VTT

beyond the obvious

Towards a consumer-centric last-mile ecosystem

Roadmap 2020–2035

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Introduction

The goal of the 2-year Open Mode ecosystem project was to co-develop new logistics solutions and services for consumers. The project partners were VTT Technical Research Centre of Finland, The University of Helsinki, eNexus Oy, OGOship Oy, and Hakonen Solutions Oy. Business Finland funded the project.
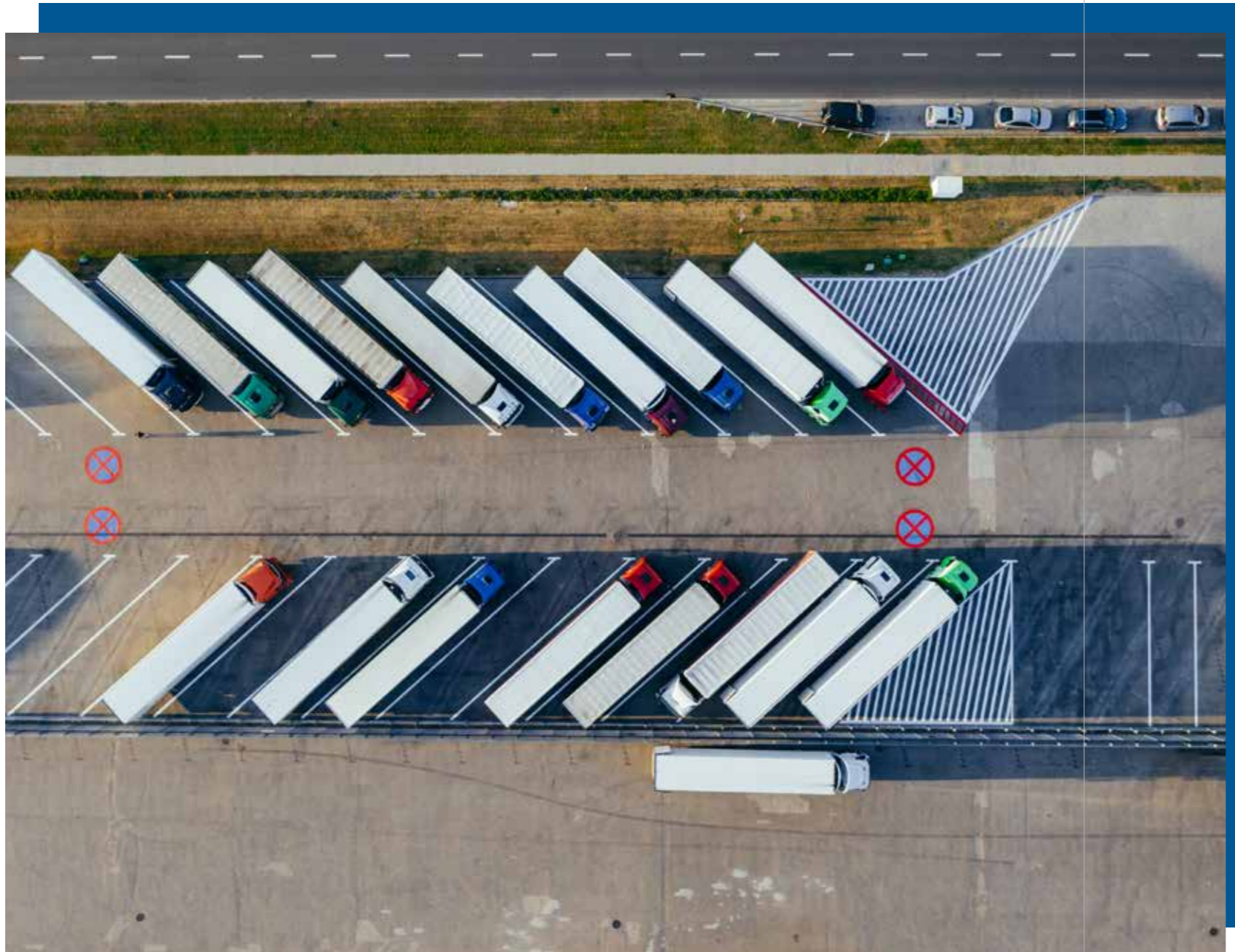
The project was inspired by the idea of an open consumer-centric ecosystem, where conventional supply chains will be replaced by efficient, smart and decentralised real-time logistics services. This roadmap report synthesises the project's findings. It presents a roadmap towards and a vision of an open, consumer-centric ecosystem. The roadmap and vision are designed specifically for Finnish stakeholders operating in logistics and last-mile delivery.

During the later stages of the project, the COVID-19 pandemic spread around the world. It immediately ignited many of the critical trends related to last-mile logistics, such as e-commerce, home-centric delivery models, value chain flexibility and service innovation. The future was already here, and companies had to adapt quickly. As the pandemic evolved into a long-lasting issue, we began to see changes in consumer behaviour.

The pandemic will have a significant impact in the upcoming years, and especially on the first phase of the roadmap. We believe that sustainability and circularity will dominate the later phases as we approach the vision for the year 2035. Besides them, technological leaps, especially in automation, will affect last-mile logistics.

We have written the roadmap report for anyone operating in the last-mile space: retailers, transportation companies, warehouse operators, logistics researchers, and technology developers. While the report has been written from a Finnish perspective, the ideas can be applied anywhere. The report provides the backbone and the direction for last-mile development initiatives for this decade and beyond.

With the volumes of online shopping and the need for last-mile deliveries rising, questions about the efficiency and sustainability of the services become acute.

Summary

With the global COVID-19 pandemic, many of the issues related to the future of e-commerce and last-mile deliveries that just recently were pure speculation, quickly became a part of the new normal. Now at the height of the pandemic, it seems clear that our behaviour patterns have already shifted fundamentally. Many of the late majority and even laggards in e-commerce have suddenly been inspired to order home deliveries of goods ranging from groceries to clothing and even restaurant meals. This wave of normalisation of the last-mile service use is likely to carry into the post-COVID world, despite possible rebound effects directly after the epidemic.

Notwithstanding preferences for home-centric living, or for instance experience-based showroom browsing (see future personas in Chapter 2), increased demand for the last-mile services seems inevitable. Thus, with the

volumes of online shopping and the need for last-mile deliveries rising, questions about the efficiency and sustainability of the services become acute.

