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Innovating sustainable last mile parcel delivery solutions for Indian urban areas.

Jätkusuutliku kulleriteenuse viimase miili lahenduse arendus India linnapiirkondadele.

Key words : Sustainable, Fast, Safety, Artificial Intelligence

MASTER THESIS

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Abstract.

Logistika ja transporditeenuste teemadel on tehtud arenenud maades palju uurimistöid. Samal ajal vajavad uued arengumaad aga neile tuntud probleemidele värskeid ja innovaatilisi lahendusi. E-kaubanduse arenedes on viimase 6 aasta jooksul kasvanud plahvatuslikult toodete otse postitamine ja üha rohkem logistikaettevõtteid keskendub kiirele tarnele, sulgedes samas silmad selle tegevusega kaasnevate .negatiivsete keskkonnamõjude eest. See on valupunkt, millele oma töös keskendun

Töö analüüsib praegu India linnades rakendatavate viimase miili kullerteenuste mõju ja pakub siin välja uudse lähenemise sellele teenusele. Läbiviidud uuringu tulemused osutavad, et on tõsine vajadus ettevõtete rakendatavate monotoonsete praktikate ümberdisainimiseks. Olen töötanud läbi uuringud, mis keskenduvad viimase miili kullerteenuse innovatsioonile. Nende põhjal olen kaardistanud seotud osapoolte kasutajateekonnad, tekkivad kulud, otsesed ja kaudsed mõjud nagu ebaõnnestunud .tarned, sõidutrajektoorid ja keskkonnamõjud

Minu lähenemine on inspireeritud Euroopa turust kuna siinsed riigid nagu Eesti on sammu jagu ees tehnoloogia rakendamisest inimeste heaolu tõstmiseks. Kasutades ära võimalust õppida uusimatest arengutest astusin sammu edasi, et luua spetsiaalne lahendus India turule

Abstract.

There has been a lot of studies done on the logistics and transportation services in many developed countries around the globe. At the same time some new developing countries require novel and innovative solutions to old problems. With the emerge of e-commerce the demand for direct product delivery has increased significantly in the last 6 years. As the result more and more logistics companies are focusing on just quick delivery, closing their eyes on the negative long-lasting environmental impact of .such activities. This is where my thesis comes in

This study focuses on analyzing the impact of current last-mile delivery solutions implemented in the urban areas of India and proposes a novel approach for these services. The outcome of the research findings suggests that there is a crucial need to redesign the existing monotonous methods practiced in many companies. I have read and reviewed the existing papers focusing on innovative solutions aimed to increase the productivity and efficiency of the last mile delivery. Based on the studies I have mapped out the journey of stakeholders, cost incurred, direct and indirect .consequence such as failed deliveries, delivery areas, drives and environmental issues

My core study of research was inspired by the European market, as countries such as Estonia itself, are way ahead of other areas in implementing technology for the betterment of people's lives. Getting the opportunity to learn from best developments, helped me to step further and create a specific solution for Indian market

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PREFACE

This thesis is my final work for my Masters's Thesis at the Tallinn University Of Technology. It could be considered as the documentation of my research findings during my study period. It provides the results of the last mile delivery problems being faced in the country India. The basis for this research originated from a personal experience back in India with last-mile logistics and to come up with a solution to solve that problem. As the world moves further into the digital age, giving opportunities to more logistics companies to form there will be a great need to bring out innovative solutions to tackle the old problems innovatively. Not only helping the customers who receive deliveries but also the drivers as well as the unnoticed stakeholder such as the environment and many more. It is always crucial to research on such sensitive topics because it gives the way to the other researchers to continue where I left off.

It was a great learning experience and I enjoyed learning about different technology uses in many countries for the benefit of their people.

I could not have achieved this without the support of my Professors and the Tallinn University of technology that provided me the opportunity to present my findings. Thank you for your support.

Chapter 1. Introduction

Logistics services or parcel services have drastically changed over the years. Logistics could be found operational in almost every industry. In sustainable economic development, an efficient and reliable transport system is required to play a decisive role. This depends not just on the transport system, but also on the capacity of logistics companies to make efficient use of the resources available. Without the transport or logistics companies, economic growth in various sectors can not be imagined. Efficient operations produce not only economic but also social benefits that minimize travel time, improve protection and security and reduce emission volumes. Earlier such services were used to define the flow of raw materials but currently, such services provide more functions. Customers nowadays require products to be delivered at the right place at the right time and right quantity. With the rapidly growing technology, in the fields of communication and informatics, logistics have adopted various ways of fast processing of data throughout. Such courier services have become viable not only for manufacturing but also for individual companies. The purpose of this paper was to complete an analysis and understand the approach used currently by delivery services (courier) and determine the problem areas which could be resolved by introducing new technological approaches.   Being the backbone of any country's economy, the logistics industry is still underdeveloped compared to the other highly developed sectors due to inadequate infrastructure and ineffective management capabilities. Given these realities, the most significant bottleneck of the logistics industry is the last mile delivery challenge, which has the highest cost in the entire logistics process. It has become crucial for logistics service providers to find innovative ways to come up with a new solution for last-mile distribution problems. The study aims to understand the logistics problem of the last mile in India by approaching the European mindset towards innovative solutions. Europe has been the technological hub for a decade and could help with these innovative advances. The research is done with the help of DLH Service Provider case studies to explore last-mile distribution alternatives and customers of such deliveries. A case study based on one business process was performed related to the research issue. The methods of data collecting used include interviews, communication by telephone or email, and survey.

1.1 Context

E-commerce has grown significantly over the last decade. Global e-commerce sales ratios nearly tripled between 2014 and 2019. This trend has been fueled by a variety of factors, including urbanization and rising middle-class purchasing power, an expanding global customer base, an expanding range of products range of items available for purchase online, and the introduction of emerging modern market models, as well as technical advances in the distribution segments that allow for immediate and time-definite delivery…. [2]

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[2] Overview of Last-Mile Logistics in India http://student-blog.iima.ac.in/?p=2204

Chapter 2. Theoretical framework

An analysis of the current state will be given in this section. In order to take into account what has been done to enhance last-mile delivery by involving customers, a brief summary of delivery methods will be given after describing the issues that have occurred in the last-mile. Following this the emphasis would be on performance metrics for productivity and satisfaction. The involvement of the consumer and its consequences would then be discussed. As discussed above this project comprises three segments. Drivers(discussed above) Middle men(Road) and Customers(which is being discussed below).

2.1 Last mile delivery

The method of supplying the ordered product to the customer is the very last step in the distribution process. This is generally referred to as the last mile and is defined as the final leg of any delivery service in which the shipment is delivered to the recipient, either at the home of the recipient or at the collection point. Last-mile deliveries may be made to the customer's home, office, reception, or pick-up lockers. Deliveries consist mainly of small packets and are usually low in volume and very scattered, although consumers expect to be delivered quickly. Delivery of the product to the customer's doorstep is also logistically complicated, inefficient, and thus very expensive. A crucial aspect of the decision to order online is the promised speed of delivery and the fact that logistics productivity indicators such as speed and reliability are powerful determinants of customer loyalty. This results in retailers promising and delivering high delivery rates, i.e. within 12 hours of ordering, also involving same-day deliveries. E-retailers have thus made the last mile much less effective by providing the service of same-day delivery. Last-mile deliveries by small trucks to consumers are often delivered to individual addresses. Around 30 percent of first-time delivery attempts fail when the customer is not at home for example. To increase productivity by eliminating the need for customer attendance or increasing customer coordination, this is a major source of inefficiency that stimulates research into the development of delivery modes that involve customers.

The system in which goods pass from the supplier stage to the consumer stage is referred to as the distribution phase, which is an important profitability index because it affects both the cost of the supply chain and the customer experience. In the whole logistics process, the most important final part is the distribution process. Since Warehouse management, distribution center, and last-mile are crucial it part it is

difficult to minimize in the logistics industry[3]. In certain cases, express companies are generally concerned with how to transmit orders to various destinations for recipients on a suitable distribution path, which should cover and be as short as possible for the main service regions.

The time between the customer makes a delivery order till when they receive their product is considered as the response time. Transparency in order plays a very important role as the customer can monitor their orders from the delivery placement, which influences the customer experience. The response time of logistics is closely related to the lead-time of logistics, which includes the customer order period and the lead-time gap.

When a customer expects to wait for their product to arrive is called the order period and when the courier or logistics company begins to deliver the product is called logistics lead time. Since it depends on the product the case is sometimes measured in months and sometimes in hours. In some cases, this can be measured in months, while in others it can be measured in hours. Understanding and finding a way to extend the customer's order cycle and reduce the lead time gap will boost the customer experience of the logistics service.

Some customers will ask the logistics company to deliver their packages at a particular time. This is called the Time Window. The key issue occurs in-home delivery when no one receives the product and the failure rate has risen a lot as a result. The courier service can be sent 2 or 3 times for redemption.

[4]As logistics companies plan to ship, they arrange for particular routes for transport, and this routing problem is often another problem during the delivery process, which is called a vehicle routing problem. Reliable routing in rural or urban areas must take account of traffic. Current logistics networks are typically unable to deliver goods with maximum distribution performance. Such practice amounts to an increase I the freight carriers, buses, or trucks in urban areas while contributing to road congestion and more traffic difficulty. Due to the inefficiency of the transport system, customers would never want to pay the full amount. The key reason for implementing the VRP definition here is that when considering last-mile distribution constraints, logistics companies typically need to weigh these two variables at the same time, and that makes things very complicated.

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[3] Last-mile logistics fulfilment: A framework for energy efficiency
https://www.sciencedirect.com/science/article/pii/S2210539520300511/

[4] Vehicle routing problems for last mile distribution after major disaster https://www.tandfonline.com/doi/full/10.1080/01605682.2017.1390534/

Customers are directly confronted by last-mile distribution businesses and customer support is also important to them. Some -commerce want delivery express businesses to reflect their standard of service, make good impressions on their clients, and thus consider customer service as a major matter. The pace of delivery, stock level, and order cycle would be all essential elements when analyzing customer service.

As Froehle and Sampson stated in their work that such services can not be performed until there is customer interaction in the form of input in the process. And by doing so service process can become more efficient. As discussed above there are plenty of roles involved in the last mile delivery which affect the overall delivery process and below is the detailed summary of it.

As an information provider, the first position that has been identified in the literature is that of the customer. [5]Van Duin et al. (2016) notes that the customer should be able to update next to their address the desired delivery time to optimize first-time deliveries by eliminating the absence of control by the customer. This adapts the delivery to the customer's needs, which improves satisfaction. Second, by including customers as workers in the use of lockers as unattended modes, failure could be avoided for the first time by introducing third-party logistics. This mode requires the customer to perform the last time themselves if they wish to receive the courier. In doing so, the presence of the customer in the distribution process produces a co-delivery, since the service cannot be created without their participation. Since it requires effort, self-delivery could lead to incontinence and dissatisfaction. Another type of delivery is called crowdsourcing, where last-mile customers could participate not only in their delivery but of others too. In their product, they deliver products to those living near their locality, office, home, etc. It leads to a pooled transport of the deliveries and in turn that bring positive impact to the environment. In the third role, customers could be able to confirm both the efficiency of the process and the result. When the product is delivered to the customer's doorstep, the customer monitors the delivery of the project by performing basic checks and confirming product quality

2.2 Perceived control

Customer involvement in the last mile delivery may cause trouble of perceived control for providers considering Cocreating provides companies to essentially outsource part of the last mile to the customers. While outsourcing can decrease costs, it may lead to

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[5] Environmental sustainability of the last mile in omnichannel retail
https://www.researchgate.net/profile/Heleen-Buldeo-Rai/publication/335445142_Environmental_sustainability_of_the_last_mile_in_omnichannel_retail/links/5d949f0592851c33e94fe58f/Environmental-sustainability-of-the-last-mile-in-omnichannel-retail.pdf/

a loss of the cost of quality control and teamwork. These costs result from managing and monitoring the person who undertakes the task.

[6]According to Parida and wincent the provider and customer relationship in co-creation are neglected. The essence of the interaction between supplier and client could turn from transaction to relationship-based partnership by involving clients, which could lead to uncertain expectations, opportunistic actions, disagreements, and service failure. Cocreation with customers requires the management role of uncertainty and moreover, the government approvals like creating contracts could lead to the high cost to the overall process.

