The result of the motion picture sentiment research

Based on the average of the values given throughout the research, the subjects felt most comfortable as a pedestrian (7.79), and the most vulnerable as a car driver (6.01). In contrast, based on the average of the final evaluations at the end of the video material, the respondents' sense of safety is the lowest in the situation of waiting for the parcel (5.00). The average of the final evaluations is lower in the case of all three roles (pedestrian: 7.25; car driver: 5.06; waiting for parcel: 5.00) than the average of the evaluations provided during the entire test (pedestrian:

7.79; car driver: 6.01; waiting for parcel: 6.36). Consequently, the initial, virtually seamless situations build trust, then the increasing degree of difficulties trigger a more critical evaluation in the audience. It is also confirmed by the observation that when expressing with their own words, the interviewees mostly expected a positive outcome from the situations where they were asked about their expectations, thus the fact that the technology was not able to resolve a given difficulty appeared to be disappointing and lead to a decline in the respondents' sense of safety.

When analysing the difference between the average points of the successive scenes in terms of sense of safety, it can be identified which situations influenced and shaped the subjects' feelings to the greatest extent. Unsurprisingly, as a car driver, the collision of the delivery robot and the car resulted in the highest decrease in points, the robots received an evaluation 1.5 points lower on average from a car driver's perspective than one scene earlier. As a person waiting for the parcel, the respondents were unsettled the most by the delivery robot getting stuck on the roots of the tree, meaning a decline of 1.25 points on average in their sense of safety. The participants felt most comfortable in the role of pedestrian, here the greatest effect was exerted by the confused robot featured in the last scene, where the sense of danger increased by 4.4% in the respondents.

Although the traffic incidents reduced the research participants' sense of safety, many of them emphasised that it was the environment and the human element rather than the delivery robots which triggered some concerns about the functionality of the scheme; according to common feedback, it was not the robot and its characteristics that they held responsible for a given inconvenience.

5.Discussion

We aim to link our results to relevant findings of international studies in the related field, presented in Section 3. However, it is important to highlight that a broader comparison is not possible due to the differences in the samples, the method of inquiry, or the differences in the analytical methodologies used. Responsibly and reasonably we only have the opportunity to name the main findings of the studies. Since the questions and variables behind them can differ significantly, the findings are suitable for establishing general context only and not for drawing deep and detailed conclusions.

The phenomena experienced during the preparation of the present paper show that even though little reference is made to autonomous delivery robots in public discourse, the Hungarian population is far from neutral about the topic. At the same time, due to the scarcity of available content, civil discussions may escalate into making assumptions and connections unsupported by facts. The same observations can be found in international studies where participants have not yet encountered autonomous delivery robots in real life, such as in the research conducted by De Groot (2019) or Kasper and Abdelrahman (2020).

In our study, we did not find a statistically significant correlation between the acceptance of autonomous delivery robots and demographic characteristics, which is consistent with the findings of Kasper and Abdelrahman (2020) but contradicts the results of Figliozzi et al. (2020) and Joerss et al. (2016). However, our results regarding the lifestyle of the participants align with the findings of Figliozzi et al. (2020). In line with the results of Kasper and Abdelrahman (2020), we identified a significant relationship between general openness to technology and willingness to make financial sacrifices. Yuen et al. (2022) emphasised the role of perceived usefulness in the acceptance of autonomous delivery robots, which corresponds to our finding that respondents also considered usefulness as a significant factor.

It could be observed that information continuously shaped and refined the attitude towards delivery robots and this could be presented as a positive and negative effect as well. It would be important to establish a credible forum which enabled sharing informative contents by insiders and their consumption by lay people. Technology and transport journals, and the commercial media in general, could play a great role in this area since they have already provided advertising

space for logistics service providers, there is currently no reason why they could not provide information for consumers about deliveries by a delivery robot in the same way. The research subjects' individual unstructured feedback also indicated that when encountering the idea of delivery robots it is less than obvious for a layman what benefits such a development entails and whether it is more than just the current capabilities of technology. It is worth communicating the motivations behind the development of delivery robots as well as the issues of last-mile delivery and urban motor vehicle traffic by utilising marketing opportunities, in the same way that emphasising environmental awareness is already applied by numerous companies in their commercials.

The questions raised by the research subjects cannot necessarily be traced back to the lack of awareness. People who are interested in and really intend to learn about the topic cannot find a considerable amount of information on the planned framework of the Hungarian introduction of delivery robots. Transparent planning would be essential on the part of the transport policymakers, developers and other stakeholders to reduce mistrust, which is established based on insufficient and incorrect information contributed to by the lack of official communication.

The research identified connections regarding social attitude (e.g., differing acceptance of different delivery robot types), although it could not find a relationship between the given variables in several points of the research. It is advised to study the Hungarian public on further (larger) samples to confirm or revise the phenomena recorded in the present paper and their significance. In addition, the present paper only examines the Hungarian environment welcoming the delivery robots in terms of social attitude, while the other environmental aspects influencing the functionality of the concept, such as legislative, economic and infrastructural context are still unexplored. Their investigation is essential to elaborate a well-founded and operational strategy to introduce delivery robots.

6.Conclusions

We approached delivery robots from two directions, through the issues of last-mile delivery and autonomous technology, learning about the crisis of the above segment of logistics which has developed approximately in the last ten years and the solutions autonomous freight vehicles may provide to the existing problems. We find autonomous delivery robots in the cross-section of logistics, service quality, and transport needs. We aimed to prepare a research study which involves data collection with several methodologies and combines the advantages of each procedure by conducting them in their own structures but linking them logically.

In the first stage of the empirical study, we conducted netnography research, where we analysed the online comments in the topic of autonomous delivery robots from the past year. With the help of this method, we identified the common attitude types (optimist, realist, problem-raising rejectionist, total rejectionist, conspiracy-theory believer) and we examined the incidence rate of each type by assigning the commenters to these groups.

Using an online questionnaire, we identified the relationship of demographic and lifestyle characteristics and the attitude towards delivery robots. The result of the survey did not identify rejecting demographic groups, on the other hand, there is a relationship between lifestyle habits or the type of the robot and acceptance.

In the final stage, we carried out motion picture sentiment research, where the research subjects watched a short video featuring delivery robots in various situations and were asked interview questions regarding the experience material in order to facilitate highlighting their deeper feelings and ideas underlying acceptance or rejection. One of the problems that concerns the respondents is the negative influence of the human factor on the operation of delivery robots.

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