Professional last-mile delivery is in all cases more efficient than individual shopping using a personal vehicle (Yrjölä 2001). However, organising the deliveries to minimise route overlap and providing sufficient coverage to remote areas may require regulation. Regulation can help balance the surging demand with the unevenly distributed population. Delivery volumes determine the best ways to organise the services.

There are different models for arranging the services, as illustrated by the four scenarios (in Chapter 1, Market Dynamics). Indeed, each scenario emphasises different aspects of the last-mile delivery dynamics. Still, the scenarios are best understood as complementary, and not mutually exclusive views of the future of last-mile deliveries. It may well be that all of them, in some form, are part of our future. The ecosystem-based vision and roadmap presented here aim to outline an infrastructure that enables different kinds of practices.

How people reach their consumables has wide-ranging consequences on our built environment. Changing consumer behaviour (discussed in Chapter 2) creates new demands for the last-mile infrastructure currently being designed and built. Besides e-commerce,

working from home, the possibility and increasingly the tendency to live and work in multiple locations, and the ageing population contribute to the overall systems-level rearrangement, where the last-mile services play their own role. Warehousing, pick-up and delivery technology (the topic of Chapter 4), and less tangible issues such as regulation (Chapter 1) are all in their infancy.

In this report, we present a vision – a desirable, possible future image, which inspires action towards a common goal (Meadows et al. 1992) – of a technologically sophisticated ecosystem model for last-mile deliveries in Finland. The vision emphasises a model that allows a multitude of actors to participate on an equal footing. The ecosystem's priority is to respond to customer preferences in a sustainable manner. Last-mile deliveries should include not only deliveries, but also reverse deliveries. Besides the transportation of goods, last-mile deliveries should function as a mediator in peer-to-peer operations and enable service provisioning. This is truly a futuristic vision, as many aspects currently are not available. In the subsequent chapters, the vision is presented in detail. Also, some critical questions are raised of certain aspects of the vision. Critique helps point out areas where action is needed to reach a desired future state and to identify the trends and drivers that point to a less optimal direction.

Vision for the Ecosystem

The last-mile ecosystem of the future is environmentally sustainable, technologically automated, operationally adaptive, and open to various stakeholders. The ecosystem is consumer-centric and utilises data effectively. Optimised route-planning and smart vehicle choices help to avoid congestion in dense areas, such as city centres. The ecosystem actors offer a broad range of services to the end-users, including reverse logistics and additional services at the delivery location. The vehicles, the warehouses, and all other systems in the ecosystem are highly autonomous. Diverse actors operate in the ecosystem, from small start-ups to large multinational corporations.

The Roadmap

The roadmap is a framework of the trends, drivers and actions that lead to the vision. It consists of four levels. The trends and drivers create the context for the actions. The themes of the roadmap are megatrends, logistics industry, consumer behaviour and technology. In the roadmap, critical trends, drivers and actions have been positioned in different phases. However, their impact is broad, and in reality, their impact is not limited to a particular column.

The roadmap was developed in a workshop organised by VTT on 23/10/2020. The workshop participants were Ville Hinkka, Jari Kaikkonen, Angelos Balatsas-Lekkas, Anu Seisto, Maria Antikainen and Kaisa Vehmas from VTT, Tuomo Pirhonen from eNexus Oy, and Minna Lammi from The University of Helsinki. Pauli Komonen and Sofi Kurki from VTT facilitated the workshop. After the workshop, VTT developed the roadmap further during the writing process of the report. Extensive environmental scanning supported the identification of the trends and drivers of the framework.

	Megatrends	Logistics industry	Consumer behaviour	Technology	Actions
2020–2025	• Climate change • Ageing population • Urbanisation • Globalisation • Market consolidation • COVID-19 • Disinformation • Technology intertwined with geopolitics	• Complexity of global supply chain • Emission reduction • Cost pressure • Traffic congestion in metropolitan areas • Growth in instant and same-day delivery • Micro mobility • Dynamic pricing	• Accelerated adoption of digital services • Increased online shopping • Adjustable services • Home as a multifunctional centre of life • Contactless consumption • Working from home • Social fragmentation	• Low-level autonomy • Connectivity in vehicles • Predictive analytics • Data utilisation in route optimisation • Smart tags • Electrification of vehicles • Biofuels • Voice control • Gesture control • Multi-brand parcel lockers • Pavement droids • Flexible and fast APIs	• Investments in data, analytics and automation • Creation of ecosystem models • Data sharing policies • Consumers as stakeholders in business modelling • 360 degree view to safety and security • Regulation to limit the scope of digital giants
2026–2030	• Circular economy • Sharing economy • Platform monopolies • Post-Covid rebuilding of economy and societies	• Shared operations and services • Data-driven industry requires trust • Ecosystem-thinking influences operating models • Crowdsourcing • 24/7 delivery • "Uberization" of trucking • Urban warehousing • Growth of third-party logistics	• Integrated mobility • Access over ownership • Social pressure for sustainability • Ready-made food • Hybrid models in working • Smart homes • Experiential retail	• Mid-level autonomy • VR/AR technologies in consumer interaction and vehicle monitoring • Data-driven service offering • Drone delivery • Digital twins • Hydrogen power • Semi-autonomous trucks • Fast and dynamic EV charging as a standard • 3D printing in customization	• Operating models and regulation ensuring last-mile delivery fluency as units increase • Electric vehicles broadly in use • Standardisation of certain parts of the consumer interface for building a common platform • Regulation and business models for drone deliveries
2031–2035	• Carbon-neutral cities • New environmental paradigms	• Integration of drones, bots and autonomous ground vehicles in delivery models • Supergrid logistics • Production, consumption and delivery close together • Unmanned aerial vehicle OEMs and fleet operators • Smart containerisation	• Sustainability and circularity in consumer solutions • Increasing amount consumer-related climate regulation • Life as a service concept	• High-level autonomy • Hybrid vehicles switching from delivery services to sharing functions • Quantum computing • Bionic enhancement in work force	• Reaching zero-emission operations • Utilisation of multi-purpose vehicles • Smart home integration • Automation leading to new work-force requirements • Production and warehouse re-location

Market Dynamics and Regulation of Last-Mile Services

We have created alternative future scenarios for last-mile logistics. The scenarios depict the future market dynamics. We used the four future archetypes developed by Jim Dator (2009) as the basis for the scenario narratives. In this approach, the future is described from the viewpoints of continued growth, collapse, discipline, and technological transformation. Before writing the scenarios, we conducted environmental scanning and data mining of emerging technologies.