Crowdsourcing requires monitoring of quality control and requires a mechanism to enable bidding and compensation for participants as the quality and effectiveness could vary. These types of monitoring and mechanism are crucial to controlling the present organization's objectives. Due to this the company does not have full control over the process nor it relieves its core responsibility. Since participants are involved in the last part of delivery some processes could lead to negative outcomes as the firm may take different directions and the participant different what was not planned as per the regulations. [7]For this, it is important to observe and implement various roles and responsibilities and structure a linear contract between the customer and the company as the ambiguity between customer and provider is the main reason for decreased performance.

The overall theoretical framework suggests that customer involvement in correlation and last-mile service is well established but requires further research in the last-mile context. Researchers such as Sampson and spring have established roles for cocreation but confirmation is required to determine to examine as to what extent these roles are implementable. There are plenty of customer roles that are required to be researched and monitored. Since customer involvement has shown efficiency and satisfaction but individual impact and role are not well documented.

2.3 Purpose and background

The purpose of this research thesis is to understand the approaches adopted by different companies for their delivery services and to dwell deeper to explain particular limitations and requirements for various distribution alternatives and how that could

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[6] https://link.springer.com/article/10.1007/s11365-019-00558-9
[7] Last-Mile Delivery for Consumer Driven Logisticshttps://www.sciencedirect.com/science/article/pii/S2352146519300973

be reinvented and implemented for a much better future. As an organization has historically worked only in a business-to-business sense, there could be a variety of different touch points that need to be re-designed to meet the needs of customers. To keep into consideration for the research, the logistics service consists of express air and road services. The last mile of road express services as a result of outsourcing, is completely different from the last mile of air express services.

Chapter 3. Problem Space

3.1 Research methodology

The key approach to this analysis is the case study. Several evaluation approaches about innovative delivery alternatives are discussed such as cost, time consumption, geographical, nature, orders, customers as indexes to find out the efficient way to improve logistics performances. We have discussed the last mile and co-creation. We will discuss how the involvement of humans and factors influencing delivery could be improved and create a solution.

In this thesis, I have taken up a DHL company case study where the company faces the last mile delivery problems and methods the company has tried. Since the companies had gained a good amount of expertise in delivering the last mile they also require to implement new ideas to solve upcoming troubles as well as improves the overall process

Every package delivery company receives, the management requires the courier to fill the document into records. In the whole delivery process management is the only last department whole deliver a process which functions as a distribution center also All the package arriving in the center has to go through this station. Therefore management is considered as a critical department that acquires critical data which could be used to analyze. To analyze I have conducted interviews and used questionnaires as a primary data collection and for secondary research, online research papers were read to more deeply understand previous research done. We need to understand the amount of parcel company receives and the way they deliver will be calculated thoroughly to understand the pressure (physical or mental) everyone involved has to go through in the last mile logistics. The cost and time involved in the last mile delivery process will be calculated and analyzed keeping into consideration current delivery methods, alternatives and new innovative solutions will be derived.

3.2 Collection of Data

3.2.1 Primary data

Primary data is collected directly through the interview. This interview was conducted to address one specific research objective. Primary data have been analyzed and collected through qualitative and quantitative approaches. Qualitative investigation acts as a sample case study. Qualitative data consists of comprehensive explanations of circumstances. The method used in this thesis includes one interview with the DHL

management assistant working in India on the overall process and questionnaire of 10 online customers(who receivers parcels)

3.2.2 Secondary Data

[8]In this paper, mostly secondary research is cited from other research papers, articles, online blogs, papers of other delivery companies(such as FedEx, and more local companies), etc that focus on similar problems. It was important to analyze secondary data to support my thesis and promote research and by doing so it could save a lot of time. To collect data itself is sometimes difficult in a short time and have secondary research is crucial. The secondary data used includes DHL services reports which provide the evaluation of local logistics as well as worldwide logistics delivery which provides the factors(negative and positive) influencing parcels in the last mile. Some information was learned from the online portal of DHL where problems of customers are addressed as well as blog posts from the company from their website. Since the problem of customers varies according to region, so one solution might not be worth to the other but to us more the information it's better.

3.2.3 Individual Interview

The Interview conducted were aiming at acquiring desired information. The interviewee is required to provide information from his personal experience and views that provide factual results to the specific area. Individual interview *(even though it was conducted using zoom)* allows the interviewer to ask plenty of questions that result in answers and more build-up questions and more in-depth knowledge of the company's structure. Since due to the coronavirus situation lot of offices were shut off it was difficult to arrange for several interviews so I had to discuss all the probability and problems with one. Many individual interviews should be performed directly and successfully to collect as much valuable information as possible. So it is crucial and necessary to gain insights from the attitude, preference, as well as viewpoint of the interviewee Since any of their insights, could be used for research purposes.

3.2.4 Interview

Since management has more internal and lucrative information, people employed in the company's tents need to be more vigilant about the information being produced.

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[8] https://scag.ca.gov/sites/main/files/file-attachments/2958_lastmilefreightstudy-final.pdf
Developing the last mile of a parcel delivery service https://core.ac.uk/download/pdf/38098124.pdf
Parcel delivery The future of last mile
https://www.mckinsey.com/~/media/mckinsey/industries/travel%20transport%20and%20logistics/our%20insights/how%20customer%20demands%20are%20reshaping%20last%20mile%20delivery/parcel_delivery_the_future_of_last_mile.ashx

To collect information, the interviewer must word questions in a manner that is valued but also in such a way that more information is received because the interviews turn out to be more of a meeting. The purpose of the interview was to understand their approach to the whole process of delivery from receiving of the item till the delivery of it to the customer and what are the new delivery alternatives they have used and what were the outcome. Interviews in this thesis include one interview with the manager who's responsible for looking over the entire work in the industry. He is equipped with the critical information about what his employee experience and problems in these sectors are and what problem the company is going through that are being looked upon.

3.2.5 Questions

Below are the questions that i started my interview with and then build up more questions with those answers.

- What is the process of delivering a product from the warehouse?
- How much time does it take to deliver one parcel?
- How many people are involved for delivering a product in a day and how many products are delivered in a last mile delivery?
- What do you do if the customer is not at home?
- Are there any methods that the company has chosen to resolve this issue?
- What is the difference between DHl and others?
- Does DHL uses 3PL(third party logistics)

The questions mentioned above worked as a conversation starters and from where i build up more questions as we progressed.

3.3 Problem Explanation and Data collection

3.3.1 Courier

To narrow down the research and understand the core problem area, a research question was required."How will the overall problem faced by courier service during transport be improved? (to understand the overall service) ?" This included three major variables that were taken into account. Delivery Man, Road, and Customer (the receiver).

Since the process of delivering a product is similar throughout the country, An interview was conducted with the management in the UK. Complete analysis of the

research included the human in the center (driver). After analyzing the touchpoints and factors influencing each scenario the amount of time taken, troubling areas, emotions, and unknown factors of the carbon footprint were introduced. Each red point on the map indicated the elevated negative and positive emotion whereas the carbon footprint was used and how much time was taken to deliver that particular product. And with the delivery what are the unknown areas that were touched.

3.3.2 Customer

A questionnaire was developed to understand the client-side, asking questions about their understanding of buying a product and its distribution. The findings were then mapped to identify high to low value with low or high effects. The quick delivery, time, and ability to choose a delivery time, along with others that have a low impact in terms of a courier, has been given surprisingly high importance, while sustainable delivery has been given little importance, which has a high impact on society.

3.3.3 Research area

This research takes into account the case of DHL courier service, which faces the issue of logistics for the last mile. More than half of the entire logistics expense was borne by the cost of the last mile distribution process worldwide. Therefore several distribution alternatives have been planned to overcome this restriction but most of which failed. The study in this thesis is aimed at understanding and examining the problem in the current delivery situation of these various delivery methods and methods to resolve it.

3.3.4 Problem Definition

Many issues are unavoidable in the logistics industry. And for many reasons, such as the issue of vehicles, human error, traffic, infrastructure, and management capacity, the distribution problem is incurred, so finding a way to solve this problem and implementing a collection of applicable methods would allow companies to achieve competitive advantages in the logistics industry. The last mile has always been the biggest hurdle in the country, especially where timely delivery of a product is necessary. The reason why the last mile distribution process has become serious everywhere is because of its high cost. The cost of the last mile has become an inevitable issue for those online retailers because the cost will impact the profit of the business. Dynamic vehicle routing and scheduling tools could mitigate the impact of this problem, but the methods or innovations that could solve this problem are now discussed in the paragraph below.

3.4 About DHL corporation

[9]Headquartered in Bonn, Germany, the company has been providing domestic and international delivery services to a wide variety of customers since it was established. They have been continuously adopting new technology for monitoring, tracking, contact resources allocations, and new methods of end-to-end delivery processes to make sure the improvement not only in their service but also customer satisfaction.

3.5 Use Case Scenario *(currently)*

(*Figure 1*)Below mentioned figure is the detailed customer journey of a delivery guy beginning from how he reaches the office to them performing such difficult tasks. It explains the journey of how products are delivered to the customers and what all problems are faced during this time and it is not an easy process. Keeping these scenario problems into consideration I would propose a solution to eliminating unnecessary hindrances.
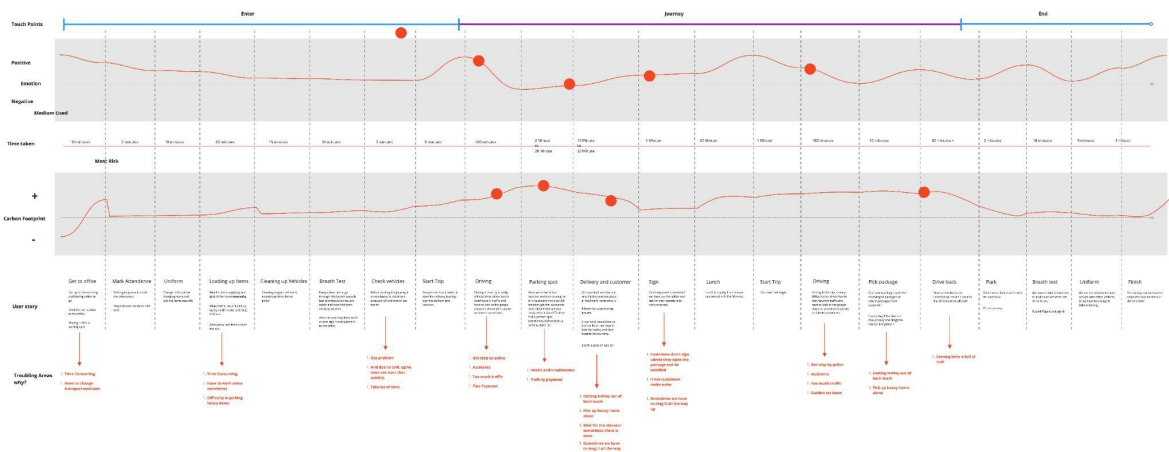
Figure 1: Journey map of courier driver/delivery

This scenario includes the current state of how the product deliveries are made:-

1. Delivery guy/girl picks up the items in the warehouse and places and arranges it in the van/bag.
2. Make sure the cell phone/ device is fully charged or not.
3. Check the vehicles before starting the trip.
4. Takes the vehicle out in the street.
5. Gets stuck in the traffic.
6. Finding location to park the vehicle for delivery.

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[9] dhl website for reference -https://www.dhl.com/global-en/home/about-us.html

7. Call the customer to make sure if they are home or not.

8. Loads the packages in the bag and walks into the society.

9. Walk up the stairs and sometimes walk to reach the customers home.

10. Get customers' signatures when making the delivery.

11. Messages customers if delivery is not made.

12. Stars the trip for another delivery location.

13. Once all the deliveries are made, they proceed for pick up of the items.

14. Calling up customers if they are home to pick up the items.

15. Starts the vehicle

16. Looks for the Parking spot

Chapter 4. Objective and Demographic

The rapid growth of Indian e-business, particularly online shopping, generates enormous orders and packages for local logistics providers, motivating and revealing problems in the last-mile delivery process in India. It illustrates Indian e-business and its scale. The conventional Indian business culture is one of the biggest obstacles to the growth of e-business in India.

