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Delivery robots serving last mile B2C: an evaluation of Tallinn residents' incentives behind the usage of delivery robots in 2020 on the basis of Starship Technologies example

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ABSTRAKT

The aim of this research work is to learn Tallinn residents' attitude towards delivery autonomous robots as a way of last mile intracity delivery on the example of Starship Technologies delivery service. Find out whether residents know about the delivery robots service and whether they use the service to order food from the restaurants and groceries from the local supermarkets. The research is also aimed to find out the main reasons behind people using or opposed to that not using autonomous robots delivery services and residents' preferences towards delivery types, whether they prefer delivery by an autonomous robot or by a human courier or any other option.

Online questionnaire has been conducted among Tallinn residents using convenience sampling method in order to gather respondents.

The current study revealed that majority of respondents actively use intracity delivery services. Predominant majority of respondents know about Starship Technologies delivery robots services, however they do not use the service. Study revealed that the main reasons of not using the autonomous robots delivery service are firstly that the service does not work in the area respondents live in and second reason being the undermarketing of the technology. Tallinn residents do not understand the benefits of delivery robots and why they should choose them over other competitors and other delivery types.

Study however revealed that most of the respondents are ready to start using the autonomous robots delivery service if the service would correspond to their main factors of delivery service choice. Study revealed that 2 main factors of respondents' delivery service choice are delivery price and the estimated time it takes to deliver the order.

Results of this study state that residents of Tallinn would actively use Starship Technologies autonomous robots delivery service if the service area would cover the whole city of Tallinn, would have competitive or lower than competitors' pricing and estimated delivery time.
Keywords: autonomous delivery robots, Starship Technologies, intracity delivery, delivery preferences.

INTRODUCTION

Motivation and problem statement

Technology is changing the world in a very rapid pace. A lot of daily routines are being changed by the new products and services that have never existed before. Startups and Tech companies are working hard to come up with solutions that make everyday tasks more simple and quick.

Time is an important asset and nowadays people value time more than ever before. Therefore start-ups and companies try to develop technological solutions that will optimize and automate everyday tasks to make them less time consuming and more convenient, yet affordable.

Going to the supermarket for groceries, going to the restaurant or buying something for your home can be time consuming. Considering that a person has to commute to the shop, park his car at the department store, search for the right store, then search for the right product, stand in a line to buy it and then commute back home. This process can be optimized via online shopping. A person can order goods online and have them delivered to his place by courier. A courier has to pick up the order and deliver it to the client, yet there are different pros and cons in delivering orders by a physical person courier.

That's where the idea of the last mile delivery process automation comes from. Delivery robots can be a quicker, more reliable and affordable way of delivering goods directly from store to the client.

This kind of services already exist and operate in different cities across the world and Tallinn, Estonia is one of them with Starship Technologies delivery robots operating in Mustamäe. But do residents of Tallinn use delivery robots?

Problem statement

It is not clear whether Tallinn residents use delivery robots to order goods. Starship Technologies delivery service operates in Tallinn for a relatively long time, yet no research

on the popularity of this service has been done. The main reasons behind people using or opposed to that not using autonomous robots delivery services are unclear.

The aim of the research

The aim of this research work is to learn Tallinn residents' attitude towards delivery autonomous robots as a way of last mile intracity delivery on the example of Starship Technologies delivery service. Find out whether residents know about the delivery robots service and whether they use the service to order food from the restaurants and groceries from the local supermarkets. The research is also aimed to find out the main reasons behind people using or opposed to that not using autonomous robots delivery services and residents' preferences towards delivery types, whether they prefer delivery by an autonomous robot or by a human courier or any other option.

Research questions

Do residents of Tallinn know about Starship Technologies autonomous robots delivery service?

What motivates current Starship Technologies customers to use this service?

What are the main reasons of people who know about Starship and delivery robots services not to use them?

Why do people who use delivery services by a human courier prefer this option over delivery robots?

Did the customers' delivery habits and preferences change during COVID-19 pandemic and quarantine?

Thesis structure

This thesis paper is divided into the main parts.

Theoretical part introduces delivery robots as a technology and delivery robots as a service.

Second part, methodics and sample describes the methods used in the research. The sample and construction of questionnaire. Author describes the problem and aim of the research in details.

Third part is fully dedicated to the analysis of questionnaires and the conclusion of the research.

1. THEORETICAL PART

1.1 Autonomous delivery robots

Delivery robot is an autonomous robot which is designed to deliver orders from point A to point B autonomously.

"An autonomous robot is a robot that performs behaviors or tasks with a high degree of autonomy (without external influence). Autonomous robotics is usually considered to be a subfield of artificial intelligence, robotics, and information engineering." (Information Engineering Main/Home Page … 2017)

First prototypes of autonomous robots were described and presented by inventor and author David L. Hieserman (David L. Hieserman 1976a, 1979b, 1981c)

"Robotic perception is related to many applications in robotics where sensory data and artificial intelligence/machine learning (AI/ML) techniques are involved. Examples of such applications are object detection, environment representation, scene understanding, human/pedestrian detection, activity recognition, semantic place classification, object modeling, among others." (Cristiano Premebida et al. 2018)

1.2 Starship Technologies

"Starship Technologies is a company developing small self-driving robotic delivery vehicles. The company is headquartered in San Francisco, California, with engineering operations in Tallinn, Estonia. Starship also has offices in London, UK, Germany, Washington, DC and Mountain View, California." (Starship Technologies home page … 2020)

1.2.1 The Self-Driving Delivery Robot

“Starship robots are advanced devices that can carry items within a 4-mile (6km) radius. The robots can detect obstacles, change speed, and stop to cross the streets. If something happens to go wrong, human operators can take over the steering, monitoring the world through the robot's 360 degree cameras. The machines are equipped with microphones and speakers and can talk to humans they meet. They are meant for a suburban environment, rather than busy city streets. Starship robots use similar technology as self-driving cars, but are cheaper to build. Customers will be able to gain access to the vehicles to collect their parcels or groceries through a mobile app. The robots are equipped with GPS tracker and lock to prevent thefts.” (Ivana Kottasova 2015)

(Starship Technologies … 2020)

“Starship delivery platform enables a new era of instant delivery that works around clients schedule at much lower costs comparing to delivery by human couriers.
Parcels, groceries and food are directly delivered from stores, at the time that the customer requests via a mobile app. Once ordered the robots’ entire journey and location can be monitored on a smartphone.” (Starship Technologies home page … 2020)

“Starship’s robots move at pedestrian speed and weigh no more than 100 pounds. They’re inherently safe and can navigate around objects and people.
For security, the cargo bay is mechanically locked throughout the journey and can be opened only by the recipient with their smartphone app. The location of the robots is tracked, so you know exactly the location of your order and receive a notification at the time of arrival.” (Starship Technologies home page … 2020)

“Starship’s small self-driving vehicles with a weight of less than 20 kg are electric-powered and are designed for driving on sidewalks with a speed of maximal 6 km/h, being capable to locally deliver their goods within 15–30 min and within a radius of up to 5 km for a price of under 1 Europer delivery. The robots are able to deliver freight of up to 10 kg for a shipment price which is up to 15 times lower than the normal price for last-mile deliveries in high-salary level economies, which makes the delivery robots interesting for e-commerce applications as well as for food deliveries or postal
services. In practice, Starship delivery robots have been tested already by online food ordering service providers in Tallinn (Wolt), as well as by Domino’s pizza delivery services to use them as personal delivery devices.” (Thomas Hoffmann et al. 2018)

1.3 Delivery robots as way of last mile intracity delivery on Starship Technologies example

“To Starship’s founders, one of the key insights which led them to embrace deliveries was the discovery that up to 50% of total transportation costs are weighted in the last couple of miles. That 95% of the things people order online are sufficiently small that they could, in theory, be transported via a smallish delivery robot.” (Luke Dormehl 2019)

“According to the concept, robots will deliver everything from shopping bags to internet purchases, pizzas and many other things, freeing us from wasting time and energy on such daily chores.” (Toivo Tänavsuu 2017)

“The small service robot has cameras embedded all around it, offering the robot a 360-degree view. The robot can even overcome a variety of obstacles to make its deliveries. It can climb curbs by lifting its wheels one by one until it makes its way up onto the sidewalk. It can also avoid collisions with people and navigate around obstacles. The robot is designed to make short-distance deliveries of small orders, the kinds of jobs that human delivery personnel don’t want.” (Robotics online...2019)

“Starship robot can carry 22 lbs. of food. While it makes a delivery, the robot’s compartment is locked so that no one can steal the food or tamper with it. When the service robot arrives at

the destination, a text message with a link is sent to the client. The recipient clicks the link to unlock the food delivery robot." (Robotics online...2019)

"Starship deliveries has reached a point where Starship's platform allows residents of Tallinn's Mustamäe borough to have robots deliver their groceries from the nearby Kadaka Selver supermarket." (Reet Pärgma 2018)

1.4 Different variations of delivery robots developed and used worldwide

This chapter briefly introduces some variations of delivery robots designed by different companies and used worldwide.

