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## A Study on Automated Solutions for Last Mile Delivery

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## ABSTRACT

In the very advanced and fast-moving world, the customer shopping behaviors are changing. Many people move towards the online shopping as they are easy nowadays with a single click or touch on their smartphone or any other device. As huge number of customers order their products online, the firms should be capable of delivering the products to the customer in the most effective and efficient way. This could create a competitive advantage for the firm. To stay competitive in the market the companies always find a way to improve the efficiency and also to cut the cost. The last mile delivery is the final segment of the entire product delivery process, where the product reaches the hand of the customer and it covers 53 percent of the total cost of shipping. The last mile delivery is the most expensive and time-consuming part of the entire shipping process. LMD accounts 41 percent of total supply chain cost. When it comes to the food delivery, the companies need to be more innovative and effective to deliver the orders with the same quality of products available in the shelves of the physical store.

In this report we had gone through various literature regarding the Last mile delivery focusing on the automated solutions which are already in the practice and the future solutions of the last mile delivery. We got valuable insights from those literature. We analyzed the roles of various actors in the last mile delivery. We studied about the changes in the customer behavior in terms of online shopping. We understood the challenges faced by the logistics firms in the last mile delivery. We deep dived into the various solutions of the last mile delivery modes such as Drones, Droids, Automated Guided vehicle (AGVs), In-car and In-Fridge delivery and Delivery box, covering both Attended and Unattended Home Delivery (AHD &UHD). We found out the Critical Success Factor (CSF) of Last mile delivery service providers in general and also for Last mile delivery of food industry. We analyzed the Critical Success Factors such as volume, sustainability, independent, flexibility, cost, speed, safety, Convenience and Willingness to Pay (WTP) for all the above-mentioned solutions. We were able to find the different and possible network designs for both conventional and automated solutions of the last mile delivery. Finally, we applied Hau Lee Model and incorporated the Critical Success Factors and based on that we positioned the different automated solutions of the last mile delivery in the Hau Lee Model in terms of Supply (service Providers) and Demand (Customers).

We could see that the possible last mile delivery solutions need more investigation. As this could play a huge role in defining a new business model, we could possibly combine all the delivery solutions under one roof to deliver the orders to the customer in a most effective and efficient way possible, majorly cutting down the cost of the last mile delivery which covers most of the overall shipping cost.

## ABSTRACT [ITALIAN]

Nel mondo molto avanzato e in rapida evoluzione, i comportamenti di acquisto dei clienti stanno cambiando. Molte persone si spostano verso lo shopping online in quanto oggi è facile con un solo clic o tocco sul proprio smartphone o su qualsiasi altro dispositivo, accedere a una vasta gamma di prodotti. Poiché un numero enorme di clienti ordina i propri prodotti online, le aziende dovrebbero essere in grado di consegnare al cliente nel modo più efficace ed efficiente. Ciò potrebbe creare un vantaggio competitivo per l'azienda. Per rimanere competitive sul mercato le aziende trovano sempre un modo per migliorare l'efficienza e anche per diminuire i costi. La 'Last mile delivery' è il segmento finale dell'intero processo di consegna del prodotto, in cui il prodotto raggiunge la mano del cliente e copre il 53 per cento del costo totale della spedizione. La 'Last mile delivery' è la parte più costosa e dispendiosa in termini di tempo dell'intero processo di spedizione. LMD rappresenta il 41% del costo totale della catena di approvvigionamento. Quando si tratta della consegna di prodotti alimentari, le aziende devono essere più innovative ed efficaci per consegnare gli ordini con gli stessi standard qualitativi dei prodotti disponibili sugli scaffali del negozio fisico.

In questo Report abbiamo esaminato varie pubblicazioni riguardanti la 'Last mile delivery' concentrandoci sulle soluzioni automatizzate che sono già nella pratica e sulle soluzioni future. Abbiamo ricevuto preziose informazioni dalla letteratura. Abbiamo analizzato i ruoli dei vari attori nella 'Last mile delivery'. Abbiamo studiato i cambiamenti nel comportamento del cliente in termini di shopping online. Abbiamo compreso le sfide affrontate dalle aziende di logistica nella 'Last mile delivery'. Abbiamo approfondito le varie soluzioni delle modalità di 'Last mile delivery' come droni, droidi, veicoli a guida automatica (AGV), consegna in auto, in frigorifero e box di consegna, che copre sia la consegna a domicilio assistita che non presidiata (AHD e UHD). Abbiamo scoperto il fattore critico di successo (CSF) dei fornitori di servizi di 'Last mile delivery' in generale e anche per la 'Last mile delivery' dell'industria alimentare. Abbiamo analizzato i fattori critici di successo come volume, sostenibilità, indipendenza, flessibilità, costo, velocità, sicurezza, convenienza e disponibilità a pagare (WTP) per tutte le soluzioni sopra menzionate. Siamo stati in grado di trovare i diversi e possibili progetti di rete per soluzioni sia convenzionali che automatizzate. Infine, abbiamo applicato il modello Hau Lee, incorporato i fattori critici di successo e in base a ciò abbiamo posizionato le diverse soluzioni automatizzate della 'Last mile delivery' nel modello Hau Lee in termini di offerta (fornitori di servizi) e domanda (clienti).

Possiamo notare come le possibili soluzioni di 'Last mile delivery' richiedano ulteriori indagini. Poiché ciò potrebbe svolgere un ruolo enorme nella definizione di un nuovo modello di business, si potrebbero combinare tutte le soluzioni di consegna sotto lo stesso tetto per consegnare gli ordini al cliente nel modo più efficace ed efficiente possibile e ridurre notevolmente il costo della 'Last mile delivery' che copre la maggior parte del costo di spedizione complessivo.

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## **LIST OF ABBREVIATION**

LMD: Last Mile Delivery

B2C: Business to Consumer

C2C: Consumer to Consumer

CSF: Critical Success Factor

WTP: Willingness to Pay

AGV: Automated Guided Vehicle

ICD: In Car Delivery

AHD: Attended Home Delivery

UHD: Unattended Home Delivery

WMS: Warehouse Management System

CPG: Consumer Packed Goods

FMCG : Fast Moving Consumer Goods

T&L: Transport and Logistics

# 1. INTRODUCTION

Logistics is the entire process of managing the procurement, storage, and transportation of resources to their destination. The transportation of packages from hubs to final destinations is referred to as "last-mile" in logistics management. As the number of business to consumer (b2c) delivery increases, it paves a pathway to last-mile delivery to emerge as the most popular sector for the e-commerce companies. Some of the challenges of last-mile delivery include reducing costs, maintaining transparency, rising efficiency, and improving infrastructure. As the retailer and product manufacturer demands for same and next day (expedited) deliveries, as tech-assisted last-mile technology platforms have emerged. Increased demand for last-mile fulfillment has placed shippers under pressure to handle a diverse set of distribution companies.

As with most other sectors, the transport and logistics industry (T&L) is currently undergoing massive changes, which bring challenges and opportunities like all changes. Due to the demand for fast delivery (on and on the same and next day) by retailers and product manufacturers, state-of-the-art technological platforms from the last mile came about. Increased demand for last mile enforcement has pushed shipowners into operating many forms of providing firms, ranging from conventional parcel operators, couriers and on demand service providers. The technological platform aids the shipper and the final customer to obtain real-time information, which allows managers to respond quickly if there are exceptions such as late delivery, address errors or damages to the product. As Amazon reinforces its logistics capabilities over the last few kilometers, rivals are more involved than ever in competitive technologies. The fear of incumbents forced major transport and logistics companies to look for alternative strategies.

Each and every stage of the logistics process is critical, from the second the parcel leaves the sender's hands and reaches the customer. Each phase must be taken seriously, but no greater priority exists than the last mile delivery when goods are carried to their final destination. The limit for logistics providers and what they are able to offer their customers continuously stretches. The operations include both terminal management and transport. An effective Warehouse Management System (WMS) are tech-savvy in operations holding a partly automated warehouse with robots and conveyor systems. The goal is to get the receiver an object as quickly as possible. This was motivated by the ever-changing market and demand for easy client experience in e-commerce, food, retail, and many other industries.

The Crucial factors in last mile delivery are fast delivery, precision in the order, geo location tracking, insurance for theft or damage of goods, Convenience to the

customers and providers. Followed by the Last mile delivery challenges such as the Cost, Efficiency, Transparency, Friction. While a smooth delivery experience is ideal for increasing efficiency and reducing costs, still few more small hiccups do need to be tackled to prevent these. Courier companies are now moving against these obstacles to provide a more effective service. The influence of technical progress aids in resolving these gradually. The continuous improvement of websites for e-commerce has led to less human physical interaction. This is a significant step toward a more efficient last-mile delivery.

Even Amazon, the world's biggest online retailer, intends to use unmanned aerial vehicles (drones) to supply packages up to 5 pounds in less than 30 minutes, in order to implement a more effective last mile supply system, especially in the e-commerce sector. Third-party on-demand service providers use technology effectively to operate the whole last miles of the distribution, from pick up to delivery, via their rapid, secure and economic last-mile delivery services. It is by far the most successful logistical approach for dealing with the issues associated with the last mile distribution method.

## **2. BACKGROUND OF STUDY**

The present service providers are influenced by many micro and macro environmental factors. A robust economy and industrialization correlates to an increase in consumers' demand, sustainability and pricing policies are forcing shippers to adopt to an innovative and viable modern solution. On the other hand, Governmental factors often overlap in areas such as corporate taxation, environmental laws, and inflation, which can become challenges to meet the service requirements in terms of supply and demand.

Focusing on home delivery logistics for business to consumer, (B2C) e-commerce is one of the greatest obstacles for many logistics firms. This portion of supply chain is also referred to as “the last mile”. Consumers’ uneven demand, various delivery time slot and most trucks running empty makes last mile delivery as one of the most expensive and critical operations. Furthermore, some trends in consumer behavior anticipate that a more flexible delivery window is demanded in the future. This situation is complicated further by the special requirements for shipping groceries.

The retail food industry is often under pressure to develop and implement socially responsible business practices, such as adopting environmentally friendly methods/solutions, degree of automation of the process, mapping the consumer

presence balancing the data privacy protection and dynamic pricing policies. Thus, following points can be highlighted in order to summarize the problem definition.

- Changing consumer behaviour
- Price policies and expansions among competitors
- Demographic challenges - Qualitative and Quantitative
- Technological Advancements
- Sustainability Laws (Standards and Norms)
- Failed delivery, returns and
- Scalability to mass markets

### **3. INDUSTRY PROFILE**

The worldwide eCommerce sales are showing linear growth in recent years. e-Commerce sales globally reached 4.28 trillion dollars in 2020, with e-retail profits expected to reach 5.4 trillion dollars in 2022. e-Shopping is one of the popular activities carried out globally. Purchases made through mobile devices drives the e-commerce industry. According to surveys, During the year 2021, globally more than 2.14 billion people are expected to use online to purchase goods or service, which is higher than the year 2016 that accounted 1.66 billion people. Even though the online grocery sales are steadily growing on a global basis, a slight variance can be seen among different regions, where the level of technology availability affects to what extent the growth can be adopted in that region.