[10]In early 2020, when a rapid infectious illness called Covid 19 broke out a favorable turn occurred. People were so scared to go shopping that most people were trapped inside their house and were unable to get what they needed, including going to the store, by regular transactions. Based on e-commerce, the only way to buy without going out was, so more and more individuals continued to try to focus on the internet shopping. [11]People have begun to understand the security and convenience of e-commerce and have recognized that the Indian e-commerce industry has begun its business after the 2020 situation. Online retailers will consider customer loyalty and adapt to changed shopping requirements as the price war between online retailers in India, which means that logistics rivalry has become more relevant than ever. The consumer-to-consumer (C2C) industry is currently the main e-commerce model everywhere, taking about 85 percent of the market and setting the groundwork for growth, but B2C e-commerce is also evolving very well, which is projected to cross 90 percent of the entire market by 2025. As India's phenomenal growth continues, both hardware and software The e-commerce sector continues to improve. Yet logistics, as an important factor in promoting online shopping and delivering customer service, remains a major bottleneck for e-commerce operators. If the logistics industry could not cope up with the rapid growth of e-commerce, the development of e-commerce or any sector would be delayed, [12]given the size of the Indian e-commerce industry, which is projected to be 125 billion by 2020. On the other hand, the rapid growth of Indian e-commerce has also generated demands and problems for the last mile of logistics.

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[10] The Impact of COVID-19 on E-commerce in India
https://razorpay.com/learn/impact-covid-19-e-commerce-india/
[11] rethinking last mile logistics post covd 19
https://www.automotiveworld.com/articles/rethinking-last-mile-logistics-post-covid-19-facing-the-next-normal/
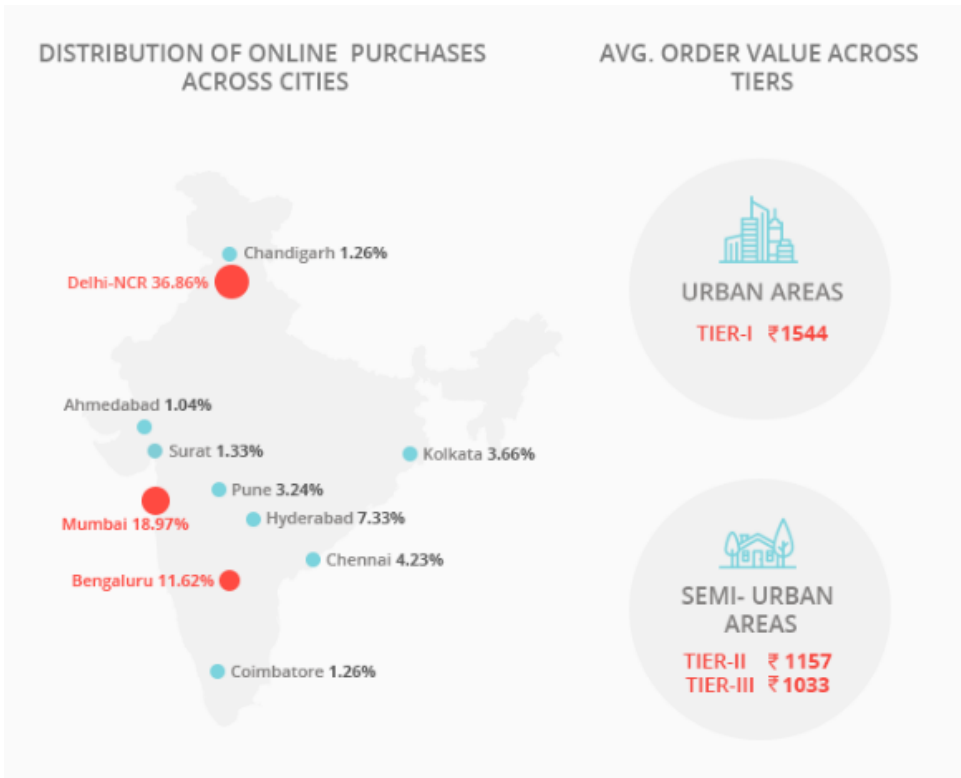[12] E-commerce Industry in India https://www.ibef.org/industry/ecommerce.aspx

DISTRIBUTION OF ONLINE PURCHASES ACROSS CITIES

- Chandigarh **1.26%**
- Delhi-NCR **36.86%**
- Ahmedabad **1.04%**
- Surat **1.33%**
- Kolkata **3.66%**
- Pune **3.24%**
- Mumbai **18.97%**
- Hyderabad **7.33%**
- Chennai **4.23%**
- Bengaluru **11.62%**
- Coimbatore **1.26%**

AVG. ORDER VALUE ACROSS TIERS

URBAN AREAS
TIER-I ₹1544

SEMI- URBAN AREAS
TIER-II ₹ 1157
TIER-III ₹1033

Figure 2. Picture source- https://www.pixelmattic.com/blog/e-commerce-in-india-2017/

It's possible to combine e-business and logistics operations. In particular, the integration of information concerns the exchange of information among all participants throughout the supply chain. In addition, demand forecasts, inventory status, capacity plans, shipment schedules, promotion plans, information on demand, and production schedules are exchanged. Ideally, such information should be made available to the relevant parties on an on-line basis on online basis without any considerable effort. The relationship between the amount of e-commerce and the cities that are common with this service was defined in the picture below. You will notice the distribution process of products is highly in metropolitan cities of India, Delhi is the first(it is divided into three areas, NCR, Gurgaon, Noida) and then Mumbai, and last is Bangalore

4.1 Population affecting last mile delivery

[13]Not only in India but other countries with population boom such as china, America, Brazil, Russia, etc require urgent improvement in the logistics efficiency where innovation is a must since the large concentration of population and activity is restricted by geographical areas. In urban areas, a large number of co-existing

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[13] https://www.mdpi.com/2071-1050/12/16/6492/pdf

activities contribute to a range of effects, such as severe congestion, environmental degradation, political problems, fraud, etc. High-density housing and office building is the most evident aspect of the economy and industry in India. For the logistics sector, high resident density implies high order density and has both advantages and disadvantages.

In India, modern housing and office trends are different in different areas. These communities are typically private and sealed, and only the members have access to these communities.

4.2 Housing and offices

A major consideration for logistics is that high-density sales will help the shipping economy, and the order density should be sufficient enough to offset the drive and delivery costs for each distribution. Even if the amount of online market purchases is twice that of today's catalog sales, to shift the basic distribution economy, it will not have adequate sales density.

[14]An example of where Japan and China have been very successful in terms of their extremely high distribution density over a relatively small region. The high-density housing and office model in India could therefore be an opportunity for the last mile delivery.

4.3 Problem areas as per customers

The most challenging thing in India is not technology, but the issue of concern. Conflict of interest—The conflict over benefit is impossible to settle smoothly. Under this situation, if the property maintenance charge would not cover their management expenses, the Property Management Firm will fail to deliver an agreement service such as collecting and repairing parcels. Individuals need to provide security officers to hand things over to homeowners or office workers. As a result, these management firms have announced that they can no longer accept parcels from express companies, and dispatchers will not be able to enter their communities directly without reservation. Even as the peak hour arrives, the capacity is not adequate for the increasing number of new deliveries, both to property firms and to express deliveries. Another problem is that India is one of the worst-hit countries after America in terms of coronavirus and causes a steep increase in the level of unemployment. And even though the lockdown has been relaxed, it's still quiet because of fear. This has caused unprecedented growth in demand for online orders and e-commerce has also been

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[14] China last mile delivery market-
https://www.mordorintelligence.com/industry-reports/china-last-mile-delivery-market

seen in this era. To respond to this situation, the micro logistics and last-mile distribution companies are scrambling to adapt. According to a recent survey by Urban Logistics Opportunities [15](Frost & Sullivan)-Last-Mile Innovation, global logistics is projected to hit $10.6 trillion in 2021 and about 70% of transportation will be accounted for. The last mile is synonymous with nearly two-fifths of the overall logistics costs and this will mean that the leading players will have to come up with new creative solutions. [16]The pandemic has driven the implementation of innovations in last-mile distribution and will continue to do so in the aftermath, providing a strategic edge for key players. [17]As per the study conducted by Statista study, the biggest difficulty faced by last-mile delivery worldwide including adapting to last-minute shifts, aligning with warehouse operations, minimizing rebounds, reducing logistic costs, and on-time delivery.

[15]

https://ww2.frost.com/news/press-releases/last-mile-delivery-models-revolutionize-space-urban-logistics-2025/
[16]

https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/insights/logistics-startups-india
[17] https://www.statista.com/statistics/816884/last-mile-delivery-logistics-providers-challenges/

Chapter 5. Analysis of Existing solutions

Last-mile delivery is not just about the product being delivered but how also they get delivered. It creates in customers an emotional moment, the happiness, joy when they receive the product they ordered. As the demands get higher, a more technically advanced approach is embraced by the e-commerce industry and logistics providers will have a great opportunity to reinvent their services and ensure an improved customer experience. Listed below are some methods used by courier services:-

5.1 Van and EV

A courier shipment is commonly used in India via Tuk Tuk or Van. Most of the distribution of goods is limited to a particular period, so when delivering one the courier has to be swift and cautious. Since these first-hand pickup trucks are expensive, most businesses prefer second-hand vehicles, since they are inexpensive and simple to buy. [18][19][20]The arrival of electric vehicles for the services is a new trend, but it is not successful. The charging time is the biggest problem with the product. Charging time in electric vehicles is a major disadvantage as most Indian customers are impatient and do not want to wait long for their vehicles to charge. While fast charging is possible on most of them, it normally takes around 80% of the vehicle to charge an hour, which is still a long wait. Second, there is no charging station. Installing a vehicle charging station involves investment in which is expensive. Service Centres in India are entirely new to EVs, due to lack of expertise, most mechanics do not operate on such vehicles, and most service centers are known to duplicate customers for citing false issues.

5.2 Motor bikes

Since the bike is a necessity in India. Dealers allow customers to buy vehicles for a very less amount of down payment. There are more than 37 million motorbikes in India currently. The role of a bike courier is to simply pick up and delivers the goods. They mostly operate on a small scale, gathering packages and rapidly distributing them across the area. Because of the benefits that biking has in urban areas, there is a demand. Bikes suffer less from road congestion issues compared to what can be considered traditional van or truck transport. It can also be seen that the more congestion is faced in metropolitan areas, the more they have an advantage. Most bikes are used by students as a part time job.

[18] https://www.sciencedirect.com/science/article/pii/S2666691X21000130
[19] shorturl.at/rMTV5
[20] https://motoroctane.com/news/198276-electric-vehicles

5.3 Smart locker or pickup station

[21][22]In India, two companies are offering smart boxes. The shipment comes to a convenient spot, and within a few days, you go down and pick it up whenever it suits you. To get access to the locker, you type in an OTP, which guarantees that nobody else is going to wander off with your stuff. If you're lucky enough to live with a smart locker in a home, you know just how useful it can be. The Smartbox company has its boxes in 100 locations in Delhi. Though Bangalore's Qikpod has 300. That sounds like a lot, but in fact, it means that the lockers are spread far and wide, and even for people living in nearby buildings, the ones within apartment complexes are usually not available. That's is the reason why plenty of lockers end up clustered in the neighborhood or around tech hubs.

[23]Moreover, the Locker system also has drawbacks compared to the pick-up station with manual operation. For example, pick-up stations offer more payment options than locker systems, such as cash payments. In India, since people do not trust anyone easily e-commerce is heavily dependent on the cash-on-delivery mode of payment for more than 50% of transactions. Cash on delivery is a mechanism in which shoppers pay for the goods in person on delivery. If the COD(cash on delivery) buyer fails to make the payment, the goods have to be returned to the seller.

The locker system can also bring inconvenience to some customers, such as elderly people, while the store workers can provide customer service at a pick-up station. In addition, since its storage room is pre-set, the intelligent locker device is more adaptive to the size of packages.[24] With various shapes and sizes of parcels, pick-up stations are more versatile, since all parcels are held in a warehouse in the shop (Weltevreden, 2008).

5.4 PickUp Offices

Many pick-up offices are managed by the government in India. And the one owned by a private person has their vehicle service and prefers to offer it on the same day. Pickup offices are very small because they have to deliver the parcel to the head office every 6 hours and the customer drops every minute to deliver the goods as well as to pick up.