Scenario 1: Goods Flexibly from Anywhere

Goods can be received in many ways and at different locations. Logistics addresses the consumer dynamically and intelligently. Consumers can have their parcel delivered at home, at pick-up points, at the workplace, at housing distribution points, in car trunks, or anywhere – depending on the location. While commerce utilises consumer data in many ways, the consumer privacy legislation is also strong. Companies use the consumer data more efficiently, which motivates consumers to share their information.

Delivery times are fast, and trading parties provide real-time updates on the delivery situation. The automation and digitalisation of logistics enable flexible operating models at a reasonable cost. Sensors and measuring devices enable the monitoring of the deliveries. Disposable packaging is reduced. Deposit packaging is a common solution.

The peer-to-peer and sharing economy is a significant part of the whole. Consumers trade a lot with each other. New services have emerged around the borrowing of goods. The production of consumer goods is globally concentrated on large units, but local small-scale production is also strengthened. Intermediate storage decreases, the number of items increases, and the customisation of products has become more common. Deliveries are accompanied by additional services such as recycling and home services. Due to the wider range of services, operators are investing in agility and customer service. The consumer has a greater capacity for consuming the services.

Scenario 2: All Goods at Home

In principle, the consumer receives all purchases at home, from groceries to consumer goods. Consumers increasingly appreciate the ease and the efficiency of their transactions. Home delivery plays a major role, especially in urban areas, but there are also pick-up points and mass-market solutions in suburban and rural areas. The home is equipped to receive consignments, and the recipient does not have to be present when the goods arrive. Shared cold rooms, smart locks, and other security solutions make it easy to receive goods.

Various services, such as the introduction of products, home maintenance or cooking can be integrated to the deliveries of goods. The expansion of the services is limited only by labour availability. IoT technologies, such as smart refrigerators, allow for highly automated orders. Brick-and-mortar stores and other outlets have not completely disappeared, but the home is the main destination for deliveries. Mobile voice interfaces and robust authentication methods support the transactions.

Trade and logistics providers have a global presence, but they deliver local solutions. Operators are heavily investing in technology. The development of artificial intelligence and next-generation mobile networks make it easier to handle large data masses. There is strong mutual trust between the actors. Services and products are becoming increasingly interconnected. Products are often modular, repairable, and recyclable, which supports the circular economy. Combining the flows of goods and people has become easier. Production is increasingly concentrated overseas, but there are also smaller, local production facilities. Durable and recyclable materials are used for packaging solutions. The number of packages and packaging processes are minimised.

Scenario 3. The Renaissance of Local Shops and Production

The growth of e-commerce reaches its limits and consumers are returning to local shops. In these pleasant spaces, shoppers enjoy excellent customer service and experience. All functions that do not directly serve the customer, such as payment and logistics, are automated, and vendors focus on helping the customer. Local production facilities and artisanal workshops also open their doors to consumers who can learn how foods, drinks, clothing or furniture are made. The products are tailored to the individual consumer. Consumers are careful about what they buy. They only buy the products they need, and the products are exactly the ones they want. Production volumes are small, but the products are of high quality.

E-commerce and local shops are being developed side by side. The boundary between them is beginning to blur. The aim is to serve the customers at local shops and to enable them to continue shopping in their

online platforms. The platforms include some adventurous elements.

Private ownership of cars has decreased. Public transport and shared electric vehicles are the primary means of commuting. An emerging trend is that consumers buy their products from the local shops and the products are delivered to their homes in order to free the consumers' hands. Products tailored to the consumer or manufactured in the presence of the consumer are delivered to the customer in the desired manner.

Customers expect the goods to be delivered flexibly and punctually. Transportation services are an everyday luxury for customers, who are ready to buy a variety of additional services. This impression is reinforced by the high quality, environmentally friendly packaging solutions. Orders from multiple locations are collected in one delivery. Distribution methods proliferate and will also enable product deliveries between consumers.

Scenario 4. One big player dominates the market

Global e-commerce continues to grow, and retail is moving almost entirely online. Consumers favour one big global player – let's call it "Aladdin" – for its superior range of services and affordable pricing. Aladdin's range of services to consumers is staggering. The services are not necessarily related to the products delivered and they do not have to take place at the same time as the delivery. The consumer can buy all possible services covering all areas of life from Aladdin, ranging from entertainment to health and childcare. Most consumers accept that Aladdin knows everything about them. For consumers, the threshold to leaving the service provider is high, as ending the customer relationship would cut the access to the entire range of services.

The flow of goods managed by Aladdin is massive and automated. Aladdin has a global network of giant hubs and transportation equipment. Although the transport network is centralised, goods can be produced

anywhere. The efficient logistics system can also pick-up goods from small local producers. Goods are therefore produced wherever Aladdin's profit margin is the highest throughout the process.

With support from artificial intelligence, Aladdin can predict people's needs and reduce the need for storage. Goods are always in motion. They leave the manufacturer as needed, and the need for intermediate storage decreases. For example, food will be fresher. Goods are delivered primarily to homes in the cities, and to pick-up points in the countryside. Transport is firmly combined, and goods and people move together.

Aladdin uses a self-driving car system for last-mile delivery. There are no longer two cars in the yard of a single house, as Aladdin's car comes when ordered and the customer only pays for the use of the car. Cars do not move empty. Transport is optimised on a regional basis by anticipating customer mobility and the delivery needs of consumables. When you order a car, it arrives with food to you and the neighbourhood.

Discussion of the Four Scenarios: Markets and Regulation

The four scenarios all assume a future where home deliveries are a standard part of everyday life. In this chapter, the final journey from warehouse to customer is discussed from the perspective of market dynamics and regulation. Last-mile delivery constitutes a fraction of the product's journey from factory to the recipient, but currently it can account for up to half of the cost (Bounds 2020). Cost is likely to be one of the decisive factors in assessing the future prevalence of the last-mile services.

According to a seminal study (Yrjölä 2001), in 2001, the optimal cost structure for home deliveries was reached with weekly, unattended home delivery. In light of the consumers' preference for fast delivery, it is noteworthy that the cost per drop was almost double when the delivery had to be done in a certain time frame (vs. an unattended drop). The extra costs arise from the back and forth driving to meet the time frame. Considering this calculation together with the difficulty of optimising the service for sparse, just-in-time deliveries, raises the question: to what extent do last-mile deliveries share their market dynamics with postal services? Postal services are traditionally believed to constitute a natural monopoly, meaning that the market functions most efficiently when there is only one operator in the field (Panzar & Waterson 1991).