Buying online is evolving as a common practice all over the world. Most of the people make online purchase because of convenience and some for the competitive prices offered by the online platforms compared to the physical stores. When it comes to shopping, digital shoppers can be swayed by a variety of digital resources, such as brand emails, product reviews, and successful Last Mile delivery. At the end of 2016, the total amount of an online purchase order placed from a tablet was U.S.106.98 dollars, compared to 143.35 U.S. dollars for PC computers. According to Online shopper reach, U.S is ranked as one of the leading online retail markets and it will be continued in the future with the growth projections for the upcoming years. In 2019, about 80 % of U.S. internet users were expected to make at least one online purchase because of the significant raise from 2013, which stood at 73 percent.

As the online sales of groceries has grown, so has the importance of planning the last-mile logistics. This is a crucial part for many companies since it covers for 50 percent of the total logistics costs, and is one of the least efficient and most polluting parts of the Supply Chain (SC) (Gevaers, van de Voorde & Vanelslander 2010, p. 2)

## **4. NEED AND IMPORTANCE OF THE STUDY**

The eCommerce industry continues to grow and in over a decade, the online shopping consumers are projected to exceed brick and mortar shopping. The current pandemic has only accelerated this trend, the demands and expectations of digital consumers are growing faster and bigger, simultaneously with the surpassing increase in online expenditures. When competing online, it is important to fulfil these expectations in order to not lose customers to direct competitors providing better experience. This does not apply only to the online buying experience on the website but also to the last miles of delivery and returns. Ignoring the experience of last-mile delivery could have a drastic impact on your eCommerce brand from stoppage of sales to the reduction of the risk of buying again.

McKinsey & Company (2016) forecast that same-day and instant deliveries will reach a combined share of 15 percent of the investigated market by 2020, with further potential to grow more even after this date. The compelling demand for same-day and instant deliveries suggests that e-grocery players should incorporate this in their offer, ideally without charging the customers for it. The market for e-groceries is especially affected by this demand, with 27 percent of the customers stating that they have deselected to buy groceries online due to the long delivery times. This is the highest percentage obtained across all of the survey's categories, implying that fast deliveries are most important for groceries. (McKinsey & Company 2016, p. 10).

The last mile offers eCommerce companies an excellent opportunity to improve their service speed, transparency, and efficiency. Not only this, but the eCommerce companies can also reduce costs and build their brand value by optimizing their final mile delivery, thus, enhancing the customer experience.

## **5. OBJECTIVE**

Our objectives are to understand how the food industry, in different arenas are addressed to the last mile delivery leveraging the automated solutions. By thorough research of different case studies about their delivery models, we were able to study the effect and the changes made in the market and to the environment. Finally, we compare the delivery models to automated solutions by the frameworks of Hau Lee's Model based on the analysis of demand characteristics, effectiveness of the solution, pricing dynamics and environmental sustainability of the solution adopted by the companies.

## **6. LITERATURE REVIEW**

All English-language papers published in peer-reviewed journals that have been retrieved and those cited in their reference lists (snowball approach) were checked for relevance by analyzing their abstracts.

### **6.1. LOGISTICS SECTOR**

The logistics sector encompasses a variety of activities such as importing materials, processing, inventory, handling or sortation, shipping, storage, or warehousing, and sending the goods to the final customer.

Incumbents are facing competition from different players. Firstly, the retailers who build their own supply chain network. Secondly, tech giants like google are in the stage of developing new and innovative solutions for last mile delivery such as autonomous self-driving vehicle. Thirdly, New startups with new and effective business model enter the market for example: Crowd sourcing delivery (Capgemini, 2016).

The new entrants and startups have a huge barrier in front of them as the industry is asset- intensive and for delivery vehicles and the network of local delivery units requires a huge investment. Yet the entrants challenge the incumbents with an asset-light approach. They introduce new effective ideas such as using crowd to deliver parcel by pairing supply and demand. Managing fluctuating demand and peak is the major factor for the companies in this sector (Lowe and Rigby, 2014). This business model is highly scalable and makes the company to add or eliminate capacity based on demand. Variable cost structure is possible in this model. (Buhler and Pharand, 2015).

The CPG (Consumer Packed Goods) and retailers challenge the incumbents with the opportunities to integrate up or down the value chain. Backward integration is way of CPG companies to protect themselves from the increasing input cost and also, they help to exert a great control over the supply chain. Meanwhile other companies are following forward integration. For instance, Amazon, is gaining greater control over the last mile by experimenting their own delivery services. Amazon increases their fleet size by buying delivery jets and roll out their own fleet of delivery trucks. By this Amazon gains an advantage on their cost saving and that helps its thin operating margin of 2.3%. FedEx and UPS are very similar to the Amazon's shipping service with a learning curve of many years in the industry. Since, the savings do not come from

an effective operation. Amazon will not be paying their profit margins to their logistics providers (FedEx and UPS). Their logistics Service, on the other hand, will be offered at no expense.

Incumbents will try to develop a new and innovative ecosystem to defend themselves from the competitive threats of the new entrants and also to win the competitors in this highly dynamic industry. To build a competitive advantage, the most 12 innovative companies “tap into external sources of skills and expertise” (Benson-Armer et al., 2015, p. 6), particularly outside of their core competencies. Acquisitions and merging are now concentrated on smaller and specialized firms which is totally different in the past years.

## **6.2. LAST MILE DELIVERY**

The Final leg of the delivery to the customers is referred to as the last mile delivery. When the goods leave the storage facility, it can be either delivered to the customer directly or distributed to the outlets such as stores and supermarkets (Gevaers et al. 2010, p. 3).

Barclay defines Last Mile Delivery as the “movement of goods between a transport hub to a delivery address” (Lowe and Rigby, 2014, p. 3). DHL describes the last mile as the “final segment of a sales chain that leads directly to the customer or household” (DHL, 2017c). According to DHL, last mile delivery is often the “least predictable part of the entire journey” (DHL Trend Research, 2014, p. 30). Parcel delivery takes place in an environment which is complex and dynamic and goes as far as to label it the “frenetic, frantic, and critical end of the market”, Capgemini (2016, p. 15). With the raise of e-commerce, consumer preference moves more towards the center of attention in the formerly business- oriented parcel delivery market. Logistic companies as well as e-commerce firms have identified last-mile services as a “key differentiator with their competitors” (Joeress et al., 2016, p. 9).

In Last mile delivery there are three main stakeholders (3C), each have their own set of expectations and challenges.

- Consumers,
- Commerce, and
- Carriers.

Consumers are the one who buys the product and receives the items which are purchased online. The (online) retailers are the commerce. The logistic providers

responsible for transporting and delivering of the goods from the commerce to the consumers are the carriers.

Logistics services plays an important role in the organization's overall success (Mentzer and Williams ,2001). As a way to gain competitive advantage, superior delivery process should be developed, and it also creates a positive impact on the profit of the organization. The last mile delivery and the profit generated are under attack by disruption of new technologies, competition within the industry and the growing consumer demands (Buhler and Pharand, 2015, p. 3). Strong relationships between retailers and the logistics provider are very much important to provide positive experiences for the end customers.

### **6.3. ROLE OF DELIVERY FOR LOGISTICS PROVIDERS**

In the entire logistics chain, last mile delivery is considered as the most expensive department as it covers approximately 50% of total parcel delivery cost (Joerss et al., 2016). Operational inefficiencies are one of the major challenges faced by the logistics provider. The firms bear high cost due to unsuccessful deliveries and routing inefficiencies. As a result, more efficient delivery is the one with the cost reduction. Due to the longer distances covered in the rural areas, there will be a drastic increase in the last mile delivery cost. Parcel delivery in urban areas is considered profitable because of customer density in a short range will lead to high volume of parcel delivery (Corrocher et al., 2012).

Defining the territory in the last mile delivery is a tedious process because the regions have to be determined without any prior knowledge of demand of customers that will be changed each and every day. Haugland et al. (2007) emphasizes two phase optimization where customers should be geographically segmented and then the delivery routes within the geographical area must be determined. Lei et al. (2012) proposed the same method called vehicle routing and districting problem with randomly distributed customers and it was optimized by two stages districting first and then routing. The logistics providers or the carriers are made to schedule multiple trips per region on the same day to satisfy same day of few hour delivery promises of online retailers. Managing the fleet and decisions are important research areas in the vehicle routing which also includes the characteristics of electric vehicles such as range limitations and recharging (Hiermann et al. 2016; Pelletier et al. 2016).

An empirical study indicates that an average delivery van remains stationary for more than 60% of daily tour times and delivery persons walk up to 12 km on foot (Allen et



al. 2018b). Retailers have only insights on consumer's preference and shopping behaviors, but the logistics providers have all the data about the customers daily routines and particularly their lifestyle which brings them closer to the customers and this is where the retailers lack. "To fully exploit data and analytics, companies must manage data from multiple sources, build models that turn the data into insights, and translate the insights into effective action." (Benson-Armer et al., 2015, p. 7). Logistics providers can leverage the data they collected from the last mile delivery by innovating new and improved plans that answers customer needs. Carriers can improve the relationship with the retailers by sharing the data and insights in order to monetize it or increase the volume share.

#### **6.4. ROLE OF DELIVERY FOR E-COMMERCE**

When people do online shopping, they are not able to differentiate between the role of the retailer and the logistics provider. Most of the mistakes made by the carriers are reflected in the reviews section of the retailer's online page. For Example, Product reviews on Amazon often contains the comments about the delivery of the product even it is positive or negative. "In the current digital age, the last mile is where consumer relationships are made or broken." (Cag Gemini, 2016, p. 3). The great focus for most of the e-commerce players is on the last mile delivery as "the only tangible element of a digital customer journey" (Temando, 2016, p. 25). The customers evaluate the company's performance based on their overall shopping experience from the beginning of the order to the end where the customer gets the product in the hand. That includes the retailer's online shopping page, delivery options, continuous communication of the delivery status when the product leaves the warehouse and until the product reaches the customer either through email updates, app notification or messages. While comparing smaller and larger retailers, larger retailers are less worried about the shipping cost as their great attention is on improving customer experience. On the other hand, smaller retailer's profit and competitive advantage are influenced by the shipping cost.

Positive delivery experience will create more sales, meanwhile negative experience will affect the firm's reputation and drop the sales. For instance, Amazon took a huge risk by offering Amazon prime with two day and free shipping for less price and the shipping was provided as a flat rate. Apparently, Amazon met their customers' need and it helped them to rapidly multiply its share (Lukic et al., 2013). In this case the last mile delivery is very important to the customer's evaluation of the online purchasing process.

Due to unsatisfied delivery options half of the consumers aborted their online purchase process (Graham, 2013). More than half of the respondents abandon the shopping cart because high shipping cost (Temando, 2016). 45% of customers are ready to order online when the delivery options are improved (Lowe and Rigby, 2014). More than half of consumers step back from shopping online due to risk of failed delivery (IMRG, 2015). 60% of consumers prefer offline shopping than online because of additional cost of home delivery (IMRG, 2015). A greater part of the respondents would buy in online if they are able to find unattended delivery at the top (Annon, 2004). Preponderance of retailers could see an increase in the sales after the number of shipping options is increased at checkout (Temando, 2016). 86% of retailers were able to meet the customer expectations after increasing number of shipping options at checkout (Temando, 2016). It appears that the frequency and intensity of the purchase increase with the exact delivery services provided at the right place. These figures also reveal that when there is an increase in number of delivery options there is a significant positive impact on revenues.