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[21] https://techcrunch.com/2015/12/09/qikpod/

[22] https://timesofindia.indiatimes.com/business/india-business/now-smart-lockers-solve-your-delivery-dilemmas/articleshow/71301115.cms

[23] shorturl.at/acjHP

[24] https://www.sciencedirect.com/science/article/pii/S2352146517307809

Chapter 6. Solution Space

In the case of last-mile services, customers have created a profusion of new demands to which the consumer goods and retail industries are clamoring to respond. Necessity is the mother of all innovation. But if brands and retailers want to preserve their viability, there are several realistic obstacles to be overcome. In this work, an attempt was made to find a new innovative solution to urban last-mile delivery, focusing on the unprecedented growth of e-commerce and technological advances. The effect of e-commerce on total traffic volume, associated congestion, pollution, and other qualitative factors of impact, such as consumer convenience and competitive dynamics, and most of all human drivers, has been given greater emphasis.

[25]According to the study by Frost and Sullivan Urban Logistics Potential, global logistics is expected to be a 10.6 trillion dollar industry in 2020 worldwide and transport alone will account for about 70% of this pie. The only way forward, in these demanding times, is to build innovative models to meet changing consumer needs. Technology will be one of the biggest game-changers in the ecosystem. People are no longer going out to buy items because of the pandemic, instead of buying them from the comfort of their homes and awaiting same-day delivery. Before thinking of a solution space we must take into consideration that it makes up the whole basic Indian problems.

6.1 Cost on re-deliveries

If the eCommerce businesses struggle to deliver the product on the first go, second or third delivery attempts result in loss of time, resources, and customer experience. [26]Experts are of the view that a delivery boy needs to make about 140-150 visits for every 100 deliveries. In the event of reverse logistics, the method of handling returned or declined goods raises the ratio to 230-270. Moreover, in the last few years, deliverymen's wages have risen significantly from Rs.10,000 to Rs 20,000, while the product's average ticket size remains the same. These issues of last-mile delivery continue to increase in small towns and rural areas. These areas account for about 50% of the total traffic generated by India's e-commerce companies.

6.2 Infrastructure

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[25]
https://ww2.frost.com/news/press-releases/last-mile-delivery-models-revolutionize-space-urban-logistics-2025/
[26] https://blog.locus.sh/when-will-my-package-arrive-the-cost-of-missed-deliveries/

The factors, including bad infrastructure, inaccurate marking, long journeys, etc also contribute to the last-mile delivery troubles. In the cases of single package deliveries, where an immense amount of expense and fuel is involved in one delivery itself these considerations may be more problematic. When the product to be shipped falls in the category of delicate, electronics, or large products, the danger multi-folds. The delivery standards of customers have also risen these days, and they expect to see real-time shipment monitoring, consistent alerts, proper contact with the delivery team, and receiving the package according to their convenience. Many e-commerce businesses face an uphill battle because of this.

6.3 Crowded City Streets

There are 12,000 and 30,000, 10000 individuals in Delhi, Mumbai, and Bangalore, in every square kilometer, respectively. I find it terrible and horrific itself. However, the issue assumes an even greater consequence when you add in the mode of transport that people use within the city. What this means is that cars are regularly logged on city roads and a measly average speed is reported inside cities. Now with the rise of online cab services like Uber and Ola, the streets are difficult and hectic to drive on.

6.4 Inaccuracy of address

[27]The area covered by a pin-code is up to 90 sq km, which means it could contain more than a million households. Failure to correctly locate the address often affects inefficiencies in relevant processes such as route planning, location of the nearest completion center, and delivery partners. Not the address also but the names too.

6.5 Vehicle Utilization

More than 70% of the last mile logistics market is made up of small suppliers and drivers. A survey was conducted by a distribution company in India named Shadowfax, which showed that this unorganized market is riddled with supply chain inefficiencies, keeping the average utilization of the ecosystem at a low of 35 percent. These inefficiencies can be grouped under three large headings: inadequate preparation of the route, improper use of space, and concentrated demand at peak times. In the logistics sector, speed and efficiency are two main measures of success. At the last mile, which is sometimes referred to as The Moment That Counts', they grow even more important. When we hear the similar problems above we tend to think of Ideas such as Automated guided vehicles, drones, bike couriers (or potentially droids), AI, Big Data, etc.

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[27] https://archive.factordaily.com/india-14-bn-problem-with-addresses/

6.6 Green Solution

Although bicycles and containerized bicycles depend on raw human power, robots, drones, and driverless cars are most likely to be the future of last-mile delivery. The vision is for autonomous vehicles to pick up packages in warehouses from the shelves and transport them directly to the doorstep of the consumer. The technology has not been mastered yet, but some of the largest firms are racing to improve it. For example, Google's Project Wing aims to be an independent drone delivery service that can deliver everything from fresh produce to emergency medical supplies within a round-trip distance of 14 km. Eco-friendly artificial intelligence (AI) robots in London are transforming the face of food distribution by serving customers by zero-emission electric robots piping hot food.

Chapter 7. Choosing between Automated vehicle or Drone

What makes transport expensive is the distribution of goods during the day? No company has ever shipped a product before 20:00. As per the interview, More than 70% of customers prefer the cheapest home delivery on the same day. So a solution space where, apart from standard packages, lockers can also prove the distribution model of choice for same-day and time-window products. A key requirement for delivery on the same day is a fast delivery operation, but more importantly, the logistics center needs to be close to the receiver so that the last mile can be covered within a reasonable timeframe. Same-day pastels are likely to require a different network from standard parcels, but as regular delivery tours normally have left the warehouses for a long time, same-day delivery items are ready for shipment.

We need to have very important preconditions in place for playing this function. They will need, first of all, a fully-fledged parcel network that allows for a high degree of consolidation. We're talking about 20 to 30 million plots a day in India alone, to get a sense of the scale involved. Second, an IT infrastructure that can handle several thousand bots and direct them through daily traffic while improving the routes regularly will need to be in place. Last but not least, a few thousand trained staff would be expected to manage the fleet. So it will be important to hire and/or retain the requisite experts. Thus creating more employment in India.

Same-day delivery would also rely on locker bots, close to ordinary deliveries, and time-window goods, but later on the same-day vehicles will depart their bases and will not mix product streams. Approximately half of the same-day delivery segment, consisting of more than 70% of packages, originates from urban areas. Similarly, delivery on the same day will provide e-commerce players with a good way to differentiate their supply and fuel growth.

This segment's relative infancy also makes it a good target for new players who would face relatively low entry barriers-only a small number of potentially automated depots would be needed from an infrastructure perspective. It remains to be seen if incumbents will use their current size, infrastructure, and business expertise to protect this lucrative segment or whether e-commerce companies will be able to seize this opportunity to penetrate the distribution market on a larger scale.

7.1 Drones deliveries

[28]Civil aviation regulator Directorate General of Civil Aviation (DCGA) announced that flying drones, also referred to as unmanned aerial vehicles or UAVs, for personal and commercial purposes won't be illegal in India. A permit is required for commercial drone service and they are not allowed to fly more than 400feet vertically. Considering this opportunity as a breakthrough most companies are trying to get their hands on the likening and researching on new drone delivery methods.

[29]As has already been pointed out in urban areas, because of the large distances that need to be driven to be in the right place at the right time, except for two-hour windows, it is incredibly costly to provide delivery within a given time window or on the same day for any form of driving vehicle. The one drawback is that drones can transport objects up to 5. Kg, but only 2 kg has been tested by the delivery companies. [30]Second, Drone sizes vary currently and as per drone size, the legality of the permit varies. And drones that have to travel long distances are huge and it is difficult to find landing sites easily. These key drawbacks can be resolved if the drone service is confined to small parcels and rural areas where it is easier to locate suitable landing sites. There is no solution, on the other hand, as centers are too far away from them.

Drone services may also be the only way to provide rural areas with same-day and time-window services, and we are some of the customers in these areas who would appreciate the deal. If the same day and time-window distribution of drones in rural areas prove feasible, approximately 20% of deliveries will be distributed in this way, most of which will be delivered on the same day.

[31]7.2 What these two methods would provide overall?

7.2.1 Reduce overall cost

It costs a lot of money to move goods from a transportation hub to their final destination. With no need for drivers to transport or secure packages, delivery robots

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https://www.livemint.com/technology/tech-news/new-drone-rules-take-effect-unauthorized-trade-to-invite-penalty-11615723982675.html

[29] https://www.ijert.org/last-mile-delivery-by-drone

[30] https://inc42.com/features/heres-why-drones-will-not-join-home-delivery-fleets-in-india-any-time-soon/

31
https://in.mashable.com/tech/14611/drone-deliveries-in-india-might-be-critical-post-covid-19-lockdown-heres-why
https://cio.economictimes.indiatimes.com/tech-talk/delivery-drones-enabling-last-mile-delivery/3253#:~:text=for%20individual%20customers.-,Last%20Mile%20deliveries%2C%20especially%20parcel%20deliveries%20could%20also%20be%20more,autonomous%20vehicles%20or%20delivery%20drones.&text=UAVs%20could%20provide%20relief%20for,roads%20and%20maintaining%20delivery%20times.

would be less expensive to maintain. The cost of producing delivery robots will of course, initially be high, but the cost of manufacturing robots will eventually decrease with an increase in the number of deliveries. The use of delivery robots would also boost the client's whole shopping experience.

7.2.2 Less delivery Failures

The delivery attempt fails when the address is difficult to locate or when the delivery is not collected by anyone. Delivery robots, however, can have GPS systems integrated to locate an address that is difficult to find. Also, robots will wait for the customer to arrive home if there is no one to collect the order and without any additional cost. Delivery robots may also be programmed to complete deliveries in serious circumstances.

7.2.3 24*7 Service

Another major issue facing last-mile delivery is traffic congestion. Delivery becomes difficult during the peak operating hours in urban areas. Deliveries can be rendered with the aid of delivery robots, even during non-working hours when there is low traffic. Deliveries can be made at any hour of the day that the customer needs because robots can operate 24*7. Delivery robots are expected to be widely introduced, with many startups showing interest in using delivery robots to fix last-mile delivery issues. The future of last-mile distribution will surely be the use of delivery robots. Companies operating in countries with high labor costs should consider using robotics for distribution until it's too late, as it will reduce their investment in labor capital and improve profitability.

7.2.4 Employment

Since most of these automated bots are required to be monitored constantly, more hiring of the human person would be required.inc

Chapter 8. Competitor Analysis

There are a lot of companies and countries that have implemented innovative solutions to improve their last-mile solutions. If you're in business, you're sure to have competitors. No business concept can run on a monopoly track in today's world. Even if your product or concept is among the most unique in the world, in some way or another, you will always have to compete with rivals. A competitive analysis is a way of recognizing rivals and knowing the strengths and limitations of the competitor in comparison to yours. To best analyze my overall competitors I took 10 companies that have roots to understand problems in last-mile deliveries.

Savioke, Eliport, TeleRetail, Aethon, Postmates, BoxBot, Evidence, Robomart, Cleveron, Starship
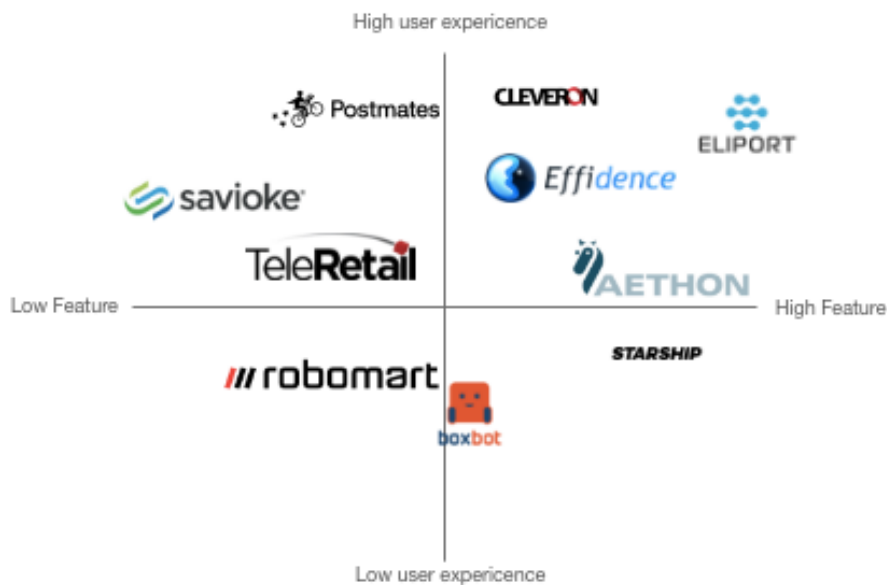
Figure 3: Competitor Analysis

The map below represents the high and low user experience along with products in terms of high and low features. The most important factors such as Ease of use(how easy it is to use for the common user to use it), Speed of value (how quickly and continually they develop innovative products and get them to market quickly), Timely Delivery (how fast is their movement), how Eco-Friendly are they, and what are the legal issues, product Quality and how safe are they.