Competing service providers overlap in their routes, which results in inefficient energy and labour use. Natural monopolies are usually heavily regulated. Postal services, which are considered central and necessary for citizens, are often legal state-run monopolies. However, in last-mile delivery, route overlap can be reduced with urban consolidation centres. The consolidation centres have been instituted by large landowners in for example Central London to reduce traffic in urban areas. All package delivery companies consolidate their goods to the same warehouse, and a single operator takes responsibility of the last-mile delivery.

Such solutions suggest that last-mile delivery might be optimally arranged by an ecosystem approach. In the ecosystem approach, an orchestrated platform leads to more optimised and balanced market dynamics. The platforms could originate from a regulator's initiative, but self-organised actors are also in a good position to build a platform and start growing an ecosystem.

However, there are alternatives, as illustrated by the fourth scenario. It describes one large player dominating not only the sales and deliveries of goods, but the entire lifestyle with healthcare and childcare. There might be some competition in the market, but it appears that the regulation has failed to induce fair competition into the field. At present, such development has gained increasing attention in Finland due to the recent expansion of the e-commerce giant Amazon to the Nordics, establishing a presence in Sweden.

The case of Amazon is particularly interesting, as it has dominated the markets in several separate fields. All of the fields play well together and create a unique infrastructure for creating novel markets. Amazon is the dominant market leader in e-commerce, where the business originated. In the US, its market share is 52% of all online sales (Sabanoglu 2020).

In cloud computing, Amazon has a market share of around 33% (Richter 2020). In livestreaming, Amazon's Twitch has a 91% market share (Novet 2020). Additionally, Amazon is still the market leader in artificial intelligence-based personal digital assistants and smart speakers (Amazon Echo) with a 21.6% market share in the second quarter of 2020 (Holst 2021). It can be argued that Amazon is a prime example of the ongoing market dynamics in the field of last-mile services. Amazon has created an extremely efficient way to vertically integrate the sales and delivery of products. The delivery model, called Amazon Last Mile, is based on engaging individual contractors to a flexible, demand-based network.

Given that the basic infrastructure of last-mile delivery is difficult to optimise, the fourth scenario can be seen as a potential outcome from the absence of any regulation.

Regarding the costs of the last-mile service, the bulk of the costs are labour costs. The first and the fourth scenario rely on automated delivery processes, for instance self-driving vehicles, or other forms of automation. Despite earlier estimates (a McKinsey report in 2016 forecasted that 80% of packages would be delivered by autonomous vehicles in ten years' time), experts now deem it unlikely that automation will be able to take care of much of the last-mile delivery any time soon (Bounds 2020). The process of delivering goods to the door is difficult to automate. For instance, using drones in urban settings is impractical. (Ibid.) The speed of technological development, however, is difficult to estimate (see more on the topic in the last chapter of this report, on Technology).

In contrast, scenarios two and three rely on human labour for the last-mile delivery process. From an economic perspective, there are different kinds of models to achieve this. Two examples are the platform economy model[1] and a more traditional employment model. In models where the last-mile service is delivered in person, labour shortage may prove an issue, if the volumes of the service increase quickly.

For instance, in Japan, where the last-mile delivery system for parcels and packages is highly developed, the market leader Yamamoto was recently forced to raise delivery prices. They had to hire gig-based employees as permanent employees. This was caused by the double effect of the COVID pandemic increasing the number of deliveries at the same time as the long stagnant service-based economy was picking up and demanding workforce to many other fields.

In all of the scenarios, the services are better in urban areas. The service in rural areas relies on a combination of automated vehicles, combining the mobility of goods and people, and designated pick-up points. The organisation of services to rural areas is ultimately a political decision. A political decision should determine the level and type of regulation that is placed on the last-mile service design and optimisation. It may be concluded that the last-mile services are analogous to financial services as fundamental and crucial for the functioning of the society. Following this analogy, their importance makes them a likely subject to some form of regulation in order to balance out the needs and the costs of the service.

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1) In a platform economy model, individual contractors are viewed essentially as entrepreneurs. The company can keep employment and service costs low. On the other hand, the model gives individuals more flexible working hours and enables them to work on multiple platforms, combine different careers and for instance work and study seamlessly. This model of employment is relatively new. As a result, legislation is lagging behind in several key aspects. The model is under scrutiny in many countries' legislative systems. Outcomes could force a change in the operating models.

Consumer Behaviour

E-commerce Accelerated by Home-Centric Lifestyle

Consumer behaviour in the near future is strongly affected by the COVID-19 pandemic. Consumers experience ontological insecurity, which influences their choices (Campbell et al., 2020). Fear and uncertainty will continue to manifest in the reactive and unstable spending patterns of consumers, until a vaccine is available for the masses (Loxton et al., 2020). During the pandemic, consumers have had to change their everyday routines. They have had to form a new relationship with space and distance, and e.g. use the home for new purposes. The adoption of digital services has skyrocketed over-night.

In Finland, working from home has generally been received positively. People expect to continue multi-location working practices in the future (Helsingin Sanomat, 2020a). This development can cause significant changes in daily transportation patterns. People increasingly consider their home as the central location of their daily lives. This can lead to a reduction in visits to retail stores, restaurants, and other locations throughout the day. Demand for smart locks, shared locker facilities, and other solutions that enable smoother home deliveries is emerging.

In a global survey conducted in 45 countries, consumers have reported shifting their spending to essentials and cutting back on discretionary product categories (Charm et al., 2020). In the context of last-mile deliveries, the spending increase in food and communication services can be transformative (Kouvavas et al., 2020). According to Frost & Sullivan (Global Automotive & Transportation Research

Team at Frost & Sullivan, 2020), self-isolation, quarantining, and working from home has resulted in a 20 to 40% increase in online deliveries, including groceries. Consumers are increasingly digitally fluent and ready to use e-commerce services for everyday needs, such as grocery shopping. Peer-to-peer consumption is booming (Helsingin Sanomat, 2020b).

According to the World Economic Forum's outlook on the last-mile ecosystem's future, a delivery time of one to three days will continue to be the largest delivery segment. However, same-day and instant delivery are the fastest grooving segments (Deloison et al., 2020). Speed is a critical factor in consumer preferences.