## **6.5. ROLE OF DELIVERY FOR E-GROCERIES**

Online grocery retailing, which is also known as e-grocery, is a type of B2C e-commerce that has showed tremendous growth in the last decade and is expected to continue its growth in the upcoming years (Mortimer et al., 2016). For e-grocery, logistics operation is very important not only for right delivery of product but also for overall customer satisfaction (Hübner et al., 2016). The e-grocery logistics are facing greatest logistics challenges (Fernie et al., 2010). Last mile distribution is one of the logistic challenges (Hübner et al., 2016).

Same day deliveries are being recently started by the online grocery stores. If the order is made before the midday, the delivery will be carried out in the same day. For the following day delivery, the store requires the order before 23:59. The time slots for delivery to the customers are managed according to the customer needs and expectations and they try to keep the logistics as efficient as possible. There is a huge difference for home delivery of food products from the other e-commerce because of specific packing for each type of food product and some products are temperature sensitive.

While delivering perishable and sensitive foods, customer's absence causes significant loss of logistics efficiency and high rate of failed deliveries. The main challenges faced in the e-grocery is the lack of attendance of customers attendance at the moment of delivery because of the storage and temperature conditions of certain

food items. The presence of a customer is very hard to predict and because of that home delivery usually results in high rate of failures (Agatz et al., 2011; Gevaers et al., 2011; Lowe and Rigby, 2014) and it leads to high delivery costs, waiting time for customer increases, and waste of energy spent in transportation. The key success factor for food delivering firms is effectively and efficiently tackling the last mile delivery and also maintaining the sustainability of freight transportation (Ehmke and Mattfeld, 2012; De Marco et al., 2014; Gevaers et al., 2011).

## **6.6. CONSUMER BEHAVIOUR**

It is important to consider the consumers and their incentives for online buying foods and how they want their foods to be delivered to them in order to create a viable solution. With the e-commerce industry continuously expanding in recent years, consumer expectations have simultaneously increased. This presents a challenge to businesses, which must not only rise to the occasion, but also sustain profitable logistics processes and distribution solutions. (MetaPack 2015, p. 2).

SyndicatePlus (2014) looked into the social demographics of online grocery shoppers based on their age, education level, and income level. According to the study, online grocery shoppers tend to be higher-income earners with a higher degree of education. 50 percent of European customers are attracted by the ability to buy whenever they want. This is followed by 44 percent who claim the ease of home delivery is their primary reason for shopping for groceries online. Another 37% appreciate the fact that they do not have to transport the goods themselves. (SyndicatePlus 2014, p. 10). McKinsey & Company (2016) conducted a survey in which 4700+ consumers in China, Germany, and the United States were studied based on their preferences for various delivery choices. This validates the fact that customers are cost conscious when choosing delivery method; 70% of customers say they prefer the cheapest alternative when choosing delivery method. The remaining 30% is split as follows: 23% prefer same-day delivery, 5% prefer dependability, and the remaining 2% prefer instant (within two hours) deliveries. (McKinsey & Company 2016, p. 9).

In a survey of the Nielsen Company on the future environment of online grocery shopping, 30 000 respondents from 60 countries expressed their existing shopping habits and which outlets they are likely to use in the future. The majority of respondents who shop for groceries online choose to have the food delivered to their home. The major percent of the online grocery purchase for home delivery is from the Millennials of age 21-34, who shares 30% of the contribution, followed by the Generation Z of age 15-20, Generation X of age 35-49, Baby Boomers of ages 50-64

and the Silent Generation ages 65+. (The Nielsen Company 2015, p. 8). In addition, the elderly people are becoming much more Internet and e-commerce savvy. This age group's increasing preference for easy online shopping has consequences for delivery. In terms of distribution choices, they are less mobile and less likely to drive long distances to and from post offices or lockers, possibly carrying larger items themselves. This raises the need for close-to-the-recipient drop-offs, such as home or in-car delivery.

Another subject is the proliferation of smartphones. In 2017, the percentage of smartphone users in Western markets was about 80%, with growth coming mostly from senior citizens aged 65 and older. Smartphone use extends far beyond communication. Smartphones act as "life management machines" and "virtual shopping assistants." (Accenture, 2016b, p. 41; Deloitte, 2016, p. 4). Eighty percent of smartphone owners use their smartphones for shopping, including gathering product details, reading feedback, comparing prices, and making purchases (Deloitte, 2016). Flexibility becomes as the most important element as one's personal consumption grows. Most shopping patterns are being influenced by the use of smartphones and tablets. When looking at the number of online sales during the day, there is a peak around midday, around lunchtime. However, the second and much larger peak occurs at night between 11 and 12 p.m., implying that shoppers may also search on their phones while sleeping. Monday is typically the busiest day of the week for home delivery. This conduct has consequences for deliveries. Retailers must monitor customer perceptions regarding delivery dates. Shopping late makes next-day deliveries impossible. As a result, many retailers have implemented cut-off times as to when an order must be placed in order to be shipped the next day rather than two days or later (Lowe and Rigby, 2014). Another example of a consumer's need for convenience is Sunday delivery. 70% of customers believe couriers can deliver on Sundays, which is not surprising given that people enjoy the comfort of having packages delivered to their door but are not at home during normal business hours.

However, a greater number of choices increases the risk for the logistics providers. The possibility of customers selecting time windows that do not fit into the planned short delivery tours might increase eventually. The studies of Agatz et al. (2011), Campbell and Savelsbergh (2005), Gevaers et al. (2014), Ehmke and Campbell (2014), and Boyer et al. (2009) all discuss on an efficient time window management employing heuristics, approximation approaches and simulation studies. These discussions affirm the cost-service trade-offs to be tackled in time window management. To address this problem, one alternative is to provide incentives (for example, a delivery discount) to steer customers into wider or particular time frames favored by the logistics provider (Campbell and Savelsbergh 2006; Yang et al. 2016).

People desire easy, comfortable lifestyles and are willing to pay for them. Convenience is extremely significant while shopping (DHL, 2016a). Personalization and Customization: McKinsey says, in reference to consumers' ever-changing lifestyles and preferences, the way consumers think, work, and shop is going to accelerate (Joeress et al., 2016, p. 2). Accenture (2016b) relies on Artificial Intelligence to maintain pace with, and eventually predict, customer behavior in the future. They use customer data to create "active profiles of tastes, habits, motives, and expectations" known as "market genomes" (Accenture, 2016b, p. 38). The benefit is that it goes beyond simply providing customers with options to understanding why those choices are made. In the last mile delivery, this approach entails anticipating any factor that may prevent or delay delivery and determining the best solution depending on the specific customer. Customers will eventually be able to request delivery where and when they want it, and delivery staff will be able to avoid putting up posters or knocking on doors like usual." (Acquisition, 2016a, p. 15) 33

Although the widespread use of such "customer genomes" is not yet in sight, logistics companies are finding other ways to provide customized delivery services. In comparison to just 5 years ago, customers today have a plethora of choices on how, where, and whenever they want their product shipped. Many carriers now allow customers to

- Specify particular days and time slots when they want their shipment delivered.
- Choose a neighbor to deliver the package.
- Choose a specific location like porch or garden to drop off the package.
- Decide the medium and frequency of communication to get updates on the delivery status (via Email, SMS, App).

A significant conclusion from various investigations is that, in addition to price and delivery speed, reliability and comfort are essential parameters to be considered from a consumer perspective.

## **6.7. VALUE CREATION – LAST MILE**

Generally, Value is described as the additional benefit that the company provides to its customers in order to enhance their consumer experience with the brand. However, value creation is one of the most difficult activities that an organization must undertake. This is particularly true for value-added logistic services. It's fair to say that same-day delivery and two-hour delivery is the perfect last mile value

addition. Companies that can meet this criterion bring more value to the customer experience and ensure customer loyalty.

According to McKinsey & Company, there are seven major developments in multi-channel e-grocery businesses (McKinsey & Company 2012, pp. 5-8).

**Blooming e-grocery:** Customer expectation towards the availability of various shopping experiences across the channels is increasing at a rapid pace.

**Evolution:** New technological advances trigger the demands from customers which urges the Brick & Mortar stores to provide innovative and compelling offers enhancing customer experiences to compete in the market.

**Social technologies (The Game Changer):** E-commerce is much more than just online transactions. The successful grocery retailers communicate in both directions and must keep an eye out for non-traditional rivals.

**CRM – Reliability and Comfort:** There is an increase in the importance of tracking and monitoring customer data. It aids in drafting personalized promotions to targeted customer group.

**Digital Dashboards:** The customer queries regarding product description, past user reviews could be clarified with the presence of digital dashboards in the shopping area like Decathlon.

**Self-Checkout and Digital Wallet:** Retailers are developing new ways to ease and enhance the customer checkout process as well as advances in mobile-based payment systems.

**Dynamic Pricing:** As Electronic Shelf Labeling (ESL) becomes more affordable for retailers; real-time or dynamic pricing can be used to a greater degree.

The main features of Last Mile delivery are Heterogeneity, Intangibility, Imperishability and Inseparability. In case of Unattended Home Delivery (UHD), Carriers have launched various possibilities of solutions such as Click&Collect, delivery to parcel lockers/ post offices/ neighbors, and delivery time slots. However, Non-standardization, customization and personalization are the normative objectives from a marketing perspective (Vargo and Lusch, 2004). Customers deliberately prefer online purchase to get more than just the product like the intangible characteristics: choices, availability, time saving and convenience. Because of the developments in UHD, the degree of human interaction shifted to digital communication and exchange.

The Value-Profit chain shows how value creation influences profit. It establishes a strong correlation between revenues, customer loyalty, satisfaction, retention and perceived service value. Revenues and development of the firm are driven by customer loyalty. Customer loyalty is driven by value and satisfaction. Value refers to the perceived satisfaction of the service in relation to the overall cost. Since it is dependent on the customer's view of the actual service received to his initial expectations, value is often subjective. In product delivery, customers incur direct cost of shipping along with other indirect costs like time required to pick up the package. Perceived service quality is the difference between the expected service quality and the actual service experienced.

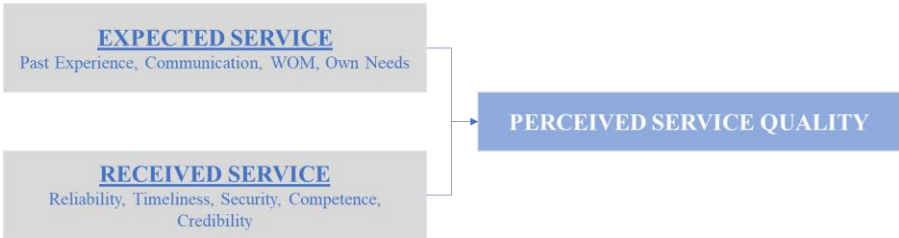


Figure 1: Value Creation (Inspired from Heskett, 1994)

To sum up, the new delivery models along with the significant changes must also consider the important elements of reliability, transparency, flexibility, reliability, timeliness, convenience, speed, safety, credibility and the costs incurred to balance the consumer demands and compete in the market.