1.4.1 Nuro

"Nuro is a fully autonomous, on-road vehicle designed to transport goods — quickly, safely, and affordably." (Nuro home page 2020)

"The R-1, Nuro's debut vehicle is the height of a sedan but about half as wide, and as long as a Smart car. It navigates using the usual suite of self-driving sensors—cameras, radars, and a spinning lidar unit perched up top. It's fully electric and has two cargo compartments that can be specialized to fit all sorts of things you'd pay money to send whizzing around town: bags of groceries flowers, pizzas." (Alex Davies 2018)

1.4.2 Robomart

Robomart is a company founded in in 2017 by Ali Ahmed, Tigran Shahverdyan and Emad Rahim, serial entrepreneurs with deep domain expertise in on-demand delivery, robotics, and food retailing. Traditionally, to buy groceries you would either physically go to the store or order goods online. Robomart introduces third way to shop — store-hailing. Client can order a robomart vehicle to his/her location. (Robomart Homepage 2020)

"[Autonomous robot's] Interiors come equipped with either a refrigeration or heating system, and Ahmed [Robomart co-founder] says he's talked to wholesalers about equipping separate

trucks to mimic different sections of a grocery aisle — from dairy, to poultry, to meat, to vegetables." (Jonathan Shieber 2018)

"Robomart has a desire for consumers to hail a store. Thus, was born the concept of "store-hailing" which allows consumers to request a mini-mart at the tap of a button. Robomart has built a self-driving store that consumers can hail just by tapping a button. When it arrives, they get to shop, check-out free, right at their doorstep. For decades, consumers had the convenience of their local greengrocer and milkman coming door-to-door, and by leveraging driverless technology, Robomart recreates that level of convenience and accessibility through its all-electric, temperature-controlled stores-on-wheels." (Brittain Lad 2019)

1.5 Coronavirus (COVID-19) pandemic and delivery robots

"Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus. Most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment. Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness. The best way to prevent and slow down transmission is be well informed about the COVID-19 virus, the disease it causes and how it spreads. Protect yourself and others from infection by washing your hands or using an alcohol based rub frequently and not touching your face. The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes, so it's important that you also practice respiratory etiquette (for example, by coughing into a flexed elbow). At this time, there are no specific vaccines or treatments for COVID-19. However, there are many ongoing clinical trials evaluating potential treatments. WHO will continue to provide updated information as soon as clinical findings become available." (World Health Organisation 2020)

"COVID-19 spreads mainly among people who are in close contact (within about 6 feet) for a prolonged period." (Centers for Disease Control and Prevention 2020)

“Social distancing, also called “physical distancing,” means keeping space between yourself and other people outside of your home.” (Centers for Disease Control and Prevention 2020)

Delivery robots are autonomous and therefore can deliver different kinds of orders without close contact between human beings. Autonomous delivery robots can be used to deliver medicine, food, groceries and other vital goods to the ones quarantined at their homes.

“I’ve got a fairly young demographic in my ward, and they love it [Starship Technologies autonomous delivery robots]. There was obviously a burst of use at the beginning, because of the novelty, but already it’s just a part of people’s routines. People are taking seriously the guidance about not going out, so something like the robot deliveries are absolutely ideal, because people can order and obtain something without going out. Particularly as their [Starship Technologies] first relationship was with Tesco and the Co-op.” (Sam Crooks the mayor of Milton Keynes, 2020; Alex Hern 2020)

“We are doing everything we can to keep our customers and employees safe. All of the sanitisation processes around our service have been reviewed by experts and we’re following their guidance on operating procedures to ensure a safe and convenient service for everyone. Without robots, more humans are needed in the supply chain for delivery, and as humans are the key source of transmission – using robots decreases this risk.” (Andy Curtis the head of UK operations at Starship, 2020; Alex Hern 2020)

2. METHODICS AND SAMPLE

The aim of this research work is to learn Tallinn residents' attitude towards delivery autonomous robots as a way of last mile intracity delivery on the example of Starship Technologies delivery service. Find out whether residents know about the delivery robots service and whether they use the service to order food from the restaurants and groceries from the local supermarkets. The research is also aimed to find out the main reasons behind people using or opposed to that not using autonomous robots delivery services and residents' preferences towards delivery types, whether they prefer delivery by an autonomous robot or by a human courier or any other option.

To do the research the questionnaire was conducted. The questionnaire was designed from scratch and conducted online via Google Forms platform.

As Starship Technologies service currently only delivers cooked meals from the restaurants and groceries from supermarkets these types of orders have been put as the main ones and therefore only competitors who deliver the same types of orders were used in this thesis.

2.1 Methods of the research instrument

The questionnaire consists of multiple choice questions and interval scales. The questionnaire was developed and conducted solely in English language.

First off the questionnaire starts with the demographic questions in order to differentiate respondents. The questionnaire is anonymous, so only the age group and the area respondent lives in is asked. Questionnaire then presents the questions about delivery type preferences, introduces respondents to the Starship Technologies delivery service and company's autonomous robot providing written information and a picture of robot and then presents questions concerning respondents views and experience with delivery robots. Questionnaire

also has questions concerning respondents delivery preferences and changes in habits during COVID-19 pandemic and quarantine in Estonia.

Convenience sampling method has been chosen for this research paper as the main way of gathering respondents.

A convenience sample is a type of non-probability sampling method where the sample is taken from a group of people easy to contact or to reach. There are no other criteria to the sampling method except that people be available and willing to participate. (Saunders, M et al. 2012)

This method was chosen mainly because there is no financial needs involved and it is simple and convenient to find respondents. Therefore sample mostly includes people from authors social circle, students of TalTech and citizens of Tallinn who has found the questionnaire in Facebook due to author and other respondents sharing the questionnaire in Facebook social network. The only required condition the respondents must meet was that respondent must live or at least have lived in Tallinn.

2.2 The research instrument

The full questionnaire in English is attached to this research work and may be found in Appendix 1.

2.2.1 Questionnaire structure

The structure of the questionnaire is provided below:

1. Introduction. Before respondents start to fill the questionnaire they are provided with a brief description about the author and the main points of the research paper the questionnaire is conducted for. Introduction also cites the approximate amount of time it will take to fill the questionnaire. Introduction part informs respondents that the questionnaire is anonymous and all the answers and any other information they will provide will only be used as a part of research work and will not be given to any third party organisations or individuals.

2. Demographic questions. The questionnaire is anonymous and therefore only general questions to distinguish demographics are asked. Respondents have to choose their age group and the area of Tallinn they live in. Age groups are divided as follows:
   14 - 17
   18 - 21
   22 - 26
   27 - 31
   32 - 39
   40 - 49
   50+

   During the creation of questionnaire author assumed that because delivery robots use mobile application to make orders and overall are more of a futuristic kind of technology, they are more known and used among the relatively younger people and therefore author divided age groups more precisely to see which age group and which generation has the most interest in delivery robots service.

   The area of Tallinn respondents live in is asked because Starship Technologies delivery service currently operates only in Mustamäe.

3. Questions concerning the usage of delivery services. Whether respondents use delivery services and which ones they prefer. What factors influence respondents decisions of which service to use. Two questions from this part are presented and explained below.
   In the first question respondents are asked to choose the most important factors that influence their decision of what delivery service to use from a multiple choice list of options. Respondents can choose more than 1 option.

   - What are the most important factors you consider when ordering food/groceries online?
     - Delivery price
     - Estimated delivery time (how quick will the order arrive at your place)

- Specific delivery service
- Type of delivery (courier, autonomous robot, food cabinet etc.)
- Other..

Delivery price - the price that client has to pay for the delivery.

Estimated delivery time - how quick will the order arrive at destination place

Specific delivery service - how important is the specific delivery service, do respondents have favourite delivery services that they use?

Type of delivery - how the order is being delivered to the client (courier, autonomous robot, food cabinet etc.)

In the second question respondents are given a list of all the most popular food and groceries delivery services that operate in Tallinn on the time of writing this thesis. Respondents are asked to choose the services they use. Respondents can choose more than one service, respondents can also provide their own answers.

4. Introduction to Starship Technologies delivery service and Starship autonomous robot. A brief description of Starship Technologies and their services with a picture of a Starship autonomous robot. Respondents are given a question whether they were familiar with Starship Technologies services and Starship autonomous robot.

5. Respondents practice and experience with Starship Technologies delivery service. The aim of this part is to learn whether people who know about Starship and autonomous robots deliveries use this service. How often they use it. If they know about the service, yet do not use it, what are their main reasons not to.

6. In this part of the questionnaire author tries to learn what would change the habits of respondents, in order to make them use autonomous delivery robots to order food and groceries. Some questions from this part and explanations why they were added to the questionnaire are below:
    - If Starship would operate in the area of Tallinn respondent lives in, would he or she consider using it?

Respondents have to choose between 2 options whether they would at least try Starship Deliveries services or they would not.

- Yes, I would at least make 1 order
- No, I don't feel the need to try

Starship currently only operates in Mustamäe, so for the people who live in other parts of the city using the service to make orders to their homes becomes impossible. The question is set to determine whether respondents would use the service if it was available in their area or this is not enough for him/her to at least try the service.
Starship has plans to expand the area of Tallinn, so robots robots would serve the whole city of Tallinn.