There were a lot of products that are new in the market and are focusing on the niche market so in terms of features they were left being. Product with more features could only be found in companies that are well established and target a huge segment of the

customer. And clever-on turned out as the company with plenty of innovative products catering to a different segment of the market. Products like Savioke have great features because of their limitation indoors and used in hotels. Similarly, I analyzed 10 companies and targeted each segment from where I can gather enough information to understand the working.

Note: the research on these products were merely to make myself aware of the technologies available in the western market and understand their uses and how they function.

Chapter 9. Optimising the solution

Why do you think last-mile delivery so important for any business? It refers to the transportation of goods or items from the warehouse to the customer's doorstep as fast as possible. There has been a huge change in the last mile courier industry in the past decade, and how the industry functions. These companies are supposed to provide, speed, safety, reliability, on-time delivery and improve a better customer experience. Deliveries and Door door pickups and online trading were never part of the last mile and it was never experienced before by any customer in India. But with the emergence of need, things start to change and the introduction of private courier companies emerged. Last-mile delivery is the backbone of all the businesses in the world. But in a country like India, the use of last-mile delivery is an important issue for a business like e-commerce since India is still growing. Customers have different requirements and problems and most of the times companies forget their main customer to understand their problem. Customer requirements like Delivery address change, cash on delivery, etc have become frequent, and more problems go unnoticed. It becomes more difficult and challenging to deliver when considering different types of packages for deliveries, where cost and fuel in huge amount are involved in one delivery only. The risk increases when the product falls in the category of fragile.

As India is recovering slowly post CovinD situation, consumer demand is starting to rise and there is a lot of trouble regarding the micro-logistics and last-mile deliveries and is giving fuel to buying more vehicles for the deliveries. The only best way is to come up with a disruptive method to meet the needs of the customer and to create that we need to target the main problem.

9.1 Problems and unexplored potential

1. Certain Window of the day delivery- In metropolitan cities such as Delhi, Mumbai, Bangalore, the customer's requested delivery time is either early morning or late at night. And from 9:00 am to 8:00 pm, distribution offices run. So if some item is not shipped, either due to customer error or delivery guy error, it is then rescheduled for delivery the next day or any other day, which eventually costs the company a lot and loses the trust of the customer in the business. It takes a lot of time during day hours to get to the warehouse station, which makes most individuals unable to get it. For not repeating the

same delivery and avoiding money deduction from their salary, which sometimes leads to misplacement or missing of the products, most delivery guys leave the parcel to the next-door neighbor or the security guard. Leaving at the door is never recommended as parcel poachers are increasing in India if they notice boxes from either DHL, AMAZON, UPES, etc.

2. Traffic peak time- Every hour is a peak hour in India but most Peak traffic time in cities starts from 8:00 am till 10:00 am and at night it is from 5:00 pm till 9:00 PM. As discussed before, in India delivery guys are required to perform two tasks at a time. First is the delivery of the items and second is the picking up of requested items for delivery. Which makes the jobs hectic and dangerous for them as well as others.

9.2 Conclusion

There are challenges in the last mile deliveries that require to be tackled as earliest as possible because the delivery style is changing constantly and people are becoming aware of the arising problems and are concerned. Indian companies are struggling with problems related to package delivery. To tackle these problem, there has been plenty of solution being implemented but failed miserably. In the following chapter we would discuss the design proposal and what lead to proposing my solution.

Chapter 10. Design Process

This section presents the ideation stage. The first step and a big part of the ideation stage were to gather information and file it into a map to look for the problem areas. This lead to two possible solutions (drone and automated) as mentioned above. Since drone delivery is highly recommended for delivering objects, it is best suited for rural areas because of the large area to land the drone as well as no buildings for it to crash into and such problems could occur while delivering in urban areas. So to deliver objects, I have decided to continue with the use of on-road automated delivery systems for the streets of Bangalore India.

India is divided into 3 tier categories, the first being the metropolitan cities, the second semi-urban, and lastly rural. Before creating a design I had to understand the kind of structure I needed to select. Since India is a highly populated city I had to make sure I choose a place more viable. There are two types of deliveries, (*Figure 4*) first being larger than freight and (*Figure 3*) second parcel. Freight requires heavy machines like trucks to operate and move around and my focus is on environmental issues I decided to move on with parcel deliveries as they are easy to carry and light. It was also crucial to elaborate on the variety of segments delivery has and their impact on the baseline. In Indian city archetypes, ⅔ of delivery vehicles used are freight and the remaining could be categorized into light vehicles. However, these vehicles continue and mark up the majority of last-mile vehicles and provide unnecessary congestion on the roads and highway due to slower acceleration and low speed. If we can replace such vehicles with EV, ES, etc, it could be impactful, but even those will bring out new challenges and I intended to create a solution that could eliminate those.

10.1 larger Than Parcel

Understanding types of parcels is really important. It provides a better perspective on different segments in the delivery process that are generally missed out on. also it helps to understand their uses cases that help in better understanding of its function.

Networks for last-mile delivery

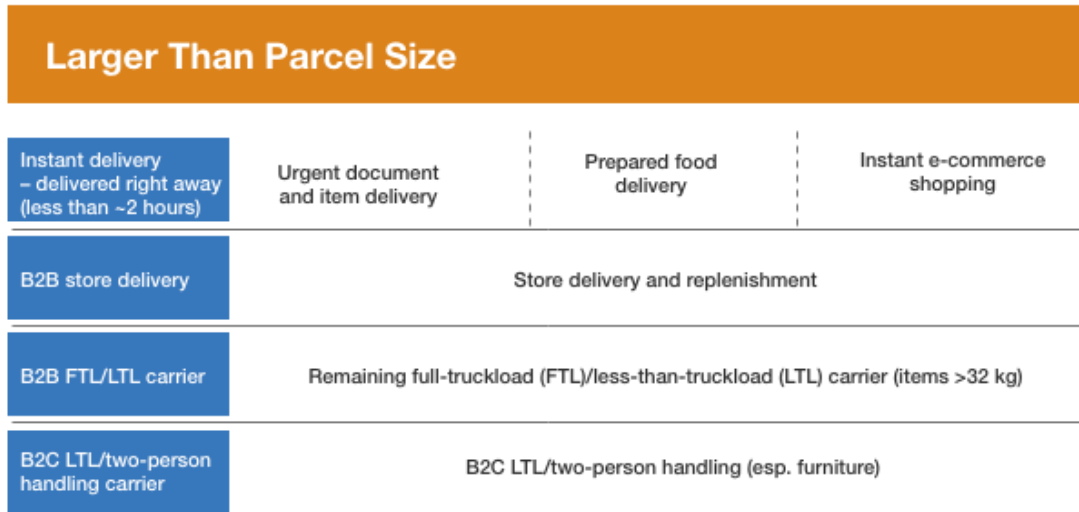| Larger Than Parcel Size			
Instant delivery – delivered right away (less than ~2 hours)	Urgent document and item delivery	Prepared food delivery	Instant e-commerce shopping
B2B store delivery	Store delivery and replenishment		
B2B FTL/LTL carrier	Remaining full-truckload (FTL)/less-than-truckload (LTL) carrier (items >32 kg)		
B2C LTL/two-person handling carrier	B2C LTL/two-person handling (esp. furniture)		

Figure 4: Segments and use case of large parcels

Parcel size deliveries are divided into 4 segments. (Figure 3.) First, it starts with the deferred deliveries that focus on the normal/express commerce shopping and product returns. Along with it on small scale business to business and customer to customer shipping but the companies that provide such services are less in demand due to customer safety. Second, are those deliveries that have the definite time arrival and considered as the priority such as largely International shipping or express shopping. Third, are the same-day deliveries. Same-day deliveries are very rare due to high demand in commerce shopping but most are people willing to pay the extra amount to get same-day delivery. But one-day delivery is really high in demand and now due to cover situation people are using services such as Amazon and more. And instant deliveries in a time frame of 1- 2 hrs are mostly used by food companies, restaurants, or delivery of urgent documents and are high in demand.

10.2 Parcel

Since most of the parcels that are delivered in indian neighbourhood are mostly small because customers prefer ordering items that could be received as early as possible and thus underlining types of small deliveries and what is their function provides a clear picture overall

Networks for last-mile delivery

Parcel Size			
Deferred delivery – arrives some day	Normal/express e-commerce shopping and returns	Small-scale B2B shipping	C2C shipping
Time-definite delivery – arrival next/specific day/time	(Largely international) B2B reliability shipping	Express e-commerce shopping	
Same-day delivery – arrival on same day	E-grocery shopping and returns	Same-day e-commerce shopping	

Figure 5: Segments and use case of small parcels

Since my main focus is not the deliveries that are small in size, larger parcel deliveries have different criteria of managing, handling, categorization, and delivering. (Figure 4)Most one their deliveries are FTL and LTL carriers. Larger Parcel size deliveries are divided into 3 segments. Firstly business to business store delivery such as items for constructions or decorating of house etc. Second, FTL(full truckload) or LTL(less than truckload) carries items that are heavy than 32kg each. Mostly the products are shipped and then dumped on the trucks. Third, LTL carriers carry products such as Ikea items that that easy to carry but still heavy.

10.3 Ongoing Digital shift

The ongoing digital shift in e-commerce has come a long traditional way and has changed the game of how we used to purchase products. With the rise of online retailers in India, such as Alibaba, Flipkart, snapdeal, amazon is largely occupied with traditional yet most ordered categories such as books, clothes, and electronics the most. Flipkart, Indian e-commerce hit 60% in the 1st quarter of 2019. However, in recent years, new categories have emerged and moved up the online scale. Attached below shows how normal vehicle parts, furniture, body care, etc have gained a rise online (figure 5). [32]Other products such as healthcare, Groceries are mostly bought in the store, but the information and their presence online have drastically increased. We can see more and more new product categories shortly, which will require the last mile to improve. Along with that, the purchase of clothing, electronic items, and luxury goods has seen a drastic increase in online orders in few years. And since most of the

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[32] https://www.finplus.co.in/top-categories-online-retail-in-india/

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users interviewed prefer ordering small items online, I have decided to consider cloths ordering as one segment to focus on while creating the product.
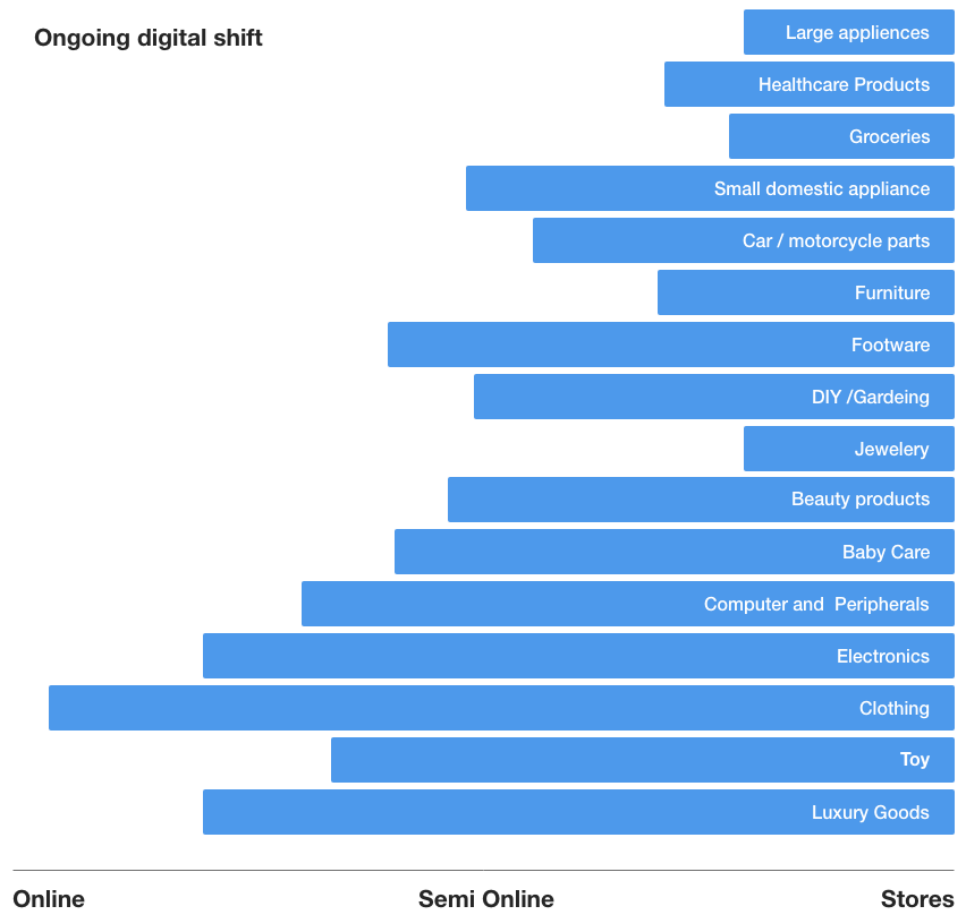