**6.8. CHALLENGES**

In order for delivery service providers to be competitive in the industry, they must build offerings that are in line with consumer lifestyles and desires, as well as improve delivery effectiveness.” (J.D. Power & Associates, 2007). The critical success factors of Last Mile delivery include the imbalance of two forces: Increasing parcel volumes, Consumer habits and lifestyle – Willingness to pay. According to McKinsey, 25% of customers in Germany, China and US are open to premium prices for same-day or instant delivery privileges. Still 75% of price sensitive customers prefer the least expensive choice of home delivery. (Joerss et al., 2016).

The leading player in the sector ‘Amazon’ has perceived the high standards as the normal standards termed as ‘Prime Effect’ or ‘Amazon Effect’. The Change-Over might be manifested because 1) Customers demands additional service (Quick delivery), or 2) Customer’s WTP is shrinking for certain services while expectations increasing simultaneously. According to Capgemini’s Customers research, Customer’s demand

for service increases while the willingness to pay for the improved service offerings decreases. (Capgemini, 2016).

## 6.9. CSFs OF LAST MILE DELIVERY IN FOOD INDUSTRY

Because of the perishable quality of the items, grocery delivery poses a significant challenge. A secured delivery ensures that the food is sent to the recipient in the same condition in which it was sent (Livsmedelsverket 2014, p. 12). The fact that food goods have a responsive cold chain can complicate last-mile logistics. Certain foods are sensitive to temperature changes, light, moisture and vibrational shocks may have effects on the product (Somogyi, Ramaswamy & Hui eds. 1996:01, p. 383). Larger the range of products higher the cold chain's complexity. Different goods that are not only temperature sensitive but also have different specifications may be transported in the same vehicle. For instance, the temperature of minced meat should be maintained under +2°C, while dairy products under +8 °C (Livsmedelsverket 2016, p. 11). All of these variables add up to the conclusion that food commodity supply chain is extremely complicated, including last-mile logistics. The safety of grocery transport is categorized into: 1) Timelines – Delivery performance 2) Hygiene – Food Safety, 3) Quality – Food defense from contamination (Emma Albertz & Josefin Frank, 2017, p.50)

## 6.10. CSFs OF LAST MILE SERVICE PROVIDERS

**Quick Delivery:** Customers expect shorter lead times, from online purchasing of goods to delivery. Time spent per delivery will be crucial to minimize in order to achieve cost effectiveness.

**Cost Effectiveness:** Home deliveries are expensive for delivery providers compared to customers willingness to pay for the costs incurred. Gaining profits in e-grocery sales is tedious for companies

**Volume:** Cost effectiveness could be achieved through high volumes. However, in case of last mile logistics, the biggest challenge is that small volumes are the new normal.

**Unattended Home Delivery (UHD):** The groceries are delivered to the customers home without their presence. The specific time windows are difficult to schedule in order to ensure a smooth operation of the system. Contradiction between the need



for time slots and the consumers' unwillingness to be present only to collect their groceries. It is quite complex to personalize all shipments on a long-term basis.

**Cold Chain:** The most difficult and important aspect of food supply throughout the supply chain is to manage the cold chain and various temperature requirements.

**Competitive price and Expanded offers:** The food industry is competing with price, making it difficult to charge enough for the extra costs that home deliveries provide and remain competitive. The cap for logistics suppliers and their customers extends continuously. This goes from loading at depots to unloading at customers' premises.

**Parking violation** due to unavailability of parking spaces, driver's lengthy walks, and missed first-time deliveries, might require potential neighbor to be identified for delivery or return the packages to the depot for pickup or a later delivery attempt, are among the key on-tour issues to be solved by the driver (Nguyen et al. 2019). Some couriers often allow customers to return the product to delivery personnel, so pickup operations will need to be incorporated into delivery tours as well (Allen et al. 2018b).

The major implications from the identification of CSF are

Last Mile Delivery's value proposition is dynamic. As previously mentioned, customer preferences and profiles are rapidly changing. In five years of span, today's value proposition will be obsolete. The replacement of critical success factors by other variables would not result in significant improvements to the value proposition. However, the key driver of transition would be a shift in the CSF's preferences, perceived value, and, willingness to pay among the critical success factors.

There is no such thing as a unique solution for all. Among the CSF, Choice and Flexibility, are the prime clear indicators of the need for individual solutions that are mass viable while still reflecting an individual's need and lifestyle. Customers are constantly looking for tailored and personalized solutions that blends into their lives. Furthermore, different consumer groups prioritize the CSF in different ways. This opens up opportunities for logistics providers to distinguish and benefit from the current market, such as the customer segments that value convenience and are willing to pay.

The solution should be versatile in size and adaptability to various product needs. The solution must possess the ability to operate independently and simple enough to use for both customers and logistics providers.

## **7. SOLUTIONS**

### **7.1. INTRODUCTION**

The future of last mile delivery is evolving. By 2025, 80% of all deliveries in the world will be achieved by unmanned vehicles (McKinsey & Company 2016). E-Commerce firms are facing huge pressure on fast delivery and be cost efficient due to the increase of customer preferences. With this exponential industry growth, the last mile delivery has become a fascinating topic for investors and media. Jeff Bezos, Amazon CEO mentioned in an interview that “One day Amazon delivery drones will be as common as seeing a mail truck” (Quinn 2015).

### **7.2. HOME DELIVERY**

Home delivery is still the common and mostly used form of delivery compared to other forms. Nowadays the popularity of the home delivery among customers is declining. There is a huge reduction of direct home deliveries to customer from 72 to 62 percent during the year 2013 to 2018 which was predicted by Barclay. Considering the other deliveries to parcel locker and parcel shops are showing a rise from 26 to 38% (Lowe and Rigby, 2014). DHL in Germany delivers only 50% of their volume directly to home (Kniepkamp, 2016). The study carried by McKinsey says that home delivery service is still preferred by more than 70 percent of customers while comparing to other delivering options. Customer feels more convenient, when the order is delivered to their doorstep. Even though the customer prefers home delivery service the relative number of home deliveries is dropping because of the inefficiency of last mile delivery. Barclay’s study reveals that the number of home deliveries will fall, meanwhile other delivery options rise (Lowe and Rigby, 2014).

The majority of the parcel delivery firms are already started to charge extra to the customers for home delivery considering the additional cost faced by the company. CEO of DPD, Boris Winkelmann, says that “In the future, it may happen, that parcel firms deliver to parcel shops by default, and that delivery to consumers’ home costs, let’s say, 50 cent extra” (Ksienrzyk, 2017). Frank Rausch, CEO of Hermes states that “Parcel delivery to a consumer’s front door must become more expensive, given the effort incurred” (Ksienrzyk, 2017).

One of the major problems faced by the parcel delivery firms and consumers are recipients not being home at the moment of delivery. During the day around 50-70%

of households are empty (Lowe and Rigby, 2014). This problem become the major critical factor for the success of home delivery, and it leads to inconveniences to consumers which eventually reduces the customer satisfaction (Park and Regan, 2004). People with busy life are not ready to wait for few hours for their order delivery (Hsu et al., 2011; Blyth and Geoghegan, 2002).

If the customer misses the delivery or the delivery fails, the customer had to collect the order from a post office or collection point (Annon, 2001). This is an extra work for a customer which covers additional cost like public transport or parking and if the parcel is heavy, they need to carry back home themselves. The customer should also be aware of the opening hours of the collection point which is mostly the regular working hours. The rate of failed delivery is increasing because of the inefficient of the last mile delivery.

Most of the customers prefer home deliveries on weekend and after business hours in order to avoid the delivery failures and exposure of the product to the weather and potential theft (Lee et al., 2016). The parcel delivery companies are also working to reduce the number of failed deliveries because it not only reduces the customer satisfaction but also it creates significant cost for the firms in terms of vehicle fuel consumption, idle time, next day delivery, storage and etc.

The above-mentioned problems can be solved by some innovate solutions and also by proper communication to the customer regarding the status of the delivery. Providing time window options could help the consumer to choose the time window in which they would be available at home to receive the order at their doorstep. Providing secured drop off location in the house premises helps the parcel delivery firms to deliver the orders even in the absence of the customers at home.

The limit for logistics providers and what they are able to offer their customers continuously stretches. The operations include both terminal management and transport. An effective Warehouse Management System (WMS) are tech-savvy in operations. The goal is to get the receiver an object as quickly as possible.

### **7.3. EXISTING SOLUTION**

The existing solutions practiced by the logistics firms and the parcel delivery service providers are listed in terms of customer presences and interaction while the order is delivered to the customers.

<b>Delivery Option</b>	<b>Description</b>	<b>Customer Presence/ Interaction</b>
Collection point	Collection point is a place where customer can pick up his order. It can be situated inside or near supermarket	Yes
Click & Collect	Customer picks the order at a physical store	Yes
Parcel Locker	Parcel lockers are normal lockers placed in public places. The customer can collect the products by unlocking the locker with the personal pin code	Yes
Attended Home Delivery	The logistics providers deliver the orders at home at customer's preferred time window	Yes
Unattended Home Delivery	The products are delivered to the mailboxes or placed in the house premises in the absence of customers by humans or robots	No
Bike Couriers	Bike couriers are employed by the logistics providers to deliver the order by bike. They are mostly used for point-to-point delivery of documents or food	Yes

*Table 1: Conventional delivery solutions*

## **7.4. EFFECTIVE WMS**

An effective Warehouse management System (WMS) are technology innovation in operations holding a semi-automated warehouse with robots, AGVs and conveyor system. The central sorting system influences the conveyors, which is mostly loop shaped with tilt trays. OCR software or barcode scanning are used to recognize the address of the shipments. Mostly firms sort all shipments according to the van's delivery route so that the driver can easily retrieve one shipment after the other from the van's shelves without huge effort.

## **7.5. AUTOMATED SOLUTIONS**

### **7.5.1.DRONE DELIVERY**

Drones are unmanned aerial vehicles, vertically starting like helicopters. Drones can carry the parcels to the destination at high speed and follow most direct route. Drones can perform unattended home delivery and their operations and flights requires supervision (Joerss et al., 2016). In recent years, many firms had been successfully tested their prototypes such as DHL (DHL 2014), Amazon (Amazon 2020), and Alibaba (BBC 2015). More than 60% of customers are showing interest in different delivery services like drones (Joerss et al., 2016). More than half of consumers are expecting drone delivery in future (Temando, 2016). Amazon CEO, Jeff Bezos, claims: “One day seeing Amazon drones will be as common as seeing a mail truck” (Lee et al., 2016, p. 11). Drones are electrically powered; they are fast because of unobstructed air travel and they can operate autonomously with little supervision. Drones are designed to carry a single and not too heavy shipments at a time. Considering the operational constrains of drones handling a significant number of shipments might require a substantial fleet size. It’s still questionable whether drones can carry heavy parcel with reduce cost. Drones have positive impact on sustainability, lower costs and reducing human workforce.