- What delivery type would you prefer? Considering that the price and delivery time is better for the courier.
  - Delivery by a courier
  - Delivery by autonomous robot
- What delivery type would you prefer? Considering that the price and delivery time is relatively same
  - Delivery by a courier
  - Delivery by autonomous robot
- What delivery type would you prefer? Considering that the price and delivery time is better for the robot.
  - Delivery by a courier
  - Delivery by autonomous robot
- Commentate your answer to the previous 3 questions
  - *Text form*

These questions are set to determine respondents' preferences between physical person courier delivery and an autonomous robot delivery if two of the most important factors, estimated time of delivery and delivery price would be better for the autonomous robot, for the courier or relatively close for both.
Respondents also have an ability to comment on their answer, this will help the author to better determine what is behind the respondents decision.

Second part of the questionnaire is dedicated to the COVID-19 pandemic and quarantine in Estonia. Questions in this part are set to determine whether there were any changes in habits of ordering food and groceries online and changes in delivery preferences.

- Did you use Food delivery services before the COVID-19 Quarantine?
    - Yes, I have used delivery services before the quarantine as well
    - No, I have started using Food delivery services after COVID-19 pandemic
    - I don't use Food Delivery Services at all
- Did you start using delivery services MORE during the COVID-19 Quarantine?
    - Yes, I have started to use delivery services MORE on Quarantine
    - No, I use Food Delivery the same way I used before
- During COVID-19 pandemic less contact and interaction with other people is preferrable. Would you consider using Starship autonomous robot delivery service instead of a courier (person) service?
    - Yes, I would use delivery robots more
    - No, delivery by couriers are just fine

Third part of the questionnaire is designed for respondents who have used Starship. This part is set to determine Starship customers satisfaction. Questionnaire includes questions concerning Starship customers satisfaction with delivery time, delivery price and overall user experience of the service.

3. EMPIRICAL PART

In this part of the thesis author describes and analyzes the results of the conducted questionnaire.

Questionnaire has been conducted online via Google Forms in the period from 13th of April 2020 to 20th of April 2020. Convenience sampling method has been chosen for gathering respondents. More on the sampling method can be found in the paragraph 2.1 Methods of the research instrument.

Detailed questionnaire review can be found in paragraph 2.2.1 and the full questionnaire as it was presented to respondents can be found in Appendix 1.

3.1 Sample characteristics. Demographics

In total there were 67 respondents. All the respondents are current or past citizens of Tallinn. Respondents' gender was not asked.

Most popular age groups were 18 - 21 and 22 - 26 with 49,3% (33 people) and 35,8% (24 people) of total respondents respectively. There were no respondents younger than 18 years old and 1 respondent from the highest 50+ age group.

Data shows that sample mostly consists of the younger generation. Author assumes that younger generation could be more interested in latest technologies and therefore be more aware of delivery robots services.

Groups of all the respondents are shown in a Chart 3.1 below.

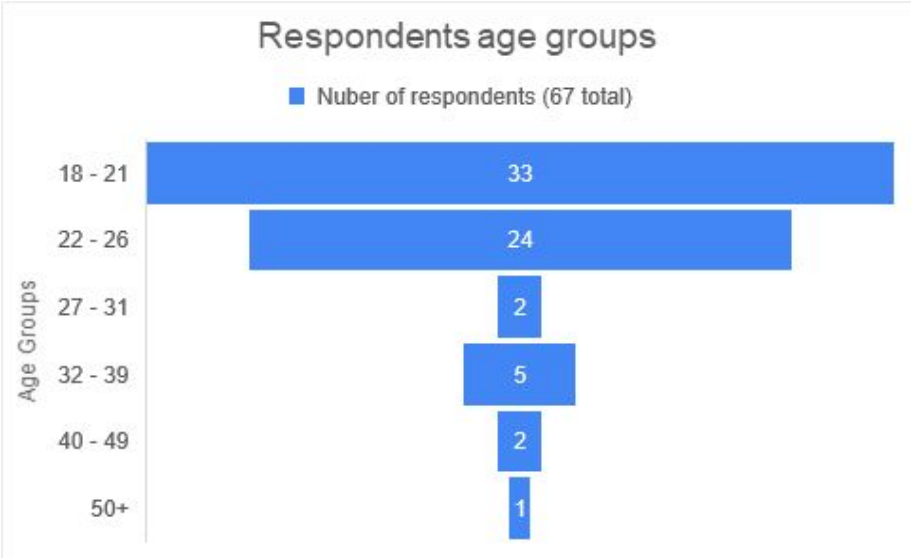

Chart 3.1.1 Respondents age groups.

Area of Tallinn respondents live in is an important factor to be considered in this research work as Starship Technologies delivery service currently only operates in Mustamäe. The largest amount of respondents live in Mustamäe with 26,9% (18) of respondents and in Kesklinn (City Center) with 25,4% (17 people). Third and fourth most popular districts are Kristiine and Lasnamae with 16,4% (11) and 14,9% (10) of respondents respectively.
Chart 3.1.2 shows all the respondents living districts.

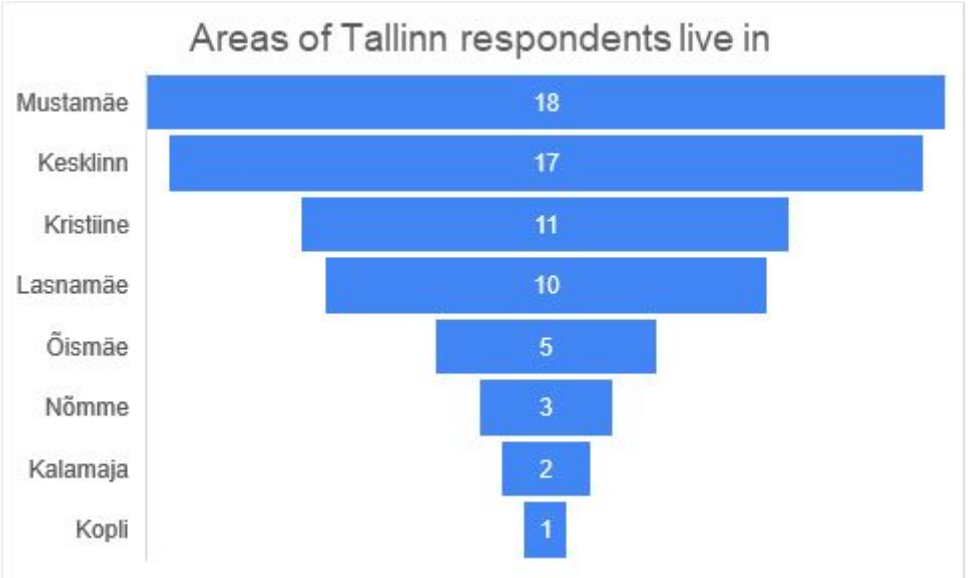

Chart 3.1.2 Areas of Tallinn respondents live in.

3.2 Delivery preferences

This part of the questionnaire contains questions concerning the usage preferences of delivery services. Whether respondents use delivery services and which ones they prefer and what factors influence their decisions.

Almost ¾ of the respondents mentioned that they use delivery services to order food and/or groceries. 73,1% (49) use delivery services and 26,9% (18) do not use delivery services to order food/groceries. Chart 3.2.1 shows the exact percentages.

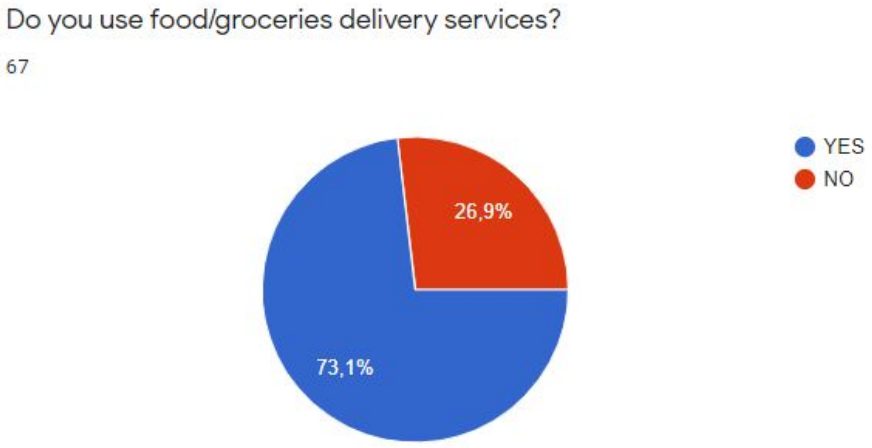

Chart 3.2.1 The amount of respondents using food/groceries delivery services

The following question is set to determine the most important factors that influence respondents' decisions of what delivery service to use when ordering goods with an intracity delivery. Respondents were asked to choose most relevant factors for them from a multiple choice list of different factors. Respondents could choose more than 1 factor. 49 respondents who answered that they use food/groceries delivery services have answered to this question.

Chart 3.2.2 shows that the delivery price and the time needed to deliver the order to their door (ETD) are the most important factors with 89,6% (60) and 92,5% (62) of respondents respectively out of 67 respondents in total mentioning these factors. Results of these question also show that respondents are less dependant on a single specific delivery service, meaning they can use different services depending on the more important factors described above. 35,5 (24) mentioned that specific delivery service is an important factor for them. Type of

delivery, meaning having the order delivered by a courier, an autonomous robot, delivered to an automated food cabinet or any other way is the least important factor from the list with 22,4% (15) of respondents mentioning this factor.