Sustainable Consumption and Sharing Models Are Maturing

In our vision, sharing economy practices, services, and business models mature during the second half of the decade. While private ownership remains dominant in most product categories, consumers consider material, individually owned goods less important. A demonstrative example is the popularity of bike sharing. According to Statista (2020b), the amount of bike sharing users will grow from 669 million to 897 million by 2025.

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In the post-COVID world, consumers' lifestyle and housing preferences are more versatile than before. Urbanisation remains a critical megatrend, but the surge in remote work vitalises rural areas and countryside towns near metropolitan growth centres. Private vehicle ownership is still crucial in sparsely populated areas, but city centres and suburbs rely increasingly on public transport and shared vehicles. Different transport modes, such as public transport, taxis, and private vehicles, are seamlessly integrated.

Environmental issues increasingly affect consumption. The social pressure to consume sustainably grows stronger and brands respond to people's environmental concerns. In transportation and logistics, consumers value sustainable and transparent practices. Especially younger generations expect zero-emission practices.

Future Personas Depicting the Variety in Consumer Behaviour

In the next decade, sustainability and circularity have become the driving forces of consumption. Climate regulation has tightened. Climate change is addressed in all kinds of consumption situations, practices, and habits. Nevertheless, consumers vary in their preferences and lifestyles. As part of the scenario process, we created four future personas to describe the future lifestyles related to retail, e-commerce, and delivery services. Future personas are a futures method, which lets scenarios come to life (Fergnani, 2019). Future personas are scenario-specific characters who live in the future. The scenarios are described in the former chapter about market dynamics and regulation of last-mile services. The personas are located in Finland and they depict different kind of people in various stages of life.

Janna in the Scenario "Goods Flexibly from Anywhere"

Janna is a 39-year-old mother of two, who lives in Turku and works as an international expert. Janna does not want to spend any extra time shopping, picking up or transporting goods from one place to another. She has a unique, data-driven consumer profile that automates most of her purchases. Although the consumer privacy legislation has tightened in the 2020s, Jaana finds data sharing useful in her everyday life. Ultimately, she is in charge of the data she wants to share.

Online stores know the essentials of Janna's everyday life. This allows goods to arrive flexibly at home, at the workplace and at pick-up points. Using Jaana's data, online retailers are able to predict her shopping need far into the future and provide her with highly personalised solutions. For environmental reasons, Jaana favours peer-to-peer shopping, especially in clothing and furniture. She is active in the recycling groups of her neighbourhood. She is interested about the carbon footprint of new products. In addition, legislation mandates that the environmental footprint of products needs to be specified.

Demanding work makes Janna value her free time. She is willing to pay for services that save time. Although her work is international, she does not like to travel and prefers a relatively simple, ecological lifestyle. Technology plays a significant role in Janna's life. With voice control and smart home solutions, technology is seamlessly integrated in many everyday situations.

Markku in the Scenario "All Goods at Home"

Markku is a 76-year-old pensioner from Kuopio, who lives in an apartment block. Because of the stagnant economy, ageing population and technological advancements, most services for the elderly are delivered straight to their homes. Markku receives grocery deliveries, health care services, as well as various maintenance and repair activities directly at his apartment. Markku is often at home, but when needed, the suppliers of food and other goods can deliver their shipments by using a smart lock system.

Markku's neighbourhood is full of elderly people. As a result, home service solutions have been actively developed. Markku has acquired the necessary ICT skills to use digital services efficiently in his working life. In addition, the city of Kuopio has invested in senior citizens' digital skills. The use of e-commerce and other digital services has gradually increased in Markku's life. As a consumer, he is frugal and favours well-known, traditional brands.

While many services are delivered and produced at Markku's home, he has hobbies and friends outside the home as well. As he no longer needs to visit grocery stores and shopping malls, Markku has directed his energy elsewhere. However, sometimes Markku longs for random encounters in stores.

Karo in the Scenario "One Big Player Dominates the Market"

Karo, 47, lives with her family near Oulu. Their house is in a rural setting, yet reasonably close to the city. Karo wants to provide her children with a peaceful environment, a small village school and daily access to nature. Adults enjoy the peace of mind that results from having no hustle and bustle around them. The village community provides security and creates an opportunity for daily interaction with likeminded people.

Karo's village has joined the Aladdin network. The villagers place joint orders for groceries and other consumer goods, which are then delivered to the village's central pick-up point. For a small extra fee, an Aladdin autonomous car or drone brings the orders directly to the consumer. Karo's family regularly uses Aladdin's ride services, especially for leisure activities. Karo works from home or from the village telecommuting hub that she cofounded in a former communal house.

Like many other people, Karo has abandoned the individualistic way of living, and adapted to a world of co-ordering and sharing. She enjoys an impressive number of services considering her remote location. Housing costs are also relatively cheap. Aladdin is continually expanding its portfolio. The latest addition is a telemedicine service that enables Karo to reach high-quality medical experts around the world at any time of the day.

Sofia in the Scenario "The Reneissance of Local Shops and Production"

Sofia is a highly educated 28-year-old woman, who lives in downtown Helsinki. She is used to ordering goods and services from online stores, but lately she has grown tired of the digital environment. Online shopping has enabled Sofia to make inexpensive purchases that are often of poor quality. Over the past few years, Sofia's consumption has increasingly shifted towards showrooms created by strong brands and lifestyle communities. The showrooms allow her to discover high-quality novelties and tailor-made products. At the same time, the showrooms are places for like-minded people, who enjoy the immersive experience and the opportunities to interact with each other.

The showrooms have made experiential consumption the new normal that Sofia demands from other services, too. Adventurousness no longer characterises the products she consumes. Perhaps as a way to distance herself from everyday life, she considers the place, the atmosphere, and the service more important than the product itself. Sofia uses online stores only if they can offer the experience and personalised service that have attracted her to the brick-and-mortar stores.

Sofia does not own a car. She prefers the convenient and quick access provided by stores within a walking or cycling distance.

Service Innovation in Last-Mile Deliveries

New delivery vehicles are changing the face of the last-mile services. Logistics companies develop and experiment with new solutions to combat inner-city congestion and growing consumer demand. For example, the DHL City Hub is a customised trailer that can carry up to four containers. The containers are used by the DHL Cubicycles, which are customised cargo bicycles that can bear a container with a load of up to 125 kg (DHL, 2019). UPS has developed a similar cargo e-bike solution, which can bear a load of up to 180 kg. To make their deliveries, couriers ride on sidewalks and designated bike lanes (UPS, 2018).