Drones are more efficient for smaller parcels and for operation in rural areas. Delivery for remote locations and to cover long distance is more expensive nowadays. Drone delivery are cost-competitive in rural areas. Drones are considered as the ideal solution for the customers who expect specific time window delivery or same day delivery in the rural areas. Drones are preferred for delivery in difficult terrain, and they can take short routes. They have positive impact on environment as there will be less trucks running for delivering the orders to customers.

The size of drones increases when they are designed to carry heavy parcels and to fly long distances. It is difficult to find places for landing the drones in the high dense urban areas which mostly requires 2sqm area. Currently drones can only carry up to 5kgs. Even if drones are designed to carry heavy parcels, they cannot do multiple deliveries. Due to the restriction to carry single shipment at a time, the shipping route is well organized. The firms should also focus on the staffing and fleet sizing to carry out efficient last mile delivery. Drones are not allowed to takeoff during stormy weather and breakdowns.

Given the benefits and drawbacks of drone delivery, there are two reasonable concepts that can be applied for drones in the last mile delivery (Murray and Chu

2015). In the first concept the drones are operated directly from the depots to the customer destinations, With the limited flight range of drones which is about 20kms it might need a dense and expensive depot in order to serve large urban areas. The second concept is designed to overcome the drawbacks of the first one. In the second concept, firms will be using a vehicle like a mobile van as a launching platform for drones. Drones' delivery is always used to execute unattended delivery at the consumer house by dropping the packages at a defined location in the absence of customers.

Drone Delivery requires a strong legal framework, safety and liability regulations combined with efficient IT capabilities and trained professional supervisors and technicians. One supervisor can remotely monitor more than eight drones. The traditional parcel delivery firms need to build the capabilities and assets. Many firms started testing the drones and they are UPS, Amazon Prime Air, Google, and Hermes. The market potential is growing exponentially.



*Figure 2: Drone delivery (Ideal and incorporated with mobile launching platforms)*

## **7.5.2.AGV's**

Delivery robots are another form of autonomous delivery vehicle (or simply called bots). Several companies like Amazon and Starship Technologies, are either producing or selling delivery robots. When compared to drones, autonomous delivery bots have distinct advantages and disadvantages. Bots run at a pedestrian pace of around 6km/h on sidewalks, significantly slowing their distribution speed but allowing them to transport slightly heavier packages of up to 10kg (Starship Technologies 2015). A drone, on the other hand, must be monitored at all times by a dedicated flight operator and is not permitted in neuralgic areas like airports (FAA 2018). Bots are subject to less security restrictions, so in various field experiments, one operator was permitted to supervise clusters of bots (Bakach et al. 2020).

Bots can hardly ease the time burden of last-mile distribution due to their sluggish delivery speeds. However, Application of bots for delivery are already in practice, by Amazon (Dormehl 2020), the German Post (T3n 2017), Hermes in London and Hamburg (Bertram 2017), for package delivery or pizza delivery in German and

Dutch cities (Starship Technologies 2017). The key distinction between drone and bot-based delivery concepts is that bots are only suitable for attended home delivery. Customers are notified via a mobile app when a delivery bot arrives, and they must unlock and open the cargo bay as well as remove the shipment.

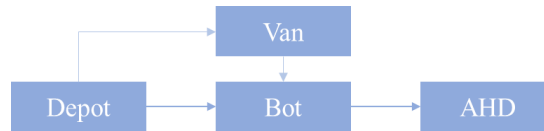


Figure 3: AGV Network (Inspired from Jennings and Figliozzi (2019) & Boysen et al. (2018b))

AGVs (autonomous ground vehicles) are self-driving vehicles that share the road with normal cars. When outfitted with parcel lockers, AGVs effectively replace existing delivery vans). They will distribute packages without the need for human interaction. If such vehicles are required to be monitored, one operator may centrally manage up to ten AGVs. Customers are informed of the exact arrival time in advance. When the AVG arrives at their residence, the recipients are instructed to retrieve the parcel from the locker.

The technology necessitates the presence of the receiver at the time of delivery in order to open the carrier and retrieve his package. From the perspective of the customer, parcel delivery through AGVs is not significantly different from conventional home delivery. AGVs are simply a particular mode of transportation, one that does not require a driver. The dilemma of not being at home continues. On the other hand, AGVs could provide Sunday delivery even in countries with strict labor laws that prohibit working on Sundays in most professions, such as Germany (Joeress et al., 2016). Customers place a high emphasis on versatility. 70% of customers expect couriers to deliver on Sundays, which is not surprising given that people enjoy the comfort of having packages delivered right to their door but are not at home during normal business hours (Lowe and Rigby, 2014). During the night, the vehicles can be used as standard parcel lockers. This will also allow parcel companies to save money on the real estate costs associated with traditional parcel lockers. AGVs are widely embraced in public, with 40% of consumers saying they will certainly or probably use AGVs with parcel lockers (Joeress et al., 2016).

According to Joeress et al. (2016), existing modes of traditional parcel delivery will be replaced by AGVs with parcel lockers due to its cost advantages over today's conventional last-mile delivery. Assuming EUR 20/hour of labor costs approx., the estimated cost savings is of 40% or more. In rural areas, the deployment of such driverless vehicles is expected to pay off. They will work longer hours, providing greater flexibility in delivery times and increasing operational efficiency (Lee et al., 2016).



Figure 4: AGV Network (Inspired from Zhe Ding (2013))

Mobile parcel lockers, unlike their stationary counterparts (see Fig. 3, left), are fitted with an autonomous drive, allowing them to change locations during the day. The opportunity to shift locations broadens their appeal to clients, who can travel around the city center during the day. The key difference between delivery and the associated vehicle routing issues with roaming delivery locations is that mobile lockers must wait for pickups after consumers are notified of the arrival of a nearby mobile locker via a smartphone app. As a result, mobile parcel lockers are not as flexible and (likely) stay at a single location for a longer period of time till the pickup. However, AGVs do provide Overnight pickup and Sunday deliveries. AGVs are parked in their delivery areas and function as normal parcel lockers if there are any unsuccessful deliveries during the day. Customers pick up the goods overnight. This paves the way for cost savings of real estates such as parcel lockers for the service providers. Also, in countries where labor laws like working on Sundays is prohibited, AGVs could be the most prominent solution. Schwerdfeger and Boysen (2020) were the first to explore the complex facility position issue of mobile parcel lockers that resulted. They conclude that mobile lockers have the ability to significantly minimize fleet size as compared to stationary lockers. Autonomous vehicles are much less dangerous to bystanders, so they seem to be getting closer to being licensed in public spaces. Both autonomous delivery systems (i.e., drones and bots) are mathematically similar, but differ primarily in basic parameters such as payload, prices, and operating ranges. As a result, it will be useful to explore how consumers with varying characteristics and needs can be divided between all types of autonomous delivery devices and their alternative launching choices.



Figure 5: AGV Delivery (Ideal and as Mobile locker)



### 7.5.3.DROIDS

Similar to AGVs, Droids are small autonomous vehicles that deliver parcels right to doorstep. They are only marginally bigger than the parcel itself. They drive at low speeds of 5-10 km/h and use sidewalks and bike lanes to get around. They are designed to ride alongside pedestrians, bicyclists, and automobiles. Droids are not designed to travel long distances, such as distribution to rural areas. Within 5-30 minutes, the droid will travel short trips from the fulfillment center to the customer. The customer is alerted via smartphone app to open the robot's locker. The robots are secured against theft, and only the receiver has access to the one-time pin that allows them to retrieve the parcel. The droids must be monitored. However, due to their small size and slow speed, a single operator could handle hundreds of them (Joerss et al., 2016). Companies like DHL and Hermes uses drones with pilots. Starship and Hermes have partnered and have been running trials in Germany & Hamburg, since 2016. The study shows that droids are well-liked by both package recipients and pedestrians (Bertram, 2016).

If they do become quicker than the existing speed, they will most likely look very different from what we see today because they will have to use normal streets and will no longer be able to ride along sidewalks and pedestrian areas. However, no such developments have pointed in that direction. To summarize, autonomous vehicles such as droids, AGVs, and drones will carry almost all B2C & C2C packages in the near future. Developed countries will be the first to implement these new autonomous delivery models because labor costs are a bit intense to justify the investment. Autonomous distribution models can significantly increase the asset-intensiveness of the last-mile. Labor costs in developed countries are likely to stay low enough to avoid significant technological change affecting the last mile in the next decade (Joerss et al., 2016).



Figure 6: Droid Delivery (Groceries, Commercial products, Healthcare)

## 7.5.4.IN-CAR DELIVERY

In-Car Delivery, also known as Trunk Delivery, is a term that enables consumers to receive parcels and other deliveries in their car's trunk. According to DHL, In-Car Delivery is “a fresh and appealing service targeting youngsters seeking to improve the quality of urban life” (smart, 2016). Customers must register for the service with the carrier. The idea is straightforward. When making an online purchase, customers can choose their vehicle as the delivery location. The carrier uses geo-location to locate the vehicle, opens the trunk with a temporary and digital access key, and delivers the box. After a good drop-off, the customer gets a notification, and the delivery person's one-time key expires immediately. In-Car Delivery (ICD) incorporates the benefits of both home and unattended delivery. So far, it is the only form of unattended delivery that does not divide the last mile between carrier and business. In other words, the package is delivered directly to the customer (assuming his car is nearby), so he is not required to be present when the parcel is delivered. The delivery into customers car is similar to attended home delivery with alternative delivery choices and time windows based on the shifting locations of customers during the day.



*Figure 7: In-Car Delivery (Partnered and Ideal)*

## 7.5.5.IN-FRIDGE DELIVERY:

In-fridge delivery is the tailored home delivery service for groceries. This allows the delivery driver to deliver the food items directly into the fridge in the absence of customers at home. In-fridge delivery could solve the problem of delivering sensitive food items which need to be maintained at certain temperature. This concept requires a digital lock at the front door. While the order is about to be delivered, the driver gets the approval to enter the house with the help of the digital key and place the groceries inside the fridge. (ICA 2016).



Figure 8: In-Fridge Delivery (Partnered and Ideal)

### 7.5.6.DELIVERY BOX (RECEPTION BOX):

The delivery box or the reception box are placed in the house premises for example: at the home yard or the garage. The box is installed with a digital lock which can be accessed by the delivery driver. The driver can place the order in the box when the customer is not available at home. This can protect the product from the potential theft, weather conditions, and also from the damages created by pets.



Figure 9: Delivery Box (Partnered and Ideal)

## 7.6. CSFs BASED ON AUTOMATED DELIVERY SOLUTIONS

**Choice:** The new automated solutions will not be a replacement for current distribution methods. However, it acts as an alternative distribution service, broadening the range of services available to customers.

**Convenience:** The automated solutions provide a high level of convenience of the parcel being delivered right to home or elsewhere. It eliminates the need for length, time-consuming trips to post offices or collection points and the necessity of being present in home to receive the orders.