Based on this data author can assume that respondents tend to choose delivery service and a type of delivery based on based on what service and type of delivery at the current moment is the cheapest and/or delivers the order the fastest.

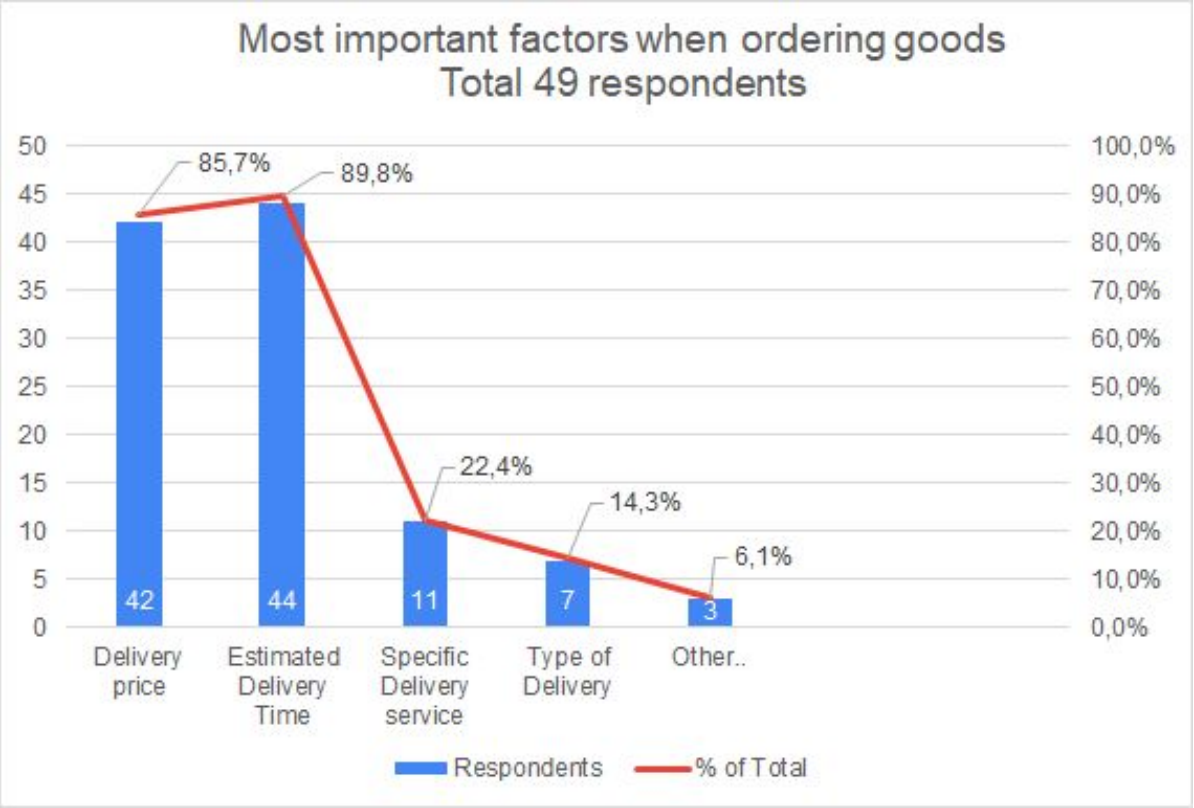

Chart 3.2.2 Respondents' most important factors when ordering goods with an intracity delivery.

In the following question respondents were given a multiple choice list of all the most popular food and groceries delivery services operating in Tallinn at the time of writing this thesis. 49 respondents who answered that they use food/groceries delivery services have answered to this question. Respondents could choose more than 1 service. Results are shown in the Chart 3.2.3

Chart shows that all the platforms provided in the list are used by at least 1 respondent. Wolt and Bolt Food are the most popular food/groceries delivery platforms with 83,7% and 77,6% of respondents respectively using them. e-Selver, Barbora and Coop E-shop are on the second place and used by 16,3%, 14,3% and 12,2% of respondents respectively. Starhip and Carrot.ee are the least popular services with only 8,2% (4 respondents) and 2,0% (1) using their services.

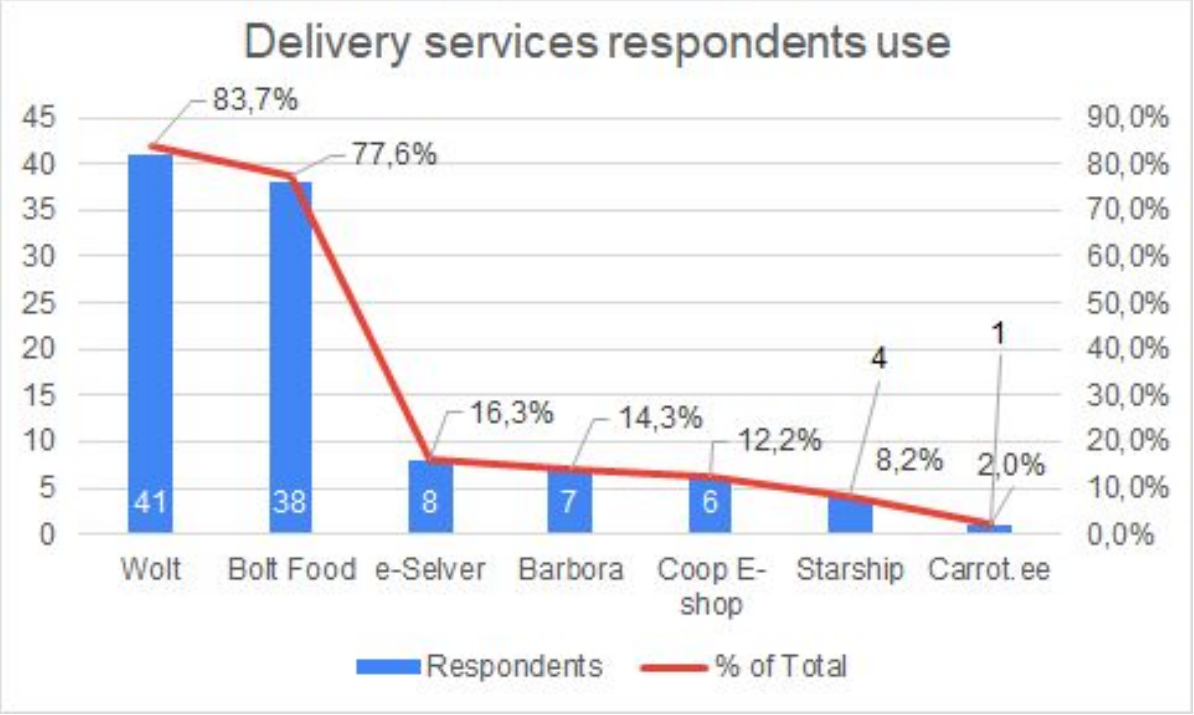

Chart 3.2.3 Delivery services used by the respondents.

At the time of writing this thesis Wolt only delivers cooked meals from restaurants, while Bolt Food delivers groceries from several supermarkets across Tallinn as well as cooked meals from the restaurants. Barbora, Coop e-shop, e-Selver and Carrot.ee solely deliver groceries from the supermarket.

Based on this data author can assume that respondents predominantly prefer ordering cooked meals from restaurants rather than ordering groceries from the shop. And therefore services that deliver cooked food from the restaurants or both cooked food from the restaurants and groceries from the supermarkets are most popular.

3.3 Starship Technologies delivery service. Delivery preferences. Experience with delivery robots

Respondents were given a question whether they were familiar with Starship Technologies delivery services and Starship Technologies autonomous robot. Also respondents were questioned about their practice and experience with Starship Technologies service.

The aim of this part is to learn whether people who know about Starship and autonomous robots deliveries use this service. How often they use it. If they know about the service, however do not use it, what are their main reasons not to.

In the first question of this part respondents were asked if they were familiar with Starship Technologies and Starship autonomous delivery robot. The overwhelming majority 94% (63) of respondents answered, that they are familiar with Starship Technologies and Starship autonomous delivery robot, while only 6% (4) answering that they hear about Starship fo the first time.

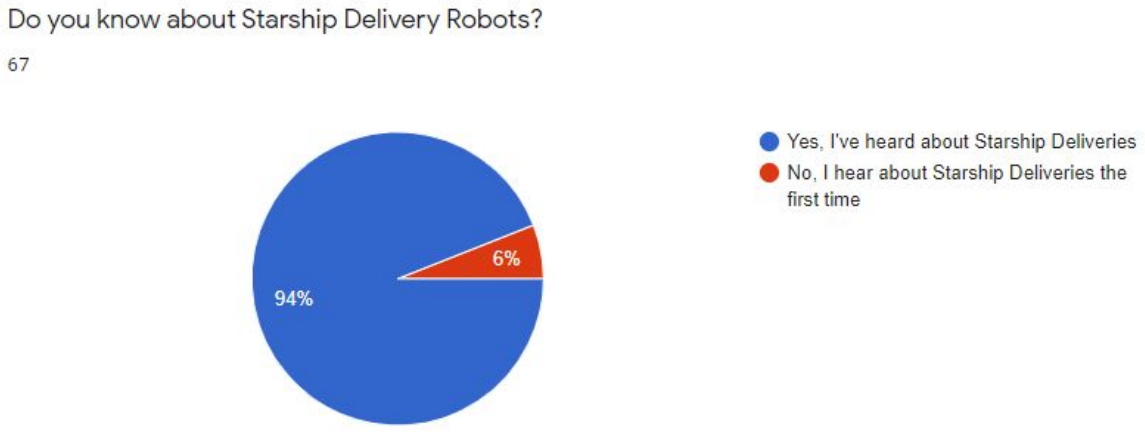

Chart 3.3.1 Respondents' familiarity with Starship Technologies and Starship autonomous delivery robot.