Ongoing digital shift

	Online	Semi Online	Stores
Large appliences			
Healthcare Products			
Groceries			
Small domestic appliance			
Car / motorcycle parts			
Furniture			
Footware			
DIY /Gardeing			
Jewelery			
Beauty products			
Baby Care			
Computer and Peripherals			
Electronics			
Clothing			
Toy			
Luxury Goods			

Figure 6: Ongoing digital shift from stores to online

10.4 Product

Humans are on the verge to revolutionize transportation, which will change our mobility. As well as generating business opportunities, autonomous vehicles provide reliable and stable transport. The implementation of AV in urban areas will help push future designs and create cities for humans. Most of the time is spent is driving in traffic congestion, parking, looking for parking spots would be eliminated and could be used for other tasks. To ensure that people adopt automated vehicles, the whole experience should be showcase as interactions with robots rather than just robots or cars.

10.5 Ideation

The prerequisite of creating a product that is the amalgamation of the storage boxes and automated vehicles requires a deep understanding of India. India is a country where unless every external factor like road, electricity, population, etc is not considered the producer does not quality, and companies like Amazon and flicker and Alibaba inured loss in the first year because they did not consider many factors. Currently, there is a heavy impact of e-commerce in traffic volumes both commercially and private and as well as people and there is no doubt that certain aspects of interdependence are in trouble. Sometimes e-commerce has a strong effect, as a person makes the individual car or bike trips to the shopping areas, however additional traffic is caused due to the regular use of delivery vehicles by companies for goods as well as traffic that is caused by the people who have come to pick up the parcel from these stores. The least traffic occurs n commercial since there is a reduction of replenishments in stores

The following graph (Figure 5) represents private as well as government last-mile delivery companies and individuals add its impact.

Commercial and private traffic volume

Last Mile Traffic	Traffic caused by e-commerce shopping through parcel delivery
Last mile Individual traffic	Individual traffic caused by recipients picking up parcels (e.g. from parcel lockers
Commercial traffic	Reduction due to fewer store replenishments
Individual Traffic	Reduction in individual traffic as online shoppers lower on shopping trips*

Figure 7: Commercial and private traffic volumes

The main objective of the final design was to keep into consideration the current technological or automated delivery methods being used in India but are not in demand and those which are in demand, how could we try to join both of them indeed

together for better delivery and to give a boost towards automation in India. During the analysis and understanding of problems, it became clear that there are plenty of solutions in the world(like Europe, the USA, etc) but are not being implemented in India. The main reason was that of Indian Traffic, population, No rules-following, roads and plenty more. Since there is so much population, people prefer the use of normal delivery in scooters or vans as for them it is really fast but they are not safe. So companies do not prefer to invest in the implementation and research of technology for this area in India as they can use the most common method of delivery. So to create something, I had to think of something incremental and not radical. Because we as a human cannot use anything that is not intuitive and its best to reduce the human cognition load while creating something new. But the product needs to be able to adapt as well as modified as per future needs. Because the future is all about sustainability and a clean environment we need to consider 4 areas that would affect the present as well as the future of eCommerce in India. CO2 Emission, Unit Cost, Traffic, Power Disruption. Attached below is the future expectation if EV and night deliveries are implemented. So to create a new delivery system it was crucial to understand the mentality of not only the delivery company but to understand the requirements of users(customers). And thus creating the solution best suited for the Indian population.

10.6 Concept Creation

The main function of the concept is to timely delivery of the object, Safe Delivery, the safety of the humans around, reduce the physical load on human drivers as well as the courier companies.In the concept creation section, several considerations have to be taken into account, regarding the size, dimension as well as and overall mechanical system.

The concept is created in three segments. All three areas combine the delivery of the product as well as focus on creating employment in India.

1. Automated loading Vehicle (manned as well as AI)
2. Autonomous dispensing unit (manned as well as AI)
3. Automated Locker Vehicle (manned as well as AI)

Currently, in Bangalore, there are 20 DHL offices and more than 100 other delivery companies in the area of 709 km² with a population of 8.4 million residents. And second, widely use delivery service is government postal which has 1 office available in each district(very very low). Now considering the area and constant delivery of couriers it is clear to assume that most deliveries are not fulfilled at the given time

either it is due to the courier service or the customer or it could be the traffic situations where driver suffers a lot. There arrives the problem of delivery for which I have added an automated loading vehicle.

10.8 Current System Map

This system map depicts the current process of the last-mile solution implemented in India. Since India is a densely populated country and the target audience Bangalore, has 8.4 million residents warehouse companies require vehicles in huge amounts. (Figure 8)Companies have cars around 4 to 6, along with scooters around 9- 10 since they are small and can move through traffic. Tuktuk vehicles that are relatively bigger than cars and smaller than trucks are sound 6-7 and truck are 3- 4. And this is one only one warehouse, companies have more warehouses overall and thus more vehicles. It not only releases pollution but also causes huge traffic. The only green solution in these facilities are the bicycles, but they are used less compared to other since courier require fast delivery and they do not match the speed of a motorvehicles.
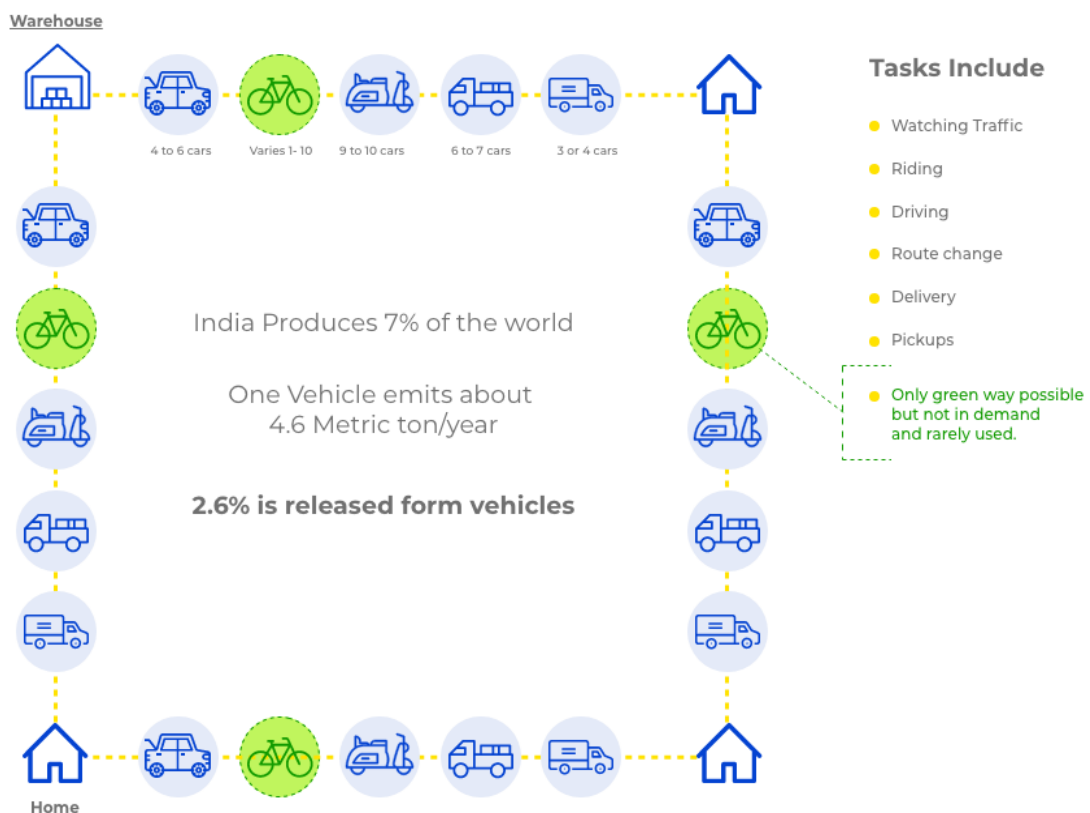

Figure 8: Current Process with india traffic

10.9 Positive Impact

India is a very busy market so before a product is created for the indian market we make sure it covers all the important factors not only to the business point of view but the overall benefit of the country in terms of emission, congestion and disruption, if the product is talking about implementing on a large scale. This map depicts the reduction in number(negative being positive) if product meets the pointers above criteria.

	Night Delivery	Electric Vehicles	Parcel Boxes	Cycle Delivery	EV's	Night Multiple Deliveries and similar time deliveries
Emissions	-35%			-10%		-30%
Unit Cost	-15%			-30%		-10%
Congestion	-25%			-30%		-10%
Disruption*	Less			Medium		Medium

Figure 9: Overall effect

(Figure 9)Most of our office or house parcel deliveries are conducted during day time that results in more traffic in already congested place and an increase in the carbon emissions rate. If night deliveries along with environmentally friendly vehicles and parcel boxes are used the emission rate of India could drop up to -35%. If that includes the possibility of night deliveries, electric vehicles.

As most of the cost incurred by the companies is due to the return or missed delvers of the product, the solution could relieve companies and reduce the unit cost by -15%, whereas congestion situation due to traffic during the nighttime would be reduced to more than-25% as there are rarely any vehicles on the road and solution would provide safe and fast delivery of the products. If we consider nighttime delivery the effect on the environment would be 30% but since customers are not available during night time, personal deliveries are not possible unless something additional is introduced. The result on the unit cost would be around 10% because of the human effort and waiting time. And still, the congestion rate would be 10% as opposed to the other because of the use of plenty of vehicles and human effort of driving it would result in I the congestion.

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Cycles delivery is beneficial to the environment but due to the rise in e-commerce, customers want their product to be delivered fast and most of these environmentally friendly mediums go to waste. Only government post offices prefer to deliver letters through their medium but rarely.