Starship Technologies builds delivery robots, also known as pavement droids. In their concept, customers place an order through an app and the little robot makes its way through the city streets. The range of the six-wheel droid is two miles and the order can be delivered in 30 minutes. The service has already been launched around the US, with major partners like Domino's and Postmates. The pavement droids are a promising delivery alternative, especially in areas with spacious sidewalks and stable weather conditions.

Renault's future vision is to combine delivery logistics with everyday life. Renault's concept vehicle EZ-PRO is designed to be used not only by logistics and delivery professionals, but also by entrepreneurs and artisans working on the way, for example. The autonomous, shared vehicle is based on a modular structure, which adapts to different uses.

The Finnish logistics company Fetch My Stuff sees the last mile as also the first mile. This makes it possible to offer different kinds of services beyond delivery. The company specialises in home logistics. Home logistics moves from the simple delivery of goods, to also offering a variety of recycling services, such as collecting empty bottles, small electronic devices, medicine, and batteries. The company also offers laundry services with a partner. If this model is the shape of things to come, a larger share of a consumer's everyday activities can be outsourced to last-mile logistics providers. This development can reduce the need to visit retail locations and decrease the overall traffic volume.

Efficiency and speed are everything as consumers expect faster fulfilment and shorter delivery time frames. Especially young consumers are also willing to pay more for same-day deliveries (Joerss, Neuhaus and Schröder, 2016). This has led to a proliferation of instant deliveries to flexible locations. For example, the Finnish restaurant food delivery company Wolt has expanded its operations to grocery retail and other goods. The crowd-sourced operating model now offers a similar instant delivery experience to groceries as it did for restaurant food.

Another major provider of super-fast deliveries is Postmates, which operates in metropolitan areas in the US. The company promises to deliver anything from any store or restaurant within an hour. The company offers a subscription model for unlimited deliveries. According to Frost & Sullivan (2019), business models that enable fast delivery services, e.g. for groceries and medication, will receive the highest investments in the future.

Retailers and consumers value traceability and transparency. Smart technology enables the tracking of the service and seeing any potential changes. GPS and RFID tags track the movement of shipments in real time and IoT-enabled sensors monitor the temperature and humidity of packages (Krug, 2020).

Growing demand for fast fulfilment has also caused a shift in the retailers approach to warehousing (Krug, 2020). Walmart, Target, IKEA, and growing number of other companies are experimenting with urban warehousing to

Growing demand for fast fulfilment has also caused a shift in the retailers approach to warehousing. Walmart, Target, IKEA, and growing number of other companies are experimenting with urban warehousing to reduce delivery lead times.

In the future, autonomous ground vehicles with e-lockers, droids, and bike couriers could cover dense urban areas. Similarly, drones can take care of rural and remote location deliveries

reduce delivery lead times (Deloitte, 2019). Amazon has also been investigating opportunities to turn vacant and even occupied shopping malls to distribution hubs and fulfilment centres (Fung, Esther; Herrera, 2020). For Amazon, the purpose is to speed last-mile delivery by placing their distribution hubs near residential areas.

Third-party logistics (3PL), i.e. the outsourcing of logistics processes, becomes increasingly important in streamlining the supply chain. According to Allied Market Research (2020), the 3PL industry will see a compound annual growth rate of 7.1% from 2020 to 2027. Third party logistics companies can use transportation assets more optimally by balancing the needs of multiple client shippers across transportation and distribution functions. As a result, they benefit from economies of scale (Allied Market Research, 2020).

In the future, autonomous ground vehicles with e-lockers, droids, and bike couriers could cover dense urban areas. Similarly, drones can take care of rural and remote location deliveries (Joerss, Neuhaus and Schröder, 2016). Early adoption of these models will concentrate in highly developed countries, where high labour costs make the return on investment reasonable. New warehousing models will allow faster service models and delivery times, especially in urban areas. If the production moves closer to the end-customer, too, the supply chain can become significantly more sustainable.
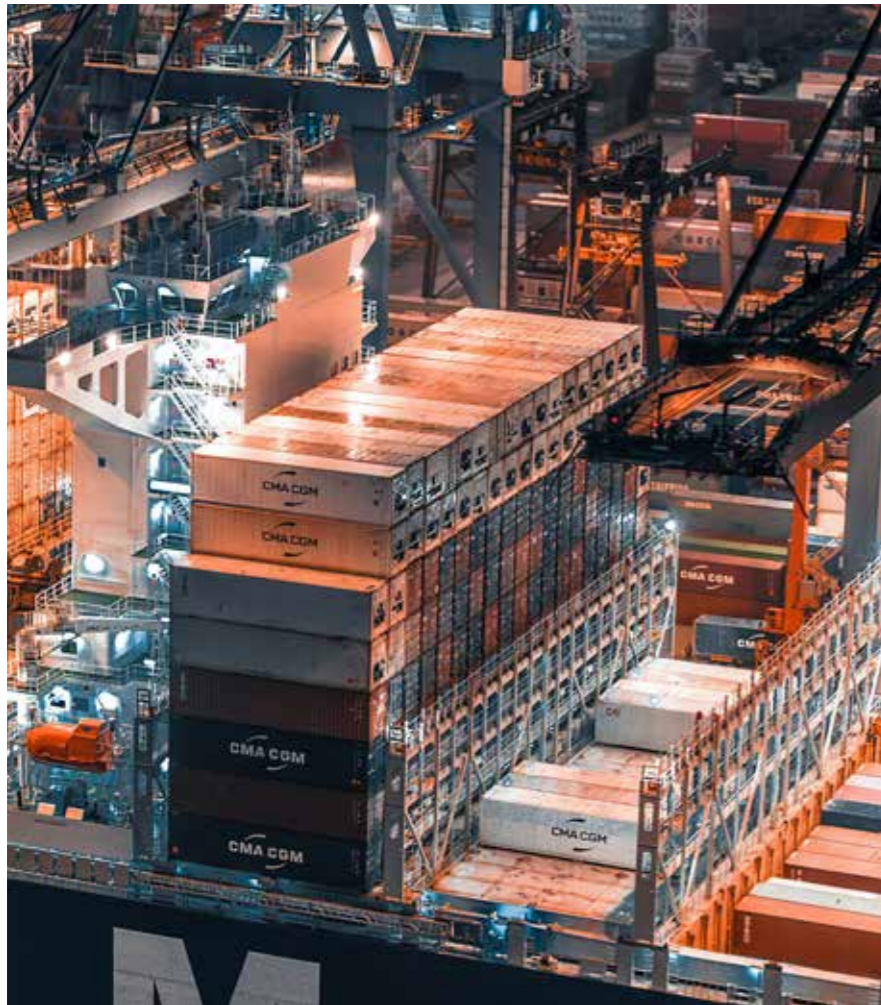

Warehousing for E-commerce

The increase in e-commerce sales in the past decade has changed the requirements for warehousing. A study by Boysen, de Koster and Weidinger, (2019) argues that the changing requirements create demand for certain types of new technologies and techniques that increase the picking efficiency. Traditional warehouses are not optimised for picking efficiency. These new technologies and techniques are ushering a new era of warehousing. This warehousing is tailored to meet the special needs of online retailers that deliver directly to end-users in the business-to-consumer segment. In contrast with the more traditional warehouses, it is now important that warehouses can handle small orders, a large assortment, tight delivery schedules and varying workloads.