Respondents who have positively answered to the previous question were asked if they have made any orders with Starship and how often they usually do. Chart 3.3.2 shows that the vast majority of respondents, 92,1% (58) have heard about Starship, yet have never done any orders. Second most most popular answer was "Downloaded the app, but didn't make any orders" with 4.8% (3) respondents providing that answer. Only 3,2% (2) respondents have

answered that they have made an order 2-5 times. No one have answered that they use Starship Technologies delivery service on a regular basis.

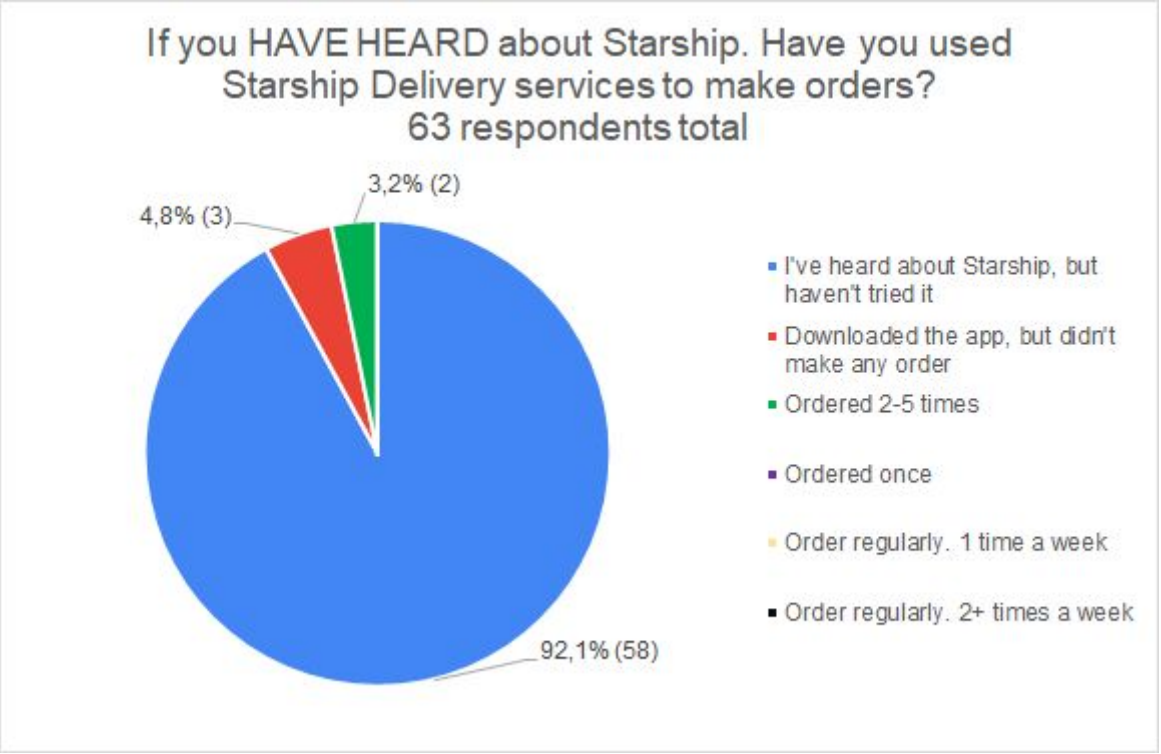

Chart 3.3.2 Starship Technologies delivery service usage by respondent who are familiar with Starship.

Following question is set to know the reasons behind not using the service among respondents who know about Starship Technologies, however they do not use the service. Respondents were given a multiple choice list of all the logical reasons based on author's assumptions, as well as the option of providing their own answer. Respondents could choose more than 1 reason. In total 61 (respondents, who have heard about Starship, but have not used the service + respondents who downloaded Starship Technologies app, but did not make any order) respondent has answered this question.

The results are variative, yet the most popular 2 were " I don't know why. Just haven't tried. I don't feel like I need to" and "It doesn't work in the area I live in." with 68,9% (42) and 37,7% (23) respondents respectively, providing that answer.

Less popular answers including answers that respondents have typed themselves include:

- “I go the shop by my own” - 1 respondent (1,64%)
- “I don’t understand how to use the service” - 3 respondents (4,92%)
- “Delivery usually takes too long” - 4 respondents (6,56%)
- “It’s too expensive” - 1 respondent (1,64%)
- “What's better about them? Wolt/Bolt seems faster.” - 1 respondents (1,64%)
- “I use delivery services for large amounts of goods. These robots are too small. Also, these robots won't bring food to my home door, I would have to go outside.” - 1 respondent (1,64%)

Based on this data author can assume, that one major factor that holds respondents from using Starship Technologies services is limitation to the service area, so anyone living outside the Mustamäe district is not able to use the service. And second is the lack of proper marketing. People do not understand the benefits of Starship Technologies autonomous robots delivery service. They do not understand why they should prefer autonomous robots delivery over other delivery services with human couriers.

Following question is aimed to know how big of a stop factor is the service area limitations. Would respondents consider using the service if it was available in their district.
Chart 3.3.3 shows that 70,1% (47) of respondents would at least make 1 order, meaning they would at least try the service. While only slightly more than a quarter of all the respondents (29,9%, 20 respondents) answered, that they do not feel the need to try the service, even if it would work in the area they live in.

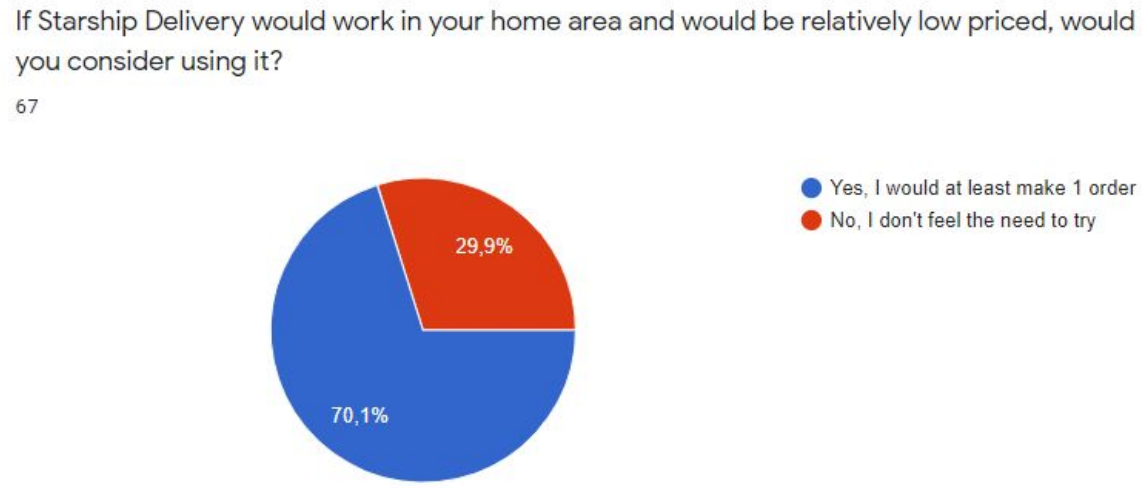

Chart 3.3.3 If Starship would work in the area respondents live in, would they consider using it?

Based on this data author can assume that Starship's limited service area is a weighty stop factor that prevents a major number of potential users from using the service.

Following set of 3 questions is aimed to determine whether respondents choose delivery robots or delivery by a human courier if we change 2 important factors: price and estimated time of delivery.

Firstly respondents were asked to choose between the autonomous robot and human courier if the price for the delivery and ETD (Estimated Time of Delivery) are better for the courier.
Chart 3.3.4 shows that in the case of price being lower and order delivered quicker respondents would primarily choose delivery by a courier. 73% (49) of respondents would choose delivery by a courier and 27% (18) would choose delivery by an autonomous robot.

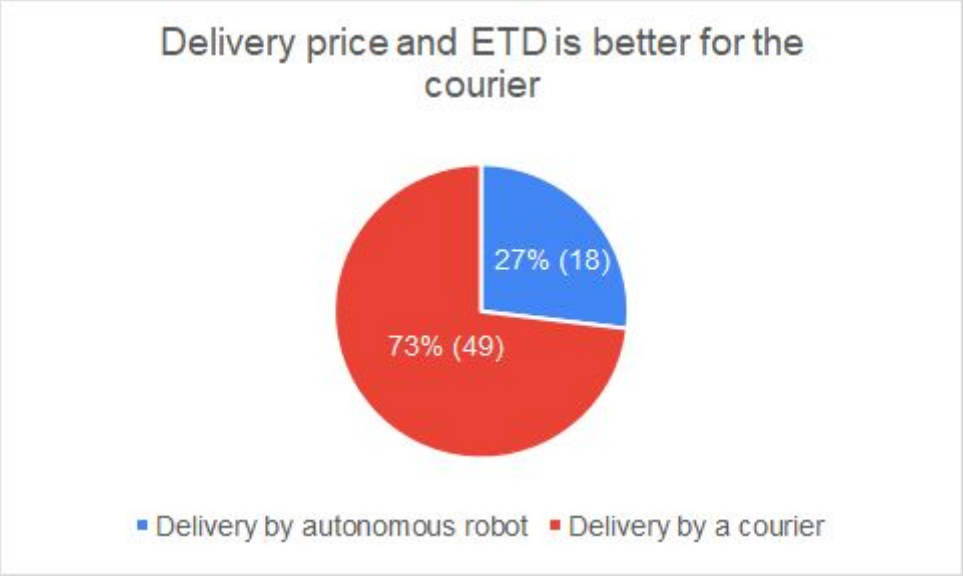

Chart 3.3.4 Delivery price and ETD is better for the courier.