**Cost:** Currently the pricing is not structured. However, it is reasonable to expect automated solutions to be priced similarly to home delivery. In the long run, the services will initially be introduced as a value service for prime customers, but will gradually become the norm, dramatically lowering the cost.

**Flexibility:** In terms of flexibility and safety, the innovative automated solutions are being frequently upgraded leveraging on the technological possibilities to enhance the flexibility and safety of the products being delivered to customers.

**Speed:** With respect to speed, every solution has its own pace of delivery. Depending on the customers preference and the service providers flexibility the corresponding solution should be adopted to race ahead in the market to attain customer satisfaction.

**Returns:** Though returns are not actually a critical success factor, it is an additional element for online shoppers. Incorporating returns along with the usual delivery in the automated solutions is quite a challenging task.

## **8. RESEARCH METHODOLOGY**

### **8.1. INTRODUCTION**

The focus of the study is on the automated solutions in the logistics Industry particularly focusing on the last mile delivery. Some players have managed to cut through consumer resistance with innovation, pricing, adapting to emerging solutions and aggressive marketing evolution. The competition level in the last mile industry is very high now. Many brands are fighting in the market for maximum share. They have to bring out a lot of differentiation among them. The major duty of the marketer is to know the reasons for preferring particular solution by the consumers.

The study conducted would help in understanding and analyzing the various aspects in the last mile industry such as Consumer behaviour and suitable automated solutions. It would indicate that the possibilities of multiple choice of delivery shall also be a key success factor, the service providers who are able to provide flexible solutions at the most competitive prices will be the winners. Finally, the delivery service providers will have to brace themselves for increased competition on a service offering level.

## **8.2. RESEARCH METHODOLOGY**

'Qualitative research is the collection, analysis and interpretation of data that cannot be meaningfully quantified, that is, summarized in the form of number' (Diggines & Wiid, 2009, p.85). Qualitative research basically depends on the gathering of qualitative data (Johnson & Christensen, 2012). Neergaard and Ulhoi (2007) define qualitative research as a research that focuses on a multi method approach that includes an interpretive and naturalistic view of its subject matter. Qualitative research is concerned with qualitative observable fact, or in other words a phenomenon that contains quality or kind (Kumar, 2008). Beije (2010) illustrates that, in qualitative research the research questions are carried out in a flexible manner allowing one to get in touch with the people concerned to a degree that is essential to grasp what is being carried out within the field.

By analysing the market needs and existing automated solutions, a supportive document is prepared and compiled with the information about the solutions. This document helps to understand a holistic approach, such as the prime motives, critical success factors and drivers behind the adaptation of solution according to the suitability and their demand characteristics that aid in applying logistics strategies.

Case study is a qualitative research method that “scientifically investigates into a real-life phenomenon in-depth within its environmental context” (Ridder, 2017). It is a useful methodology when a “how” or “why” question is being asked about a contemporary set of events over which the investigator has little or no control (Rowley, 2002). Moreover, it allows to use many different sources of evidence such as documents, interviews, observations (Yin, 2009). Therefore, this work will be based on the analysis of existing and futuristic automated solution revolutionizing the field of last mile delivery enhancing customer satisfaction, contributing to the sustainability in the environment.

## **8.3. SOURCES OF DATA**

As our source, Secondary data has been collected for the study. After identifying and defining the research objectives and determining specific information required for solving the issue, the research analyzed for the type and sources of data which may yield the desired results. Secondary data is available in the form of company records, trade publications, company reports, everyday newspaper, Textbook, websites, and libraries.

A supportive document is prepared that is compiled with the information about the automated solutions case study and this entire research is supervised by the author to aid and ensure accuracy. As a result, multiple cases have been selected because it provided the opportunity for more in-depth observation and it was particularly representative of the various challenges that the industry encountered, thus, deemed suitable for illuminating the phenomenon that this work investigates.

#### **8.4. VALIDITY AND RELIABILITY**

The quality of the results is ensured through three widely used approaches in the literature which are internal validity, external validity, and reliability.

“Internal validity refers to the identification of causal relationships whereby certain variables may influence other variables in the research study” (Yin, 2009). The internal validity is established by grounding the research in a literature review showing the relationships between consumer behaviour, technological improvements, market competitiveness, feasible automated solutions in the context of last mile delivery.

“External validity indicates the generalizability of the findings beyond the immediate case study” (Rowley, 2002). This work uses a multiple case study, the external validity is largely ensured through the presentation of relevant evidence of theoretical transference during the analysis and discussion of the results.

As mentioned in the data collection phase, the reliability of the findings is improved by triangulation of data coming from multiple sources (i.e. Journals, internal company documents and reports).

#### **9. ANALYSIS & INTERPRETATION**

The review of the literature revealed the existence of a number of novel solutions aimed at improving the performance of last-mile distribution. However, Outbound logistics for B2C eCommerce is more complicated and expensive than conventional offline channels for a variety of reasons, which would include: 1) the limited number of units dealt. Single orders are associated with logistics operations like shipping and warehouse activities. 2) Unlike in the conventional process, certain tasks, such as picking, packaging, and last mile distribution, are performed by the merchant rather

than by customers. 3) Customers' high service level expectations, especially in terms of cycle time and convenience.

The following are the primary determinants of customer service level in B2c eCommerce: Order-cycle time, Delivery convenience, Accuracy of delivery, Timeliness of delivery, Prompt access to tracking and tracing information, Product information and/or delivery schedules, Post-transaction process quality (after-sales services, return management, management of unsuccessful deliveries).

**Delivery convenience** is referred to as the capacity of the supplier to adapt the delivery mode to the needs of the end user such as the Delivery times (morning, late in the evening - after dinner, on Saturday afternoons, and on Sundays), Mode of delivery (appointment, attended/unattended), Points of distribution (office, house, doorman), Delivery time and cost (quick solutions to deliver as soon as possible).

With conventional delivery solutions as benchmark, the delivery convenience of automated solutions is rated with respect to both customer and service provider's perspective in terms of effort and cost.

Delivery Convenience	Drone	AGVs	AGV - mlocker	Droids	In Car delivery	In Fridge delivery
Customer	✓✓✓	✓	✓✓	✓	✓✓✓	✓✓✓
Service Provider	✓✓	✓✓✓	✓✓✓	✓✓✓	✓	✓
Food Industry	✓✓✓	✓✓	✓✓✓	✓✓	✓✓	✓✓

Table 2: Service Level Determinant - Delivery Convenience

As shown in the table above, it is always a challenge to balance the customer satisfaction and its associated costs. Though 'AGVs' and 'Droids' are effective solutions, it requires the customers to present at the time of delivery to receive the package and the speed is comparatively low. On the contrary, though 'In car delivery' and 'In fridge delivery' are most convenient for customers, it has too much capital and operational complexities for the service providers. Complexities such as tie-ups, Mergers & Acquisition, training the delivery personnel, technological incorporations and so on. Therefore, as a result, for the last mile delivery of food products, the most convenient delivery solutions seem to be Drones and AGV-mlocker to balance and supply and demand uncertainty.

**Accuracy of delivery** is referred to as the potential of the supplier to comply with the conditions agreed upon with the customer. Two factors are important in B2C eCommerce:

- 1) Due to the extremely high costs associated with “nonconformity,” consistency between “ordered” and “delivered” items is essential.
- 2) Compliance of the unit loads (packaging), in order to withstand the "distribution phase" and be convenient to the customer.

Both order transmission and order entry processes must be more accurate than in the conventional distribution channel. Accuracy also includes the freshness of the product or the product quality focus on its perishability. With conventional delivery solutions as benchmark, the delivery accuracy of automated solutions is rated with respect to both customer and service provider’s perspective in terms of conformance and quality.

Accuracy of Delivery	Drone	AGVs	AGV - mlocker	Droids	In Car delivery	In Fridge delivery
Customer	✓✓	✓✓✓✓	✓✓✓✓	✓✓✓✓	✓✓	✓✓✓✓
Service Provider	✓✓	✓✓✓✓	✓✓✓✓	✓✓✓✓	✓	✓
Food Industry	✓✓	✓✓✓✓	✓✓✓✓	✓✓✓✓	✓	✓✓

Table 3: Service Level Determinant – Accuracy of Delivery

As shown in the table, on a broader perspective, the autonomous solutions are much reliable in terms of accuracy of delivery compared to the conventional delivery solutions. The ‘Drone’ delivery is relatively less efficient because if the order is huge, it should be split as the load carrying capacity per drone is limited. Also, the perishable nature of food products and safety requirements adds to the complexity. Though ‘In Car delivery’ is much convenient, it is difficult to assure the freshness of the products until it is being retrieved by the customer and ‘In Fridge delivery’ is safer and quality assured, however, the capital and operational complexities is a trade-off. Therefore, as a result, for the last mile delivery of food products, the solutions with higher accuracy and ease are AGVs, mlocker and Droids to effectively satisfy the customer requirements.

**Tracking and tracing** is referred to as the ability of the retailer to provide reliable information on both order fulfillment and delivery time. There are two methods for providing information:

- 1) “Pull” request from customers.
- 2) "push" from service providers via email or SMS on order progress updates.

With conventional delivery solutions as benchmark, the tracking and tracing ability of automated solutions is rated with respect to both customer and service provider’s perspective.



Tracking and Tracing	Drone	AGVs	AGV - mlocker	Droids	In Car delivery	In Fridge delivery
Customer	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓
Service Provider	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓
Food Industry	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓

Table 4: Service Level Determinant – Tracking and Tracing

As shown in the table, tracking and tracing became a common feature as it evolved from premium standard to the normal standard. Almost all delivery solutions both conventional and automated solutions possess the capability of tracking and tracing the order. However, the accuracy and effectiveness of the tracking differs. In case of ‘In Car delivery’, the efficiency of tracking is comparatively low as there is a frequent change or update in the delivery location which changes the order of delivery on the move. Therefore, unlike other parameters, Tracking became an essential feature of the last mile delivery.

**Unsuccessful deliveries:** The merchant must resolve the issue as soon as possible, preferably without incurring additional costs. Reasons for failed deliveries: Absence of customer, due to customer errors in the delivery address, or the courier was unable to locate the delivery address. Preventive measures include: carefully defining delivery features like delivery time window and requiring the customer to provide correct delivery information. Corrective steps include specifying specific protocols in the event of a failed delivery for both the customer and the courier.

With conventional delivery solutions as benchmark, the rate of possibilities of unsuccessful delivery occurrences and managing of it by automated solutions is rated with respect to both customer and service provider’s perspective in terms of availability and quality.

Unsuccessful Deliveries	Drone	AGVs	AGV - mlocker	Droids	In Car delivery	In Fridge delivery
Customer	✓✓✓	✓✓	✓✓✓	✓✓	✓✓	✓✓✓
Service Provider	✓✓✓	✓✓	✓	✓✓✓	✓✓	✓✓✓
Food Industry	✓✓✓	✓✓	✓✓	✓✓✓	✓✓	✓✓✓

Table 5: Service Level Determinant – Unsuccessful Deliveries

As it is evident from the table, Drone delivery is highly effective in eliminating and also managing the unsuccessful deliveries. ‘AGV’ and ‘In car delivery’ has the higher possibilities of unsuccessful delivery as it requires the customer to be present to receive the products of fresh quality. Though “AGV-mlocker’ is capable of waiting for the customer and delivering fresh, it is a drawback for the service provider as it might

affect further deliveries due to long waiting times. Similar to drones, 'Droids' and 'In Fridge delivery' also eliminates the possibilities of unsuccessful deliveries. Therefore, 'Drones', 'Droids' and 'In Fridge delivery' are considered to be more effective to resolve this satisfying the customer requirements.