Chapter 11. System Design

In this chapter I would be discussing the solution I designed after carefully analysing the problems being faced not only by the customers but the whole courier industry in India. While researching I realised that the main problem currently exists is due to 3 factors of the courier companies. Speedy delivery, scalability and sustainability. And each of these factors are linked with one another but does not work in sync. If speedy deliver is the main target of the companies, it disturbs the sustainability factor due to introduction of more vehicles and if they try to work on the sustainability it leaves the scalability option vulnerable because of the limitation in budget of the companies. And if they try to scale the business they boost up the speed delivery factor that disturbs the sustainability . So its a loop where the current system is stuck. And this intrigued me to create a green solution that could ultimately be beneficial for all the stakeholders involved.
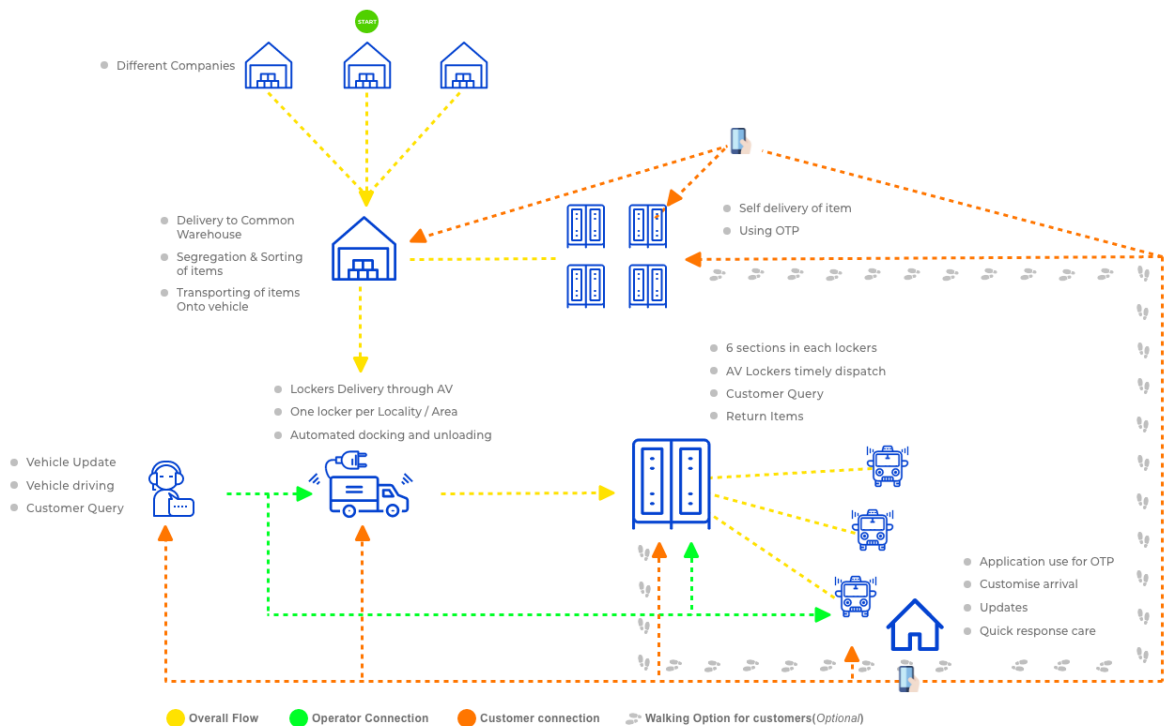

Figure 10: System Design of proposed solution

(Figure 9) The whole system is designed in such a way that the user is alway updated and could track each progress of its product and can also return the product back using the same vehicle at any given and form anywhere. An operator(driver) would be in constant touch with the user if they require quick assistance. Since every journey of the vehicle is constantly being monitored and handled by the operator, and the implementation of the system would not eliminate the job of the driver but enhance it and help building the experience of something new.

The proposed solution requires a collaborative initiative of courier companies. As you can notice the first section of the map depicts 3 different warehouses of different companies. Once all the companies receive the parcels, they would drive to the common warehouse where they can drop off their parcel or they can directly drop the parcel in the common warehouse. Once received, the warehouse would then segregate and sort the items as per the location. Along with that, the user could track the delivery of the product as per steps using the application(explained and attached in the next paragraph). Outside each warehouse would be a locker attached so that if the user is somewhere near they could pick the item themselves, thus giving users full freedom of their choice. Once the parcels has been sorted and arranged, it would be then be uploaded in the electric automated loading vehicle(Human and machine help). Each vehicle is assigned with a location as where to drop the package off. And each drop zone targets the nearby areas. Electric automated loading vehicles would contain 3 to 6 movable segments called Dispensing units that would be dropped off at the different locations. Each dispensing unit would have an automated locker that would dispense itself when requested. (*Detail explanation of the communication process and app is below*).

The next few paragraphs would consist of an explanation of how the system would work. It conspiracies of the motion of the vehicle, the type of operation it will perform, and how the servicing of the product be done if something malfunctions.

11.1 Automated Loading vehicle

Automated loading vehicles would have a base section for each locality. For example a DHL office. Each automated loading vehicle would comprise boxes of the smart locker. Each delivery area will then be divided into the section so that ALV(automated loading vehicle) could drop off the locker at the allocated station. The vehicle would consist of four wheels with a flat section in the center to add lockers to it. Each courier office would have sections attached inside where the vehicle would load the boxes. Since

automated loading vehicles are huge and carry heavy products to explain the process more clearly the operation is divided into 4 steps.

First: Each smart boxes would be fitted onto the ALV using a lifting motor that operates to raise up the lids or direct drag to the vehicle where the ALV would reduce the load of human dragging the object by lowering or lifting the vehicle accordingly.

Second: Every 4 corners of ALV(tires section) would comprise of hydraulics to adjust according to Indian roads as well as lowering and lifting. Third: Once the boxes are loaded onto the vehicle it would lock the bottom and top of the locker using integrated strains. Fourth: Once properly loaded and secured, the ALV would then drive towards the designated location to drop off the boxes. Each vehicle is operated by humans.

It is also crucial to make the product in such a way that if any trouble arises it should be easily fixed manually too. So Before the start of any journey, during the journey, and at the end, the ALV would send a system check to the human-computer to make sure everything is in working order. In the event of a mechanical problem, general repair or even adjustments to the necessary components, the ALV should be easily available. Without the need to unscrew the entire ALV from the ground, the lifting mechanism is connected in all four directions of the product and is easy to get out and fix. Since the most fragile and important part of the product is the locker It should be easy to remove during the change of vehicles. All the tires would be self-fill, so there is not a concern of vehicles stop due to the tire. If some situation arises where it is required to remove and add a new one, A compartment at the bottom could be found where all spare tires and toll could be stored.

11.2 Autonomous dispensing unit

Once the ALV arrives at the destination it would unload all the respected smart boxes and leaves for the other spots. This activity would take place only during the night time or early morning, to avoid traffic congestion. The movement of the unit could be explained as such. Consider it as a small cargo container with boxes attached to all four sides. Once dropped by the ALV all four sides would activate for the delivery. The unit would have very important operation to perform. The operation is divide into two parts. First: As soon as the boxes are dropped it would send a signal to the system to let them know the arrival of the parcel and how many parcels are there. Second: It would send a notification message to all the customers nearby for the delivery of the products. Third: Users could let the smart box know the timing of their arrival to collect the parcel or whether they would like it to get delivered. The time slot for delivery would be before morning rush hour and after rush hour.

Similar to ALV, the smart box would send a message to the system at the start and at the end to let them know the problems in the situation. The major problem that could arise would be a connectivity issue and that could be solved by a repair person. To keep the machine safe, all the mechanical components are saved inside the box as those boxes are automated robots. So the problem in one won't cause trouble for the other. Since the whole component does not move it is stable ad thus safe for the material inside as well as the surrounding around it.

11.3 Automated Locker Vehicle

As soon as the Locker is delivered it would analyze the route to the nearest and most delivery areas depending on the time as well as the customer requirements. User would use the application and ask for the vehicle to arrive at their doorstep or near their location. One the order is given the vehicle would perform few operations.

This operation is divided into First: As soon as the smartbox received the confirmation front the customer. Lets say ⅔ of the customer prefer the robot delivery, then it would automatically dispatch itself from the container and gradually approach the destination. Second: As soon as the robot arrive at the destination it would send the message to all the customers nearby to collect their parcel or product. Third: The box could only be accessed through the OPT(one-time password). Once the user is at the vehicle they would need to enter the passcode into the machine to open the box. Fourth: Once all the desired products are delivered it would move ahead to the other area and would notify those customers.

Since its an automated vehicle, the problem that could arise would be tire deflation or stuck due to malfunctioning. As soon as it happens the vehicle would send the message to the customer regarding the delay as well as to the company to let someone arrive and fix the component that is causing the problem. The bottom of the machine would be completely intact so there won't be any trouble with product wear and tear during the water season as well as during summer. Since there would be two internet connectivity and would be activated only during the malfunction, the secondary connectivity would make sure if its a system problem it would try to resolve it by restarting or upgrading or reinstalling of software, if required. But if it happens to be a mechanical error a person would have to appear physically.

Chapter 12. Safety of the product

There are plenty of areas where safety needs to be focused on. In this section, i would only be talking about the most basic problems being faced by any product in India. Starting with

12.1 Road safety - Signals- population

Since it is evident that it is an Automated locker vehicle. It is important to make sure that if the product needs to be delivered to the other side of the location how it should be able to cross the road? Now the location that i have chosen for the courier delivery is near the IT hub in Bangalore. Being that area the IT hub, the traffic rule is followed rigorously. And now due to coronavirus most of the offices are recommending work from home which is leading to the reduction in the use of cars and other vehicles. Even the frequency of humans has reduced. So each area is rule-following which makes the delivery and movement of the robot more quickly and safely from one place to another even after following rules. The routes for bigger busses is an altogether different way which makes it safer.

12.2 Delivery of a product

To deliver the product it is important to make sure that the product is delivered to the exact person since the vehicle would require the insertion of OPT(one-time password) onto the screen to open and collect the parcel box. As soon as the customer enters the OTP(one-time-password) it clicks the photograph of the person and sends it to the customer's cellphone to make sure it was them. If the reply arrives negative, it gets reported.

12.3 Wear tear

The only concern of wear tear in Bangalore is the rain. Even if something happens to the Delivery robot, such as fall down in a pothole or drenched in the rain or during festivals such as Holi where the use of water is everywhere and people like to throw water balloons on every living and nonliving thing, To make sure all the couriers are safe each box would be completely airtight sealed off.

12.4 Public Destruction

Public destruction is either by throwing stones intentionally or by kicking or pushing the product by toppling it intentionally.

The Vehicle is comprised of 360 sensors as well as 360 video recording that is sent to the head office every second for records purposes. Having sensors around it, it creates a 3d mapping if someone running at a certain speed towards them and analysis it to make way for them. If the it recognizes the crowd, the red and yellow color would start flashing at the top to indicate its presence. Even if someone crashes it takes the video as well as the image of the person. Since every robot is maneuvered by humans in certain areas human drivers could decide the path for the vehicle.

12.5 Technology Required

The Customer Information Module, Environment Information Module, and Robot Information Module will be the three main components used. These three would be linked together to have a service allocation that is compulsory for a human supervisor to handle. I decided to have a coordination module to guide the system in order to obtain the area structure, from where it would install path planning and resource management. In terms of sensors, it is necessary to install Wi-Fi, Lazer, vision and face tracking. Overall, this involves the creation of a service bot.

12.7 Communication process

No matter what the product is, the best product is the one which communicates to the users. Because that way users feel involved and secure, knowing there is somebody or someone to help if something goes wrong. This is where the the communication comes in. Before creating a system design, i had to make sure there should be communication not only one on one but all the way in the loop.
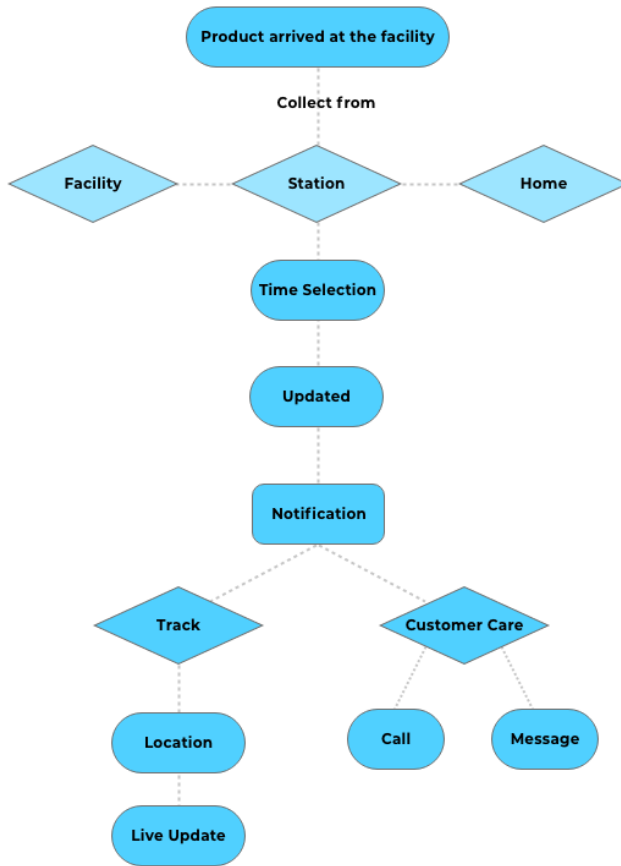
Communication Process

Figure 11: Communication Process

As discussed before the product would have three-way communication. Three way communication includes human, machine, and customer communication. Explanation of the Communication process is crucial to the proposed solution. In every stage users would have complete access to receive the parcel anytime and any place and would be in constant connection with the customer care and the machines to keep them updated. When the products arrive at the facility, the users would receive the message as to which location the user wants to collect their parcel. They would be provided with three options first, facility(which is a common warehouse where companies would drop the product), second station(its the location of the dispensing unit), and third home (robot delivery). To access any of these options users must carry their phone with them because of the OTP requirement. Once the user has selected the option, they would need to select the timing for their delivery (and collect the product mentioned time. The user would have the complete liberty to change the timing and place at any given time.