According to Boysen, de Koster and Weidinger (2019), there are six warehousing technologies and techniques that are particularly suitable to meeting the new requirements for warehousing.

Mixed-shelves storage is an innovative strategy that divides SKUs (stock keeping units) to multiple locations within the warehouse instead of just one location. This increases the probability that a particular is SKU is close by when it is needed.

Batching and zoning are typically used together with mixed-shelves storage. Batching means combining multiple orders together and collecting them during one picking tour. It increases pick density per tour. In zoning, each picker is given a specific area of the warehouse to operate in. The need to walk long distances is reduced. One customer order can then consist of SKUs from parallel zones. **Sorting** simply refers to the practice of categorising items based on their characteristics.

Dynamic order processing systems make it possible to adjust the picking tour priorities after the tour has begun. Pickers can react to urgent orders and minimise their delivery time.

Automated Guided Vehicles assist pickers. AGV's increase the number of items that can be picked and decrease the picker's need to walk. Typically, an AGV moves a batch of items to the deposit when an order is complete. It then returns to the picker, who can continue their tour while the AGV delivers a complete order.

The idea of **shelf-moving robots** is very straightforward. The robots move the racks and inventory pods to a stationary picker. These robots can eliminate non-value adding picker movement and increase picking performance. These systems work especially well with the tight delivery schedules of e-commerce.

Advanced picking workstations consist of three elements that complete the system. 1) SKU bins are placed in carousel racks or Automated Storage Retrieval Systems (ASRS), which can move the SKU bins. 2) The SKU bins are delivered to human pickers via a conveyor system, which is also capable of buffering SKU bins until the whole order arrives for the picker. 3) A human picker places all the required items into a shipping bin, which then moves the full order further in the logistics chain. The advanced picking workstation identifies when an order is processed and automatically starts the fulfilment of the next order. The picker does little unproductive work. [1.]
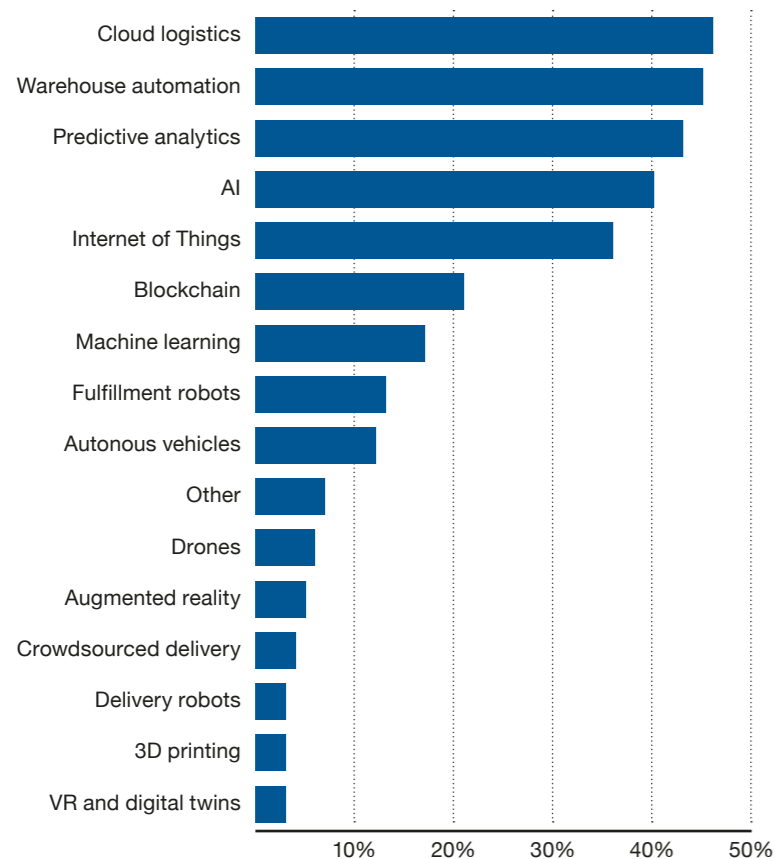
According to Dekhne et al. (2019), a new paradigm is emerging in warehouse automation. Prominent technologies have the potential to remake warehousing operations. These technologies include multi-shuttle systems, analytics tools, optical recognition, conveyor connection, management systems, smart storage, 3D printing, swarm AGV robots, smart glasses, and picking robots. The technologies assist the movement of goods and improve their handling.

For example, automated guided vehicles (AGVs) can move cases and pallets, while robotic arms with sensors grasp goods. Drones are already used in inventory management inside warehouses and for yard management outside. Managers monitor activities with augmented reality glasses. Based on the analysis of Dekhne et al. (2019), many operations could be automated by 2030, as artificial intelligence takes over the repetitive activities currently performed by human pickers. On the other hand, investments in warehouse automation have been growing slowly, at about 3 to 5 percent per year to 2025 (Dekhne et al. 2019).