**Return management** is referred to as the merchant's ability to properly serve customers in the event of a return. If the returns are for non-conformity purposes, the merchant must deliver this service to consumers quickly, conveniently, and without extra costs. In all other instances, at a very low rate. Here the customer service issues include: customer convenience, return costs, and required packaging/labelling for the return.

With conventional delivery solutions as benchmark, the effectiveness of return management using automated solutions is rated with respect to both customer and service provider's perspective in terms of effort and cost.

Return Management	Drone	AGVs	AGV - mlocker	Droids	In Car delivery	In Fridge delivery
Customer	✓	✓✓	✓✓	✓✓	✓✓	✓
Service Provider	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓
Food Industry	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓

Table 6: Service Level Determinant – Return Management

As it is evident from the table, AGVs, mLocker and Droids are quite effective when compared with the other means of automated solutions such as Drones, In Car and In Fridge delivery. Though product returning process is still a cumbersome in conventional methods, the implementation of automated solutions adds an additional concern of proper packaging and handing it over to the bots or drones at the time of product pickup. From customer's perspective all solutions are a hard experience with the drones and In Fridge mode it's a bit more complex. Therefore, on the whole AGVs and Droids seems to perform well for returns management followed by the Drones.

In addition to these determinants, as identified in the literature review, the critical success factors of the LMD solutions are:

**CSF Food** - Timeliness, Hygiene - Food Safety, Quality

**CSF Customer** - transparency, credibility, choice, returns, UHD/AHD (convenience)

**CSF Performance** - Volume, Sustainability, Cost effectiveness, Independent, flexibility, safety, speed, reliability.

These were grouped together in order to identify themes among the findings and to perform selective coding. The most frequently occurring themes were then chosen for further examination, and the findings were used to identify the critical success factors for grocery home deliveries. This, along with the other analysis results, is used to determine which parameters to focus on, fulfilling the purpose of this thesis study, and developing a comparative framework.

The selected CSF to be considered for the evaluation of the automated solutions are the Volume Sustainability, Independent, Flexibility, Safety, cost and speed for operational performance, Food safety for the sector, and finally Convenience and willingness to pay for the customer. Every identified solution is matched up with the CSF and rated accordingly with a scale being ✓, ✓✓, ✓✓✓ as from low to high level of efficiency accordingly.

## 9.1. DRONES

Drones will be tomorrow's parallel logistics. It is now possible to deliver urgent orders to difficult-to-reach areas and to deliver between post offices. The deep analysis on the insights from the literature review interprets that, drones play a pivotal role in the modern delivery solutions of last mile delivery. In regards to food industry, Drones are effective in maintaining timeliness, Hygiene and the quality of the food products from the pickup to the delivery. It is also effective for customers with the convenience of UHD/AHD providing full transparency and credibility.

The performance of the solution in case of last mile delivery is rated by means of adherence to the critical success factors.

DRONE								
Volume	Sustainability	Independent	Flexibility	Cost	Speed	Safety	Convenience	WTP
✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓

Table 7: Performance of Automated Solution – Drone

Unattended Home Deliveries (UHD) are made possible through drones for home deliveries of groceries. Though the volume carrying capacity is low, the speed at which it can deliver is phenomenal. The solution is highly sustainable, Independent, Flexible and also in case of Food safety, it is remarkably efficient as it delivers provide in the same quality of which it is sent out from the depot. However, in case of UHD, post the delivery the safety risk is transferred to the customers. The customers are convenient with this solution as it could also deliver the package unattended and so

the willingness to pay is high. The cost effectiveness is low as the cost incurred per delivery is high, this is in accordance with the low volume carrying capacity. On the whole, Drones seems to be an effective solution for home delivery of groceries to targeted customers.

## 9.2. AGVs

Automated Guided vehicles are still evolving in the last mile delivery. The AGVs delivery the product to the doorstep of the customer with less human interaction. From the literature review, AGVs will play a crucial part in the last mile delivery. In terms of food industry, AGVs can carry the customer ordered products to the drop location effectively. With further development in future, it will be used for the delivery of temperature sensitive products. Anyhow with AGVs the customer should be present to collect the product.

AGVS								
Volume	Sustainability	Independent	Flexibility	Cost	Speed	Safety	Convenience	WTP
✓✓✓	✓✓✓	✓	✓✓	✓✓✓	✓	✓✓	✓✓	✓✓

Table 8: Performance of Automated Solution – AGV

AGVs can carry more volume to the destination. It very cost efficient as it does not require any deliver man in this process and it eliminates other cost of delivery vehicles. AGVs can only go at slow speed and they use walking pavements for movement. The orders can be retrieved from the AGVs with pin which is only provided to the customer at the time of placing order in the ecommerce website. This solution is sustainable but it can perform only Attended Home Delivery as the customer presence is very much required to collect the order. AHD reduces the flexibility and the customer convenience and it eventually reduce the willingness to pay as there are many other solutions which performs Unattended Home Deliveries.

## 9.3. AGV (mLocker)

Automated Guided Vehicles with Locker or mLocker. It is a combination of locker and Automated Guided Vehicle. These mLockers can move around the city and stops at a common place, where the customer can pick up their orders. It can be near their home or work location. As they have similar features like AGVs, for food industry they can

solve the problem of delivering food which are temperature sensitive with some further development. Customer interaction is very much required in this case.

AGV mLocker								
Volume	Sustainability	Independent	Flexibility	Cost	Speed	Safety	Convenience	WTP
✓✓✓	✓✓✓	✓	✓✓	✓✓	✓	✓✓✓	✓✓	✓✓

Table 9: Performance of Automated Solution – AGV (mLocker)

As the mLockers have huge space its easier for them to carry more volume. As they are similar to normal AGVs, Customer presence is much required at the time of delivery. mLockers delivers the order to the customer after the pin verification. The speed of delivery is very less as they move in the guided pavement at a very low speed. The Convenience is slightly less as the customer interaction is essential for the delivery of the orders. It has some cost reduction as it eliminates the delivery man and the transportation cost of a normal delivery van. Willingness to Pay will be slightly less as the convenience of customer is less but they are very sustainable.

## 9.4. DROIDS

Droids are small robots which are recently developed for the product delivery. They can pick up small orders and deliver at the doorstep of customers. According to the literature review, droids are especially for delivering small products which could possibly eliminate the cost of the traditional delivery. For Food Delivery, Droids can perform small deliveries and effective as they can maintain the quality of the product as they are placed in a closed container.

DROIDS								
Volume	Sustainability	Independent	Flexibility	Cost	Speed	Safety	Convenience	WTP
✓	✓✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓	✓✓

Table 10: Performance of Automated Solution – Droids

As droids are very small and designed to carry small products, they cannot be used for delivering high volume of orders. They can move around the city independently and they have high sustainability. Human interaction at the customer side is required to collect the products. They cannot achieve fast delivery as they move slowly. Droids requires investment for developing fleet and base. As Droids can be used only for

Attended Home Delivery it will reduce the Convenient and flexibility which will also affect the Willingness to Pay.

## 9.5. IN CAR DELIVERY

In Car Delivery is practiced by some last mile delivery firms in associated with car manufactures. As we could see in the literature review, the orders are delivered to the trunk of the customer car. The delivery person will be provided with the access to the car trunk where he/she can place the product. The delivery person will have the access to the person car on the time of delivery process. In terms of food delivery, the sensitive food products cannot be stored in a car trunk and they will lose the quality.

IN CAR DELIVERY								
Volume	Sustainability	Independent	Flexibility	Cost	Speed	Safety	Convenience	WTP
✓✓	✓✓	✓✓✓	✓✓	✓	✓✓	✓	✓✓✓	✓✓✓

*Table 11: Performance of Automated Solution – In Car Delivery*

In car Delivery are more convenient for the customer as there is no need for the customer presence while the delivery process is done. It eventually increases the willingness to pay. The volume is confined to the space of the car trunk. The flexibility is very less as the customer need to leave the car in the location where the delivery person can access. The Initial investment for the In car Delivery is high as the last mile delivery firm should make some partnership with the car manufactures to design the car trunk that can be accessed by the delivery person. In terms of food delivery, the quality of the product cannot be maintained as the products will be placed in the trunk without any temperature control. If the vehicle is exposed to direct sunlight, the inside temperature of the vehicle will be high. But this method of last mile delivery is more independent and convenient which have a positive impact on the Willingness to Pay.

## 9.6. IN FRIDGE DELIVERY

In Fridge Delivery is a last mile delivery method where the products are directly delivered to the fridge of the customer. This kind of delivery is very effective and efficient for food deliveries. The food products can be placed in the fridge so that the quality of the temperature sensitive product remains the same. The fridge will be installed in the front door of the customer and the delivery person can deliver the

order to the fridge even when the customer is not present at the home. The delivery person can access the fridge with the pin provided by the firm at the time of delivery.

IN FRIDGE DELIVERY								
Volume	Sustainability	Independent	Flexibility	Cost	Speed	Safety	Convenience	WTP
✓✓	✓✓	✓✓	✓✓✓	✓	✓✓	✓✓✓	✓✓✓	✓✓

Table 12: Performance of Automated Solution – In Fridge Delivery

In Fridge Delivery is more convenient and flexible as it is an Unattended Home Delivery. As the food are directly delivered to the fridge the quality of the product remains the same and especially for the temperature sensitive products. The cost is very high as there is a need of investment for installing the fridge at the front door. It will be less independent as there is human interference while delivering the products. The volume of the order can be defined by the size of the fridge. Sustainability and speed are less as the products are delivered to the fridge by traditional method of delivery.

## 9.7. DELIVERY BOX

Delivery box delivery is where the products are delivered to the delivery box placed in the premises of the customer house. It can be locked and unlocked with the pin or app so the delivery person can deliver the orders to the box even when the customer is not at home. Regarding to food delivery, the products can be saved from the theft or pet attacks. Nowadays some delivery box comes with the refrigerator so it effective and efficient to store the temperature sensitive products without losing the quality of the products.

DELIVERY BOX								
Volume	Sustainability	Independent	Flexibility	Cost	Speed	Safety	Convenience	WTP
✓✓✓	✓✓	✓✓	✓✓✓	✓	✓✓	✓✓✓	✓✓✓	✓✓

Table 13: Performance of Automated Solution – Delivery Box

The delivery box is convenient as the process is Unattended Home Delivery. The volume can be determined by the size of the deliver box available in the customer house. The products are very safe from the theft and animal attacks. The cost covers the purchase and the installation of the delivery box in the customer premises. The flexibility is high as the customer need not to be present at the house at the time of

delivery. The sustainability, independence and is less as the orders are delivered to the delivery box by the traditional method by a vehicle and delivery person.