Secondly respondents were asked to choose between the autonomous robot and human courier if the price for the delivery and ETD (Estimated Time of Delivery) are relatively the same. Chart 3.3.5 shows that in the case of relatively the same price for the delivery and ETD respondents would choose delivery by an autonomous robot slightly more often. With 55% (37) of respondents choosing the autonomous robot and 45% (30) of respondents choosing delivery by a human courier.

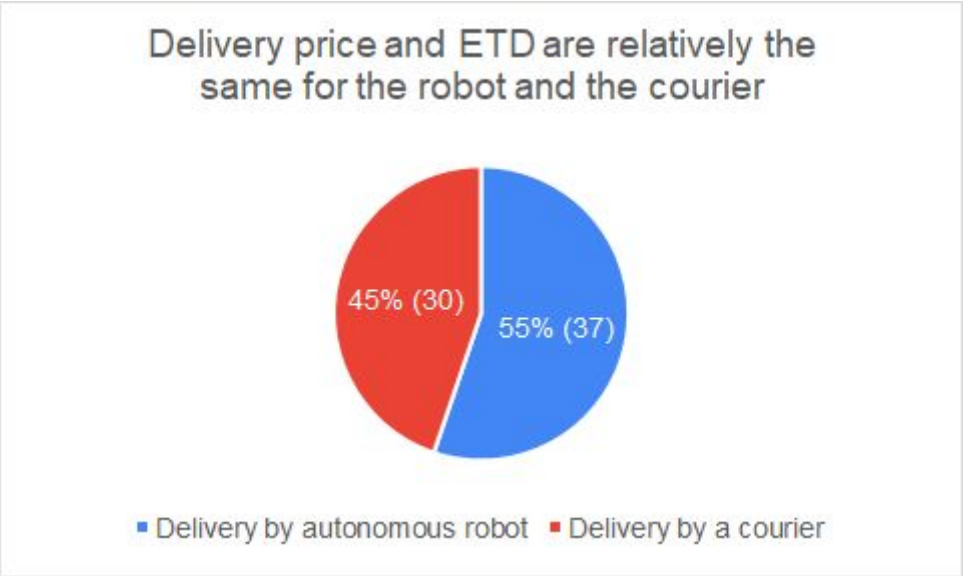

Chart 3.3.5 Delivery price and ETD are the roughly same for boths.

Thirdly respondents were asked to choose between the autonomous robot and human courier if the price for the delivery and ETD (Estimated Time of Delivery) are better for the autonomous robot. Chart 3.3.6 shows that if delivery price and ETD would be better for the autonomous robot a vast majority would prefer it over a physical person courier. 84,4% (57) would prefer autonomous delivery robot, while only 13,6% (9) would prefer delivery by a human courier.

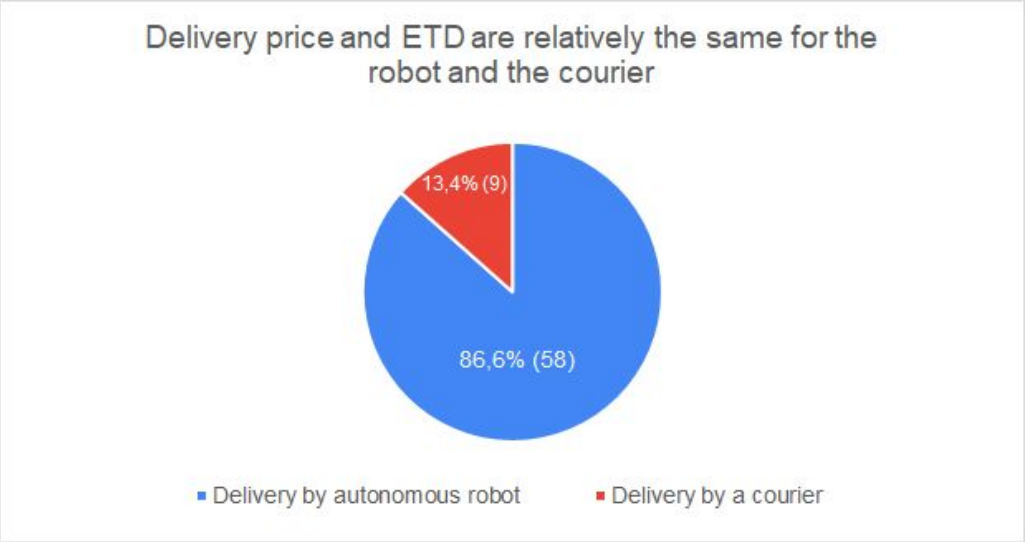

Chart 3.3.6 Delivery price and ETD are better for the autonomous robot.

Based on this data author can assume, that for the majority of respondents delivery price and estimated time of delivery are more important than the type of delivery. People are open and ready to use delivery robots if these 2 conditions are competitive.

In the end of the previous set of 3 questions respondents had an ability to commentate on their decisions. Here are some of their commentaries:

- “Deliveries by drones and autonomous robots are less harmful for the environment.”
- “Fast shipping is the most important thing”
- “Unfortunately nowadays it’s more safe to make orders with robots”
- “Courier is faster, i usually order food from restaurants and one of the good things about food delivery is you get warm food. With the robot it would take a lot longer and the food would be cold”

- “Paying people is fine, I don't mind paying a bit more for a fast and accurate delivery. Robots are not as well-developed right now, they make lots of errors and always get stuck. It takes ages for them to deliver things and at this stage it just does not worth it. I would really like to see the world when robots are super smart and efficient.”
- “If delivery time is the same, I actually don't care, whichever is more simple is the one i prefer. If robot is faster, of course i would prefer the robot for the above written reasons”
- “Actually it doesn't matter to order by a courier or robot. But for fun and to try it I would try robot.”
- “I have chosen a courier, because a lot of people doing this job in the need of money. And by supporting them by using their service I help them.”
- “I don't mind interacting with humans, but I'm just curious to see how the robot would work”
- “I don't mind which one i use, the price matters”
- “Robots are more convenient and cooler”
- “I live on the fifth floor and don’t like walking downstairs to get the order”

3.4 COVID-19 and delivery services. Habits and preferences

Questions in this part are set to determine whether there were any changes in habits of ordering food and groceries online and changes in delivery preferences. Respondents were asked 3 questions.

First question is set to determine whether respondents used food/groceries delivery services before the COVID-19 pandemic and quarantine or they have started using these services due to the quarantine. Chart 3.4.1 shows that 70,1% (47) of respondents used the food/groceries delivery services before the pandemic and 9% (6) have stated that they started using the services after COVID-19 quarantine. 20,9% of respondents have mentioned that they do not use food/groceries delivery services.

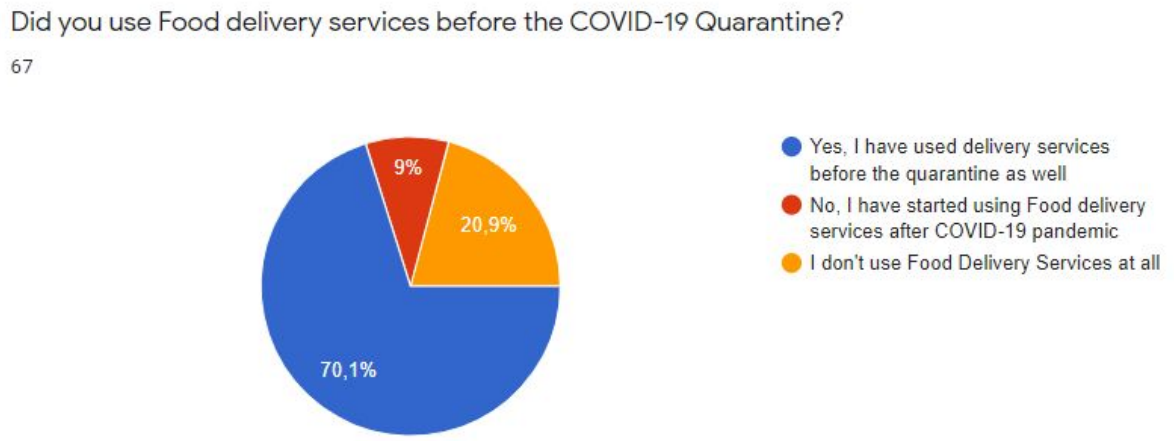

Chart 3.4.1 Changes in respondents delivery preferences and habits due to COVID-19

Second question is set to determine whether respondents started using food/groceries delivery services more often during the COVID-19 pandemic and quarantine in Estonia.
Chart 3.4.2 shows that roughly more than a quarter of respondents, 27,3% (18 respondents) have started using delivery services more often. While 72,7% (48) of respondents have stated that they have kept using food/groceries delivery services the same way they have used before the COVID-19 quarantine.