Technology

Mapping of technologies based on their perceived concreteness and range of application possibilities. N=35, logistics professionals. (Lauhkonen et al., 2020)

Bar chart categories (top to bottom): Cloud logistics, Warehouse automation, Predictive analytics, AI, Internet of Things, Blockchain, Machine learning, Fulfillment robots, Autonous vehicles, Other, Drones, Augmented reality, Crowdsourced delivery, Delivery robots, 3D printing, VR and digital twins. Axis: 10% 20% 30% 40% 50%
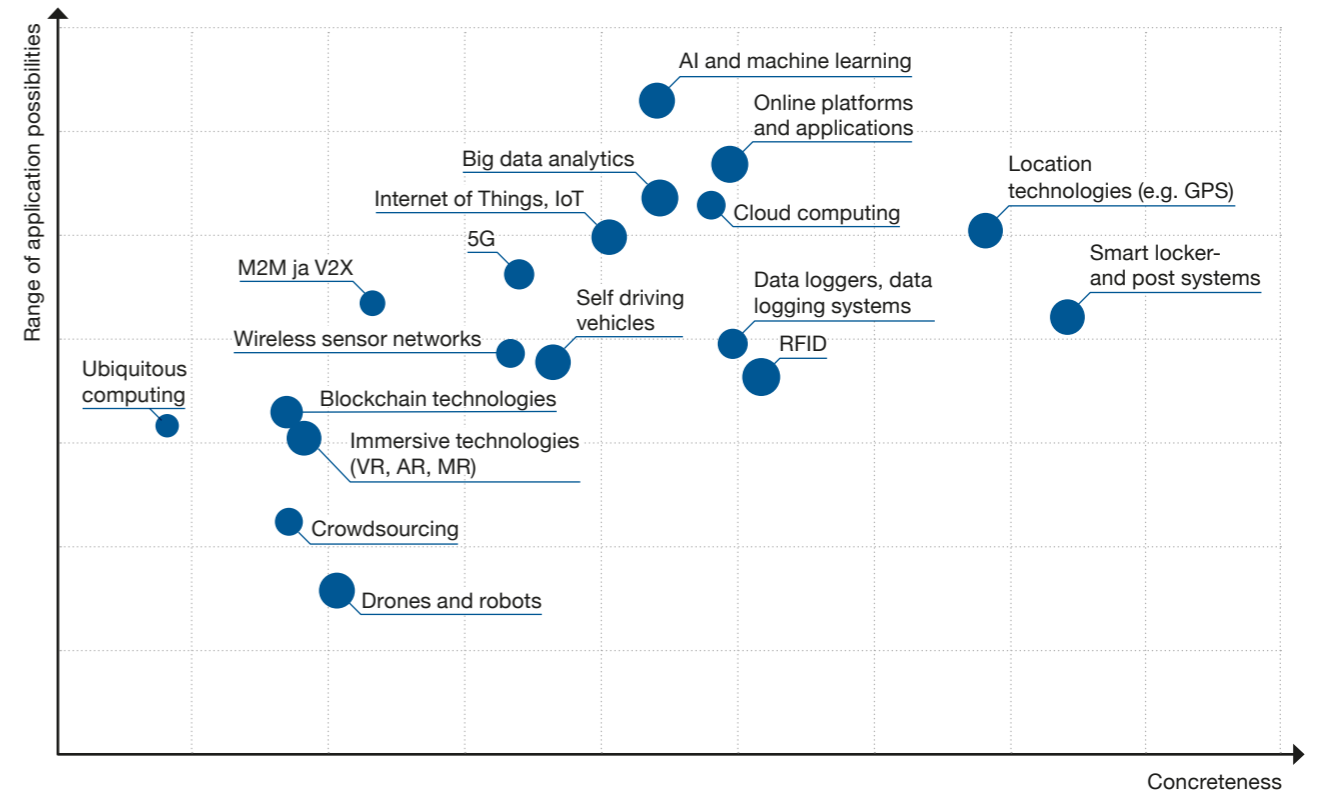
The 2020s will be a technologically exciting decade. Logistics systems are developing towards extensive automation. IoT solutions throughout the value chain create transparency and efficiency. Climate-targets and consumer expectations drive innovation in energy solutions.

According to survey data collected by Statista (Statista, 2020c), industry professionals invested in a wide range of technologies in 2020, including cloud logistics, warehouse automation, predictive analytics, AI and IoT. According to the investment decisions, automation is the driving force in logistics.

Note: Worldwide; 2020; 601 Respondents; 203 service providers, 206 solutions providers, 134 retailers, 58 media and associations.

Source(s): eft; Statista estimates; Zoho; ID 780763

According to another figure, autonomous last-mile delivery will grow steadily from the current market size of 11 billion euros to 85 billion euros in 2030 (Statista, 2020a). The growth trajectory opens up new possibilities for delivery vehicles in the last mile, e.g. pavement droids.

In a survey study conducted in 2019, VTT asked logistics professionals to evaluate the range of application possibilities, the concreteness, and the maturity of different technologies (Lauhkonen et al., 2020). The survey received 35 responses from logistics professionals in various positions. According to the respondents, the most concrete and widely applicable applications are location technologies, online platforms and applications, AI and machine learning, and cloud computing.

In DHL's trend radar (DHL, 2020), the technologies with the highest impact in the next 5–10 years include supergrid logistics, self-driving vehicles, and new security technologies. Supergrid logistics refers to the next dimension of consolidation, orchestration, and optimization of global supply chain networks, where swarms of different production enterprises and logistics providers are integrated. As in virtually every logistics future outlook, AI, IoT, data, and robotics are prominent in the near future.

Technology is transforming the traditionally asset-heavy logistics business towards a sharing economy. Logistics players are willing to address the underutilisation of assets, but the lack of proper platforms makes it challenging (Frost & Sullivan 2020). New platforms,

ecosystems, data sharing policies, automation, and connectivity create opportunities for more efficient asset utilisation.

Sustainability drives technological development. The electrification of vehicles and biofuels will become increasingly popular, even if the current driving range of EVs makes last-mile delivery challenging. During COVID-19, safety concerns have increased contactless delivery solutions. Heightened hygiene awareness may continue at least during the first half of the decade.

Based on the current technological prospects, we can vision a more automated, electrified and trackable future for logistics. On the other hand, urbanisation and e-commerce growth may lead to inner city traffic jams and increased pollution. New hybrid vehicles capable of switching from delivery functions to shared personal mobility may raise the utilisation rates of vehicles.

Even the classic future utopia of flying cars are already being prototyped and used (BBC Future, 2020). Instead of wings, the flying vehicles are designed with rotors, which allow vertical take-off and landing. Even if urban air mobility is still in its early stages, the market is expected to be valued at 1.5 trillion dollars by 2040 (Morgan Stanley, 2019). The delivery of goods is likely to be the first use case for flying vehicles, although the ultimate goal of the industry is to move people (Morgan Stanley 2019).

According to Frost & Sullivan (2019), traditional delivery modes are likely to constitute only 20% of the delivery of all items in the next 10–15 years. By 2030, autonomous vehicles will deliver almost 80% of all items. If this really is the future, technology will play a key role in the transformation.

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