Revolutionising Logistics – The Implementation of Drone Delivery Services
A Design Thinking Approach to "Last Mile" Drone Delivery

Dissertation

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Executive summary

E-commerce and online delivery are one of the world's largest industries. The ease of ordering, receiving, and returning orders has made online buying more convenient than in-person shopping. The Internet of Things has transformed our way of life. Almost every element of our life is affected by IoT, from the simplification of routine jobs to the improvement of home security.

Online delivery has created opportunities for small businesses and start-ups. Consumers like online shopping not just because to its convenience, but also due to the firm’s extensive range of products and services. This development has enabled even the tiniest businesses to offer their items online, providing users with a variety of possibilities.

Users are accustomed to the convenience of ordering anything and everything online, owing to the accessibility and convenience of the Internet. Possibly anything is available online, from food, groceries, and medications to clothing, accessories, electrical devices, and building supplies. The corporations have utilised the scenario to their benefit by penetrating the market with exceptional products and services that compete with one another. As competition intensified, businesses began to provide better services and goods, and now consumers have the upper hand in the market and can demand better service.

Now that clients are accustomed to receiving exceptional service, the delivery services must be impeccable. The last mile delivery is the most important and costly step of online delivery service, and practically all organisations are striving to provide superior service and prompt delivery to obtain a competitive edge.

In the past several years, the companies have developed the most effective strategies for achieving the finest last-mile delivery. The freight modes of delivery services aim to deliver items as quickly as possible, however owing to a variety of challenges, the majority of businesses are unable to meet the needs of their customers. Customers need efficient service, precise tracking, product safety, and faster delivery. Additionally, consumers are worried about the environmental effect of the entire service. Consequently, it is challenging to meet all user requirements.

The use of drones for last-mile deliveries has grown increasingly common. Traditional delivery techniques have a variety of disadvantages compared to drone delivery, including slower delivery times, higher prices, and inferior customer satisfaction. In addition to the ease and swiftness of delivery, drone delivery services also provide enhanced client experience. Drones may fly straight to the client's location, so the consumer does not need to leave their home to pick up their delivery. Moreover, drones enable real-time tracking, allowing

consumers to follow their packages from the moment they are picked up until they are delivered. By reducing carbon emissions, it also prevents detrimental environmental effects.

Customers cannot reasonably rely on drone delivery service due to its inherent constraints like noise, safety, privacy factors, damage. Due to legal limits and safety laws, businesses are also hesitant to utilise it routinely.

The SPARROW drone delivery system is the company's most recent innovation. The solution is designed to easily solve the majority of drone delivery challenges. BMT's innovative approach provides a revolutionary delivery alternative appropriate for uncertain, unprepared, or delicate circumstances. SPARROW is a lightweight and nimble hanging robot that allows drones to remain securely at 400 ft above obstacles and people, unseen and unheard. The SPARROW method is the answer for optimal speed range, payload capacities, and general drone delivery problems.

This dissertation is a consulting project for the company BMT, which has built the SPARROW drone to provide market-based delivery services. The objective of the project is to analyse the need for drone delivery services in the UK market and to get an understanding of consumer expectations, which will assist to define the project's scope and provide viable solutions. To assess client views in last mile delivery and co-create value between BMT and its customers, a design thinking methodology is implemented.

Design thinking is a iterative approach to problem-solving that focuses on identifying user requirements and developing solutions to meet those requirements. It is an iterative process consisting of ideation, prototyping, and testing until the ideal answer is established. In order to provide innovative solutions, it encourages collaboration, empathy, innovation, and testing.

At each and every level of the process, the user-centric approach is utilised to comprehend the user's wants and to build a design and service that is relevant to those demands. The hybrid research is performed by integrating both primary and secondary research in order to collect data to understand improve the service.

The analysis reveals that SPARROW should collaborate with businesses that provide services for apparel, accessories, and electronic goods that are currently in high demand. The report contains a detailed description of the user's expectations to be incorporated into the system's design. As design thinking is an iterative process, the end solution cannot be offered; thus, the project must grasp the requirements and do analysis throughout to keep the product moving forward to acquire the market share and to attain profitability.

Ultimately, the BMT's SPARROW is an excellent drone delivery service that is capable of penetrating the market. Based on the study, it meets the majority of consumer expectations,

and by enhancing the service using a design-thinking approach, the SPARROW could be a dominant player.

The findings of this study are both conceptually and theoretically significant, offering useful insights into the application of design thinking to the delivery sector and influencing the development of best practices.

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Abstract

TITLE OF THE PROJECT

Revolutionising Logistics – The