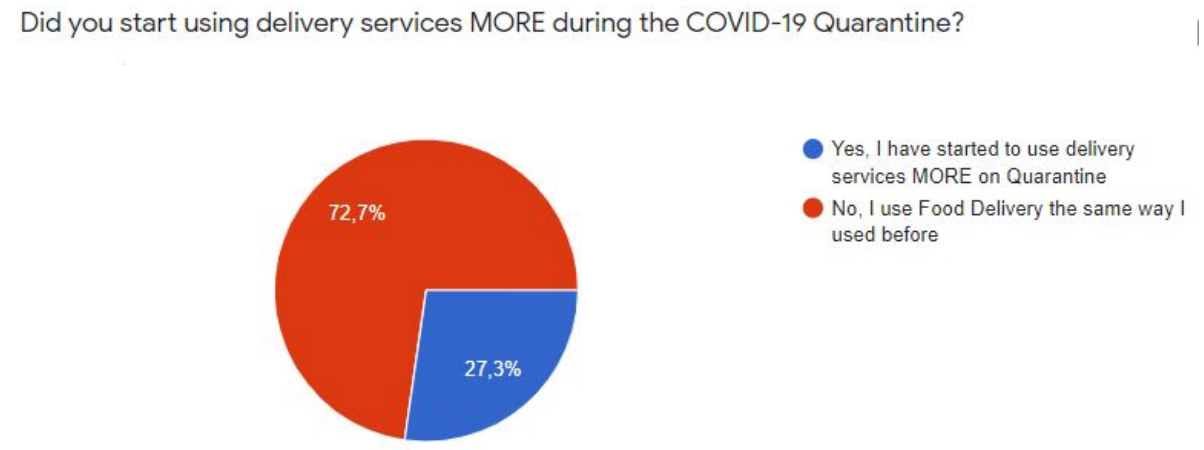

Chart 3.4.2 Changes in respondents frequency of using delivery services due to COVID-19

Third question relates to the specifics of COVID-19 quarantine. During COVID-19 pandemic less contact and interaction with other people is preferrable. So respondents are asked whether they are willing to start using autonomous robots delivery in order to stay isolated from other people and prevent the spread of the virus.

Chart 3.4.3 shows that 64.6% of respondents would consider using robots to prevent the spread of the virus. While 35,4% of respondents think that couriers are just fine and they keep using delivery services with physical person couriers.

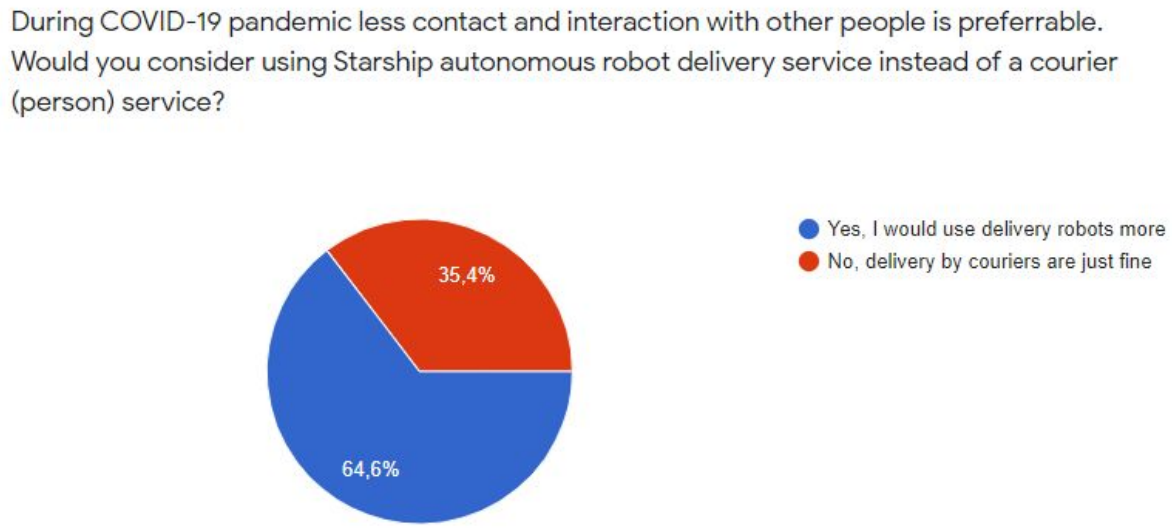

Chart 3.4.3 Respondents are asked whether they are willing to start using autonomous robots delivery in order to stay isolated from other people and prevent the spread of the virus.

3.5 Starship user experience

This part of the questionnaire is only for those respondents who use or have used Starship Technologies delivery service. This set of questions is aime to learn how respondents are satisfied with the Starship Service. In total there were 4 of respondents, who have mentioned that they use Starship.

Due to the lack of active Starship users among respondents, sample of 4 respondents is not a representative sample.

In the first questions respondents were asked to rate their overall experience with Starship Technologies delivery service on a scale from 1 to 5 with 1 meaning they are totally unsatisfied and 5 meaning they are fully satisfied. Chart 3.5.1 shows that no one had rated their overall experience with Starship with less than 3 points. 3 is the most popular answer with 50% of respondents. 25% of respondents rated their overall experience with Starship Technologies with 4 points and 25% of respondents have put a rating of 5 points.

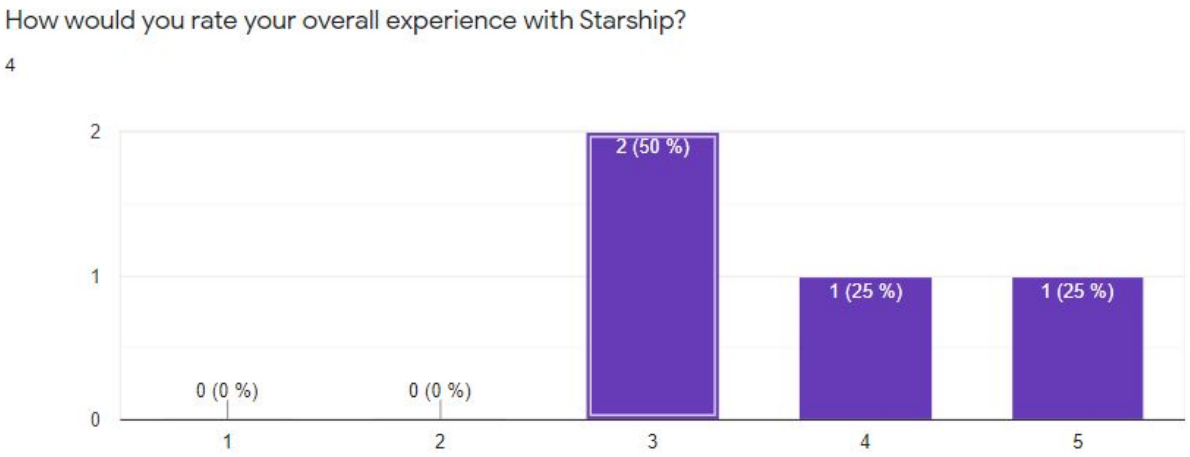

Chart 3.5.1 Overall customers' satisfaction with Starship Technologies service

Following question concerns Starship Technologies delivery service price. Question is set to determine how satisfied are Starship customers with the delivery price. On a scale from 1 to 5 with 1 meaning they are totally unsatisfied and 5 meaning they are fully satisfied. Chart 3.5.2 shows that all the respondents have put a rating of at least 3 points with the most popular answer being 4 points (59% of respondents). Ratings of 3 and 5 points were put by 25% and 25% of respondents respectfully.

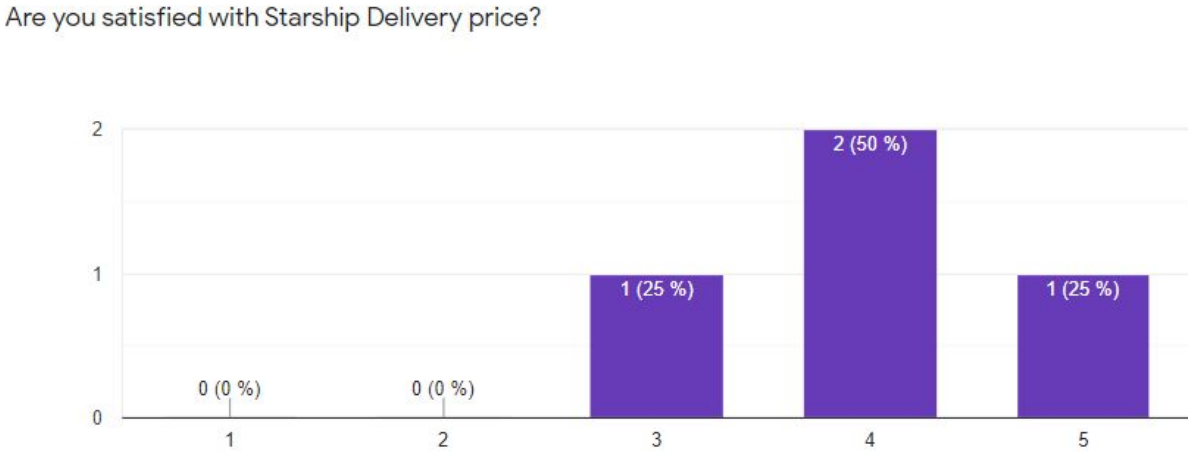

Chart 3.5.2 Customers' satisfaction with Starship delivery price

Following question concerns Starship Technologies delivery service's estimated delivery time.. Question is set to determine how satisfied are Starship customers with the ETD. On a scale from 1 to 5 with 1 meaning they are totally unsatisfied and 5 meaning they are fully

satisfied.