12.8 User App Flow

Before creating an application it is necessary to draw out it's architecture. It helps in organising contents so that users feel comfortable using the application and easily adjust without much effort. Since our application might not have enough features it is meant to be that way. As the core function of the application is to track and lock and unlock of the lockers.
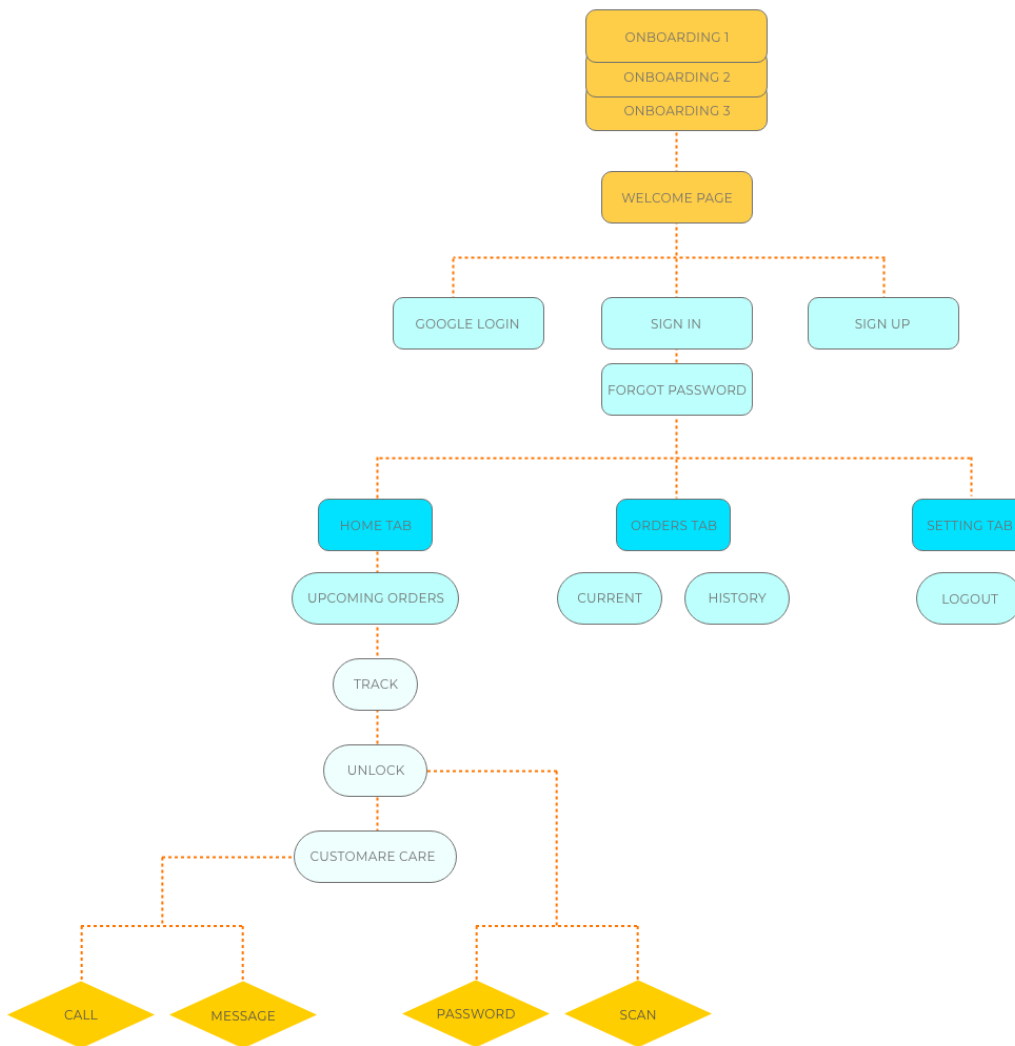

Figure 12: Information architecture of the user application

Main reason to introduce the application so that users could keep track of their package and communicate regarding the delivery and drop. Below mentioned appflow of user application. The user application would start with three onboarding screens for the users to understand what the application functionality and uses are. Along with it

the welcome screen that would include login using google/facebook, a sign in and sign up option using email. On the home page will be three bottom tabs containing Home, Orders and settings. Home consists of the information /update on the incoming orders , users could track the order. The unlock option is visible only when the user is near the locker/ warehouse or when the vehicle arrives at their doorstep. User requires to generate the OTP password to unlock the box and take the item. From the home menu users can contact customer support via message or instant call. Orders tab contains the current and history of orders.
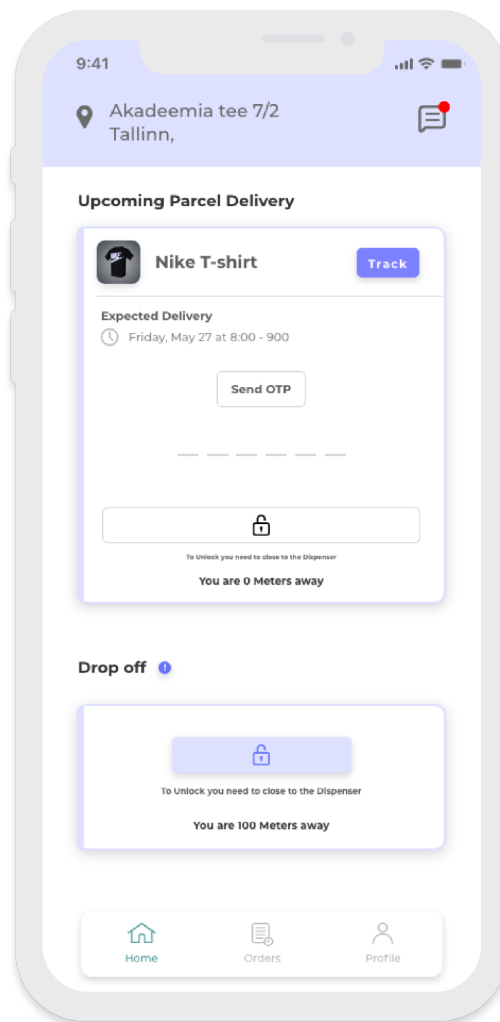
12.9 Application

Figure 13: Mobile Home Screen

Home screen is main screen that controls the whole delivery receiving as well as dropping of the packages. User could read notification and change its location for the automated vehicle to make sure the safe delivery of the product. On this screen user could get the information on the upcoming parcel and use it track the whole system. For that users need to be close to the dispenser / locker to unlock. The app would send the OTP and then the locker could be unlocked. The home screen would have 3 tabs at the bottom. Home, Orders and Profile.
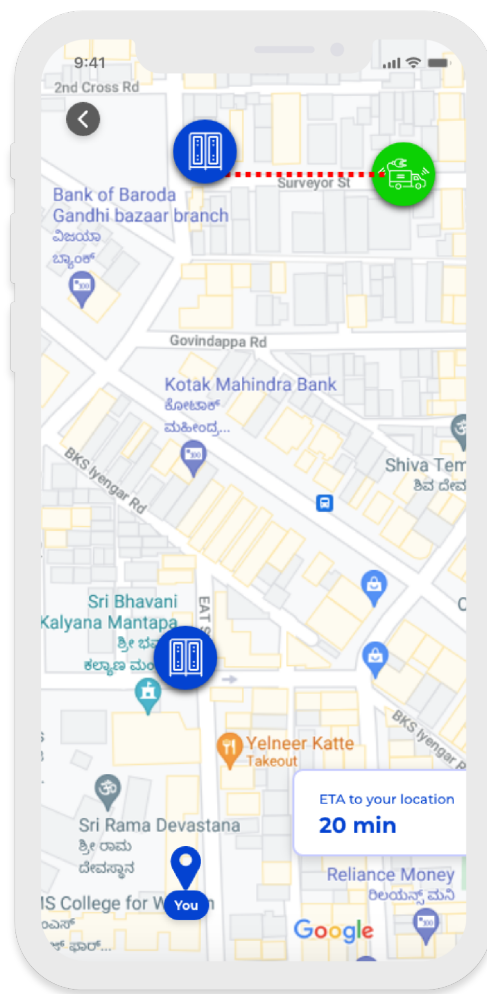

Figure 14: Track

Once user clicks on the track item, the application would open up the modal where live tracking of the items would be seen. Along with that nearby drop off location and ETA of the dispensary.

Chapter 13. Scenario *(Proposed solution)*

Scenario with proposed solution

1. Autonomous dispensing unit is placed on top of the Automated loading vehicle, by pushing or guiding as the dispensing unit has tires underneath and works separately as well as collaboratively.
2. Since there is no traffic in the morning, an Automated loading vehicle would head to the desired stations/stops to drop off the dispensing unit but would be monitored by a human driver at the back hand.
3. Once the unit has been dropped to the location the ALV would move to the other location to drop off.
4. Automated Locker Vehicle would send messages to all the customers nearby and would ask for their desired mode of delivery.
5. Based on the calculation , the Dispensing unit would open one out of four sections to move forward and deliver.
6. The HUD on the Automated locker vehicle, monitored by humans would drive itself and make sure to follow the traffic signals and carefully move around humans and use lights to alert its presence around.
7. Once it arrives at the location it would send a notification/ message to everyone around to collect their package.
8. Once all the packages are delivered, the Locker vehicle would head to the station location to lock itself up for the pickup.
9. All Automated vehicles would keep sending data to the head office regarding its performance
10. As soon as all the deliveries are made, the automated loading vehicle would arrive and pick up the Dispensing unit and head to the warehouse.

Scenario Conclusion

With the help of autonomous dispensing unity, the heavy labor work like picking up of items and arranging it in the van or car would be removed completely as the dispensing units have tires underneath to move around the warehouse. Since my product is also focused on not eliminating the human role, the delivery guy/girl would be able to help with the manual processing that sometimes a machine cannot operate, leaving room for employment and more hiring. Now, most of the delivers were made during day time and it is considered the time of heavy traffic and congestion but with the help of ATV(automated loading vehicles) deliveries could be made during night time as well as in the morning when there are rarely or no vehicles available, thus leading to faster deliveries in many places without any traffic trouble. Normally

delivery guy/girl has to wait in front of each location and call up every individual asking whether they are at home to deliver the product and most of the time they have to wait unnecessarily for a long time. With the introduction of the proposed solution, users can easily track their product and can even call the dispenser to deliver the product. The dispenser would also message the customer once it arrives at the location. Thus saving time to both deliveries as well as the customer. The automated dispensing unit is always available at a particular place so there it reduces the load of finding parking for the vehicles. Most of the delivery has to drop as well as pick up the parcels, that sums up wasting a lot of time that could be used for the delivery of the product. Using this could reduce the amount of time being used in the delivery as the dispensing unit would arrive at the user doorsteps f they need to return the parcel. In conclusion, the proposed solution would reduce the delivery time by half as well as helps in the reduction of carbon footprint along with the safety of not only the product but also of the drive

Chapter 14. Overall Conclusion

In conclusion this research has shown that automated delivery has the potential to reduce the cost , result in the customer satisfaction, more employment opportunities and door to more technology use and research for last mile delivery. Ever since the COVID situation, people have been reluctant to meet anyone and prefer to stay inside. The introduction of the product service will not only deliver parcels safely but also keep the human distance. It is important that future courier/ delivery companies should try to incorporate this as a cost saving technology to meet the growing demands of e-commerce in India. Lot of companies are moving towards same day delivery, future research should consider more technological solutions to enhance the production. As more and more data will be gathered through the use of big data, more focused on the speed, and carrying capacity would become available. But the overall focus of the companies should not only be the cost reduction but also customer satisfaction during future research.

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Rights: in case of restricted access, a note to that effect