## 9.8. DISTRIBUTION NETWORK DESIGN

There is no such thing as a unique solution for all. Among the CSF, Choice and Flexibility, are the prime clear indicators of the need for individual solutions that are mass viable while still reflecting an individual's need and lifestyle. Customers are constantly looking for tailored and personalized solutions that blends into their lives. Furthermore, different consumer groups prioritize the CSF in different ways. This opens up opportunities for logistics providers to distinguish and benefit from the current market, such as the customer segments that value convenience and are willing to pay.

A delivery network can be designed in a variety of ways, and these can change over time. Nonetheless, a few major systems for designing a delivery network can be described. These solutions, which vary in terms of cost and operation, can be implemented independently or in conjunction. Nils Boysen and Stefan Fedtke 2020, have analyzed the operational perspective of the automated solutions in regards to the various distribution network design. Taking into account the setup of infrastructure, staffing and fleet sizing, routing and scheduling: Mobile launching platforms can be used for launching the automated solutions with limited operating range to avoid the high investment cost.

The possible combinations of Network Design and Its Features:

<b>CONVENTIONAL DELIVERY SOLUTIONS</b>	
<b>VAN / BIKE / LOCKER / SHOP</b>	<b>FEATURES</b>
Depot => Van => Man => AHD	Though inclusion of an additional micro/mobile depot adds up to the investment cost, the operational efficiency of the system resulting in customer
Depot => Van => Micro Depot => Bike => AHD	
Depot => Van => Mobile Depot => Bike => AHD	
Depot => Van => Locker => Self	



Depot => Van => Shop => Self	satisfaction and cost effectiveness is really high
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<b>AUTOMATED DELIVERY SOLUTIONS</b>	
<b>DRONE</b>	<b>FEATURES</b>
Depot => Drone => UHD	The limited operating range is resolved by expanding the network with Vans and micro depots that are replenished continuously
Depot => Van => Drone => UHD	
Depot => Van => Micro Depot => Drone => UHD	

<b>AGVs</b>	<b>FEATURES</b>
Depot => AGV => AHD	The complexity of speed and limited operational capacity is managed by inclusion of vans and micro depots to the network, improving the efficiency of the network and the service offered
Depot => Van => AGV => AHD	
Depot => Van => Micro Depot => AGV => AHD	

<b>DROIDS</b>	<b>FEATURES</b>
Depot => Droid => AHD	Droids are comparatively slow and less flexible as it carries individual orders. The distribution can be made effective via the multi-echelon network design
Depot => Van => Droid => AHD	

<b>AGV mLOCKER</b>	<b>FEATURES</b>
Depot => AGV mLocker => Self	

Depot => Van => AGV mLocker => Self	In Customer's absence the AGVs serves as a mLocker maintaining the quality for the food, till it is collected by the customer. Therefore, Micro depot allows multiple AGVs and multiple trips to be performed to gain operational efficiency.
Depot => Van => Micro Depot => AGV mLocker => Self	

<b>IN CAR / IN FRIDGE / DELIVERY BOX</b>	<b>FEATURES</b>
Depot => Van => Trunk => Self	The distribution network is quite simple in these cases as it requires human intervention at the final part. Therefore, the initial vessel of transport can be a Van/AGV/Bike depending on the operational requirement
Depot => Van => In Fridge => UHD	
Depot => Van => Delivery Box => Self	

<b>OTHER POSSIBLE COMBINATIONS</b>	<b>FEATURES</b>
Depot => Drone => Locker => Self	All these and much more possible combinations of delivery network all adds up to the operational efficiency of the system. However, the effectiveness of the system depends on the point of application depending on the demand and other environmental factors.
Depot => Drone => Van => Man => AHD	
Depot => Drone => Micro Depot => Drone => UHD	
Depot => AGV => Micro Depot => AGV mLocker => Self	

Table 14: Distribution Network Designs

Each delivery mode in last mile delivery has several strengths and weaknesses, so a combination of several concepts, each focused on different customer segments, will probably be the right choice.

## **9.9. HAU LEE MODEL**

The technological application characteristics of solutions lead to current advancements and can be leveraged to increase effectiveness and efficiency in the last mile. In order to reach such an objective, a broad knowledge of the functions of the system is required for understanding the perfect harmony between the situation and the model. This model was employed here and it has been applied to the automated solutions to further characterize the scenario.

Hau Lee creates innovative business models and networks for value creation by effectively managing the value chain. Based on the changes in demand and the stability of the provided industry's operations, we can group the industry with the suitable sort of solution that can help the industry be effective in terms of demand and supply service as well. Demand variability is a measure of how much variety exists in client needs in the e-grocery logistics industry. In most circumstances, our industry's demand varies greatly. Hence, big data and data analytics are utilized. Demand variability can also be determined by examining some of the solution's demand characteristics. Based on consumer demand, the service provider uses the information to select the best solution to create a seamless customer experience. The last mile delivery system's stability refers to the distribution network design that performs consistently over time and is in control, with little change in time for continual improvement and hence a stable increase in the operations yield.

High speed and low cost are insufficient to provide companies with a sustainable competitive advantage over competitors. By optimizing the supply chain, businesses gain a long-term competitive advantage over their competitors. To gain a sustainable competitive advantage over their competitors, businesses must build agile, adaptable, and aligned supply chains, also known as The Triple-A supply Chain. Only companies that incorporate all three into their supply chains, according to Hau L. Lee, gain a sustainable competitive advantage over their competitors.

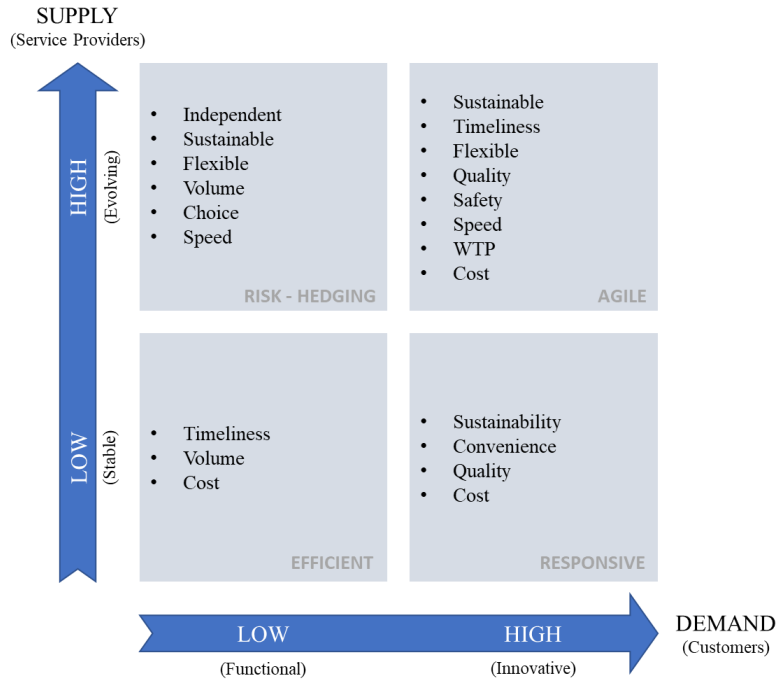


Figure 10: Hau Lee Model on CSF (Adopted from Lee. H, "Aligning Supply Chain Strategies".2002)

The identified critical success factors are initially incorporated in the Hau Lee's model to label the conventional and automated solutions respectively. Based on the labelled CSF, the solutions are incorporated as follows:

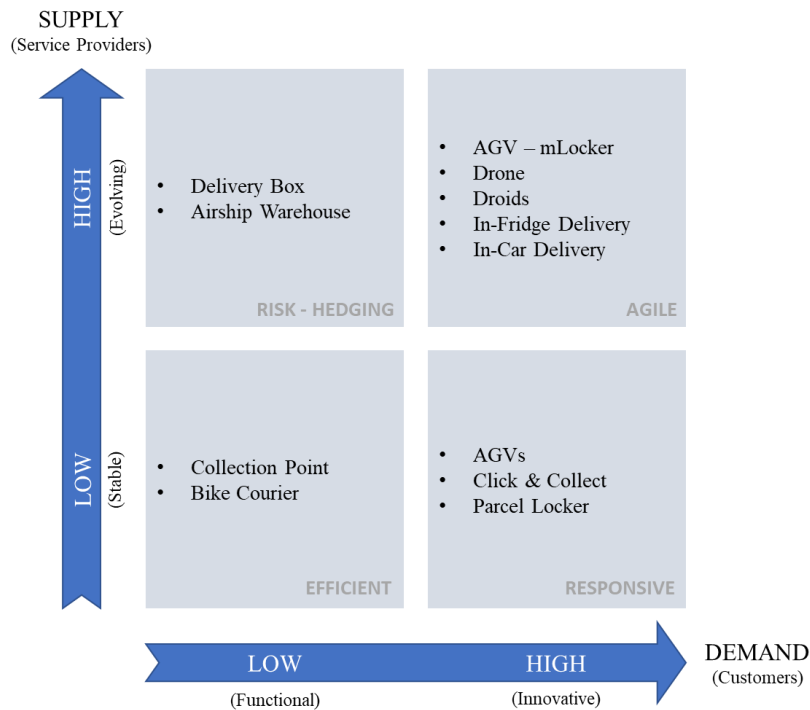


Figure 11: Hau Lee Model on Delivery Solutions(Adopted from Lee. H, "Aligning Supply Chain Strategies".2002)

It is evident that every individual solution has its own advantages and drawbacks. However, when the solutions are combined together to form an effective network of distribution design, the resulting outcome would be astonishing satisfying the critical service factors of both customer and service provider's perspective in the food Industry. Through this Hau Lee Model representation, companies could leverage on value chain innovation to develop a new business model and appropriate network structures for value creation through effective management of systems and solutions.

## **10. CONCLUSION**

Through multi-perspective case studies of the solutions, a complete investigation was conducted in order to be aware of the knowledge of existing last mile delivery solutions and their technological improvements. In addition to the solutions that have been deployed and are now attaining excellence in the food industry's last mile delivery. Consumer behavior models are also researched using similar cases in order to determine the customer's priority, the drivers, and the efforts made to adapt new techniques during the delivery phase. The report describes the variables and the effects of those factors that affect the company to participate in various activities that use environmentally friendly approaches to accomplish the SDGs. Furthermore, the characteristics that influence purchasing in the retail e-grocery environment are researched in order to decide which would be the ideal solution for the market in order to satisfy customer requirements while balancing the implications for last mile delivery service providers. Thus, the project leads are briefed on all the intricacies of existent and automated solutions, as well as their potential future developments.

It can be concluded that the vast array of possible last-mile delivery concepts still need a significant amount of additional investigation. Future research could contribute in the establishment of a new business model that generates a unique market of multimodal delivery system by merging numerous solutions to deliver with greater efficiency. A new start-up that holds together all of the various traditional and automated solutions might serve as a "last-mile bridge" between the logistics service provider and the customer. Its operating effectiveness will set the industry's norms and benchmarks by improving the benefits of social, environmental and economic values through the establishment of sustainability.

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