Chart 3.5.3 shows that respondents are neither fully satisfied nor fully unsatisfied with starship delivery time. Rating of 3 points is the most popular one with 50% of respondents choosing this option. Ratings of 2 and 4 points were chosen by 25% and 25% of respondents respectively.

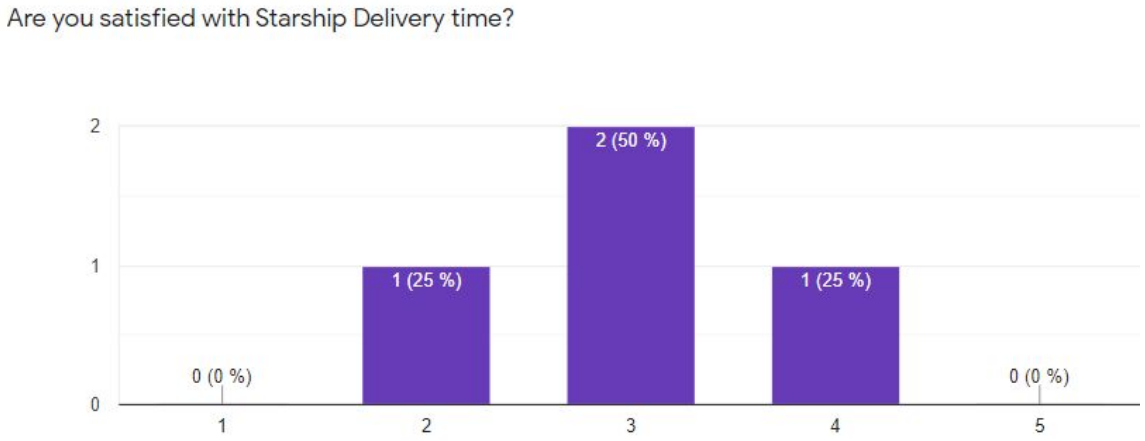

Chart 3.5.3 Customers' satisfaction with Starship ETD

CONCLUSION

The aim of this research work is to learn Tallinn residents' attitude towards delivery autonomous robots as a way of last mile intracity delivery on the example of Starship Technologies delivery service. Find out whether residents know about the delivery robots service and whether they use the service to order food from the restaurants and groceries from the local supermarkets. The research is also aimed to find out the main reasons behind people using or opposed to that not using autonomous robots delivery services and residents' preferences towards delivery types, whether they prefer delivery by an autonomous robot or by a human courier or any other option.

The current study revealed that majority of respondents actively use intracity delivery services on the example of food and groceries delivery services. The most popular services are the ones that provide an ability to order both cooked meals from the restaurants and groceries.

Predominant majority of respondents know about Starship Technologies delivery robots services, however they do not use the service. The main reasons of not using the autonomous robots delivery being that the service does not work in the area respondents live in and second reason being the undermarketing of the technology. Respondents do not understand the benefits of delivery robots and why they should choose them over other services. Third reason is the long delivery time.

Study however revealed that most of the respondents are ready to start using the autonomous robots delivery service if the service would correspond to their main factors of delivery service choice. Study revealed that 2 main factors of respondents' delivery service choice are delivery price and the estimated time it takes to deliver the order.

Study revealed that during the COVID-19 pandemic and quarantine most respondents (64,6%) are ready to start using autonomous robots delivery services in order to interact with other human beings less.

Study revealed that however 94% of respondents know about Starship Technologies autonomous robots delivery service, only 8,2% of respondents who actively use delivery services use Starship and from them there are no respondents who use Starship regularly. Meaning they have tried the service and did not become loyal and regular users. Study revealed that the main reasons for that can be the long delivery time (longer than other services').

Results of this study state that residents of Tallinn would actively use Starship Technologies autonomous robots delivery service if it would cover the whole city of Tallinn, would have competitive or lower than competitors' pricing and estimated delivery time.

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APPENDICES

Appendix 1. Questionnaire

First part. Demographic questions	
• What is your age group?	• 14 - 17 • 18 - 21 • 22 - 26 • 27 - 31 • 32 - 39 • 40 - 49 • 50+
• What area in Tallinn do you live in?	• Mustamäe • Nõmme • Õismäe • Kristiine • Kopli • Lasnamäe • Kesklinn • Südalinn • Kakumäe • Pirita • Viimsi • Other..
Second part. Delivery preferences	
• Do you use food/groceries delivery services?	• YES • NO

Questionnaire continues on the next page.

• What are the most important factors you consider when ordering online?	• Delivery price • Estimated delivery time (how quick will the order arrive at your place) • Specific delivery service • Type of delivery (courier, autonomous robot, food cabinet etc.) • Other..
• If you answered YES and you USE food/groceries delivery services. Which ones do you use?	• Bolt Food • Wolt • Starship • Barbora • e-Selver • Coop e-shop • Carrot.ee • Other..
Third part. Starship Technologies delivery service. Delivery preferences	
• Do you know about Starship Deliveries and Starship Delivery autonomous robots?	• Yes, I've heard about Starship Deliveries • No, I hear about Starship Deliveries the first time

Questionnaire continues on the next page.

• Introduction to Starship Technologies	Starship Delivery Robots are the small autonomous robots developed in Estonia by Skype co-founders. In Estonia they are currently operating in Mustamäe and you can use them to order groceries from Selver and food from local restaurants via Starship app. Robot autonomously delivers your order directly to your place and you don't have to interact with a human being.
• Starship autonomous robot picture.	
• If you HAVE HEARD about Starship. Have you used Starship Delivery services to make orders?	• I've heard about Starship, but haven't tried it • Downloaded the app, but didn't make any order • Ordered once • Ordered 2-5 times • Order regularly. 1 time a week • Order regularly. 2+ times a week • Other..

Questionnaire continues on the next page.

• If you have heard about Starship, but haven't used it. What are your main reasons not to?	• It doesn't work in the area I live in • I don't understand how to use the service • It's too expensive • Delivery usually takes too long • I don't know why. Just haven't tried. I don't feel like I need to • Other..
• If Starship Delivery would work in your home area and would be relatively low priced, would you consider using it?	• Yes, I would at least make 1 order • No, I don't feel the need to try
• What delivery type would you prefer? Considering that the price and delivery time is BETTER for the COURIER.	• Delivery by a courier • Delivery by autonomous robot
• What delivery type would you prefer? Considering that the price and delivery time is relatively SAME.	• Delivery by a courier • Delivery by autonomous robot

Questionnaire continues on the next page.

• What delivery type would you prefer? Considering that the price and delivery time is BETTER for the ROBOT.	• Delivery by a courier • Delivery by autonomous robot
• Commentate your answer to the	*Text answer*

previous 3 questions..	
Fourth part. COVID-19 and ordering habits.	
● Did you use Food delivery services before the COVID-19 Quarantine?	● Yes, I have used delivery services before the quarantine as well ● No, I have started using Food delivery services after COVID-19 pandemic ● I don't use Food Delivery Services at all
● Did you start using delivery services MORE during the COVID-19 Quarantine?	● Yes, I have started to use delivery services MORE on Quarantine ● No, I use Food Delivery the same way I used before
● During COVID-19 pandemic less contact and interaction with other people is preferrable. Would you consider using Starship autonomous robot delivery service instead of a courier (person) service?	● Yes, I would use delivery robots more ● No, delivery by couriers are just fine

Questionnaire continues on the next page.

Fifth part. Starship user experience. Questions are only for those who have used Starship Technologies delivery services.	
• How would you rate your overall experience with Starship?	**1** I'm not pleased with it …….. **5** I love it! *1 to 5 Scale*
• Are you satisfied with Starship Delivery time?	**1** It takes too long (more than a physical courier) …….. **5** I'm completely satisfied *1 to 5 Scale*
• Are you satisfied with Starship Delivery price?	**1** Too expensive …….. **5** Completely satisfied *1 to 5 Scale*
END of the questionnaire. Thank you words.	

Appendix 2. Lihtlitsents

Lihtlitsents lõputöö reprodutseerimiseks ja lõputöö üldsusele kättesaadavaks tegemiseks[1]

Mina Maksim Romanjuk (autori nimi) (sünnikuupäev: …….)

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"Delivery robots serving last mile B2C: an evaluation of Tallinn residents' incentives behind the usage of delivery robots in 2020 on the basis of Starship Technologies example" ,

(lõputöö pealkiri)

mille juhendaja on Kai-Katrin Parktal,

(juhendaja nimi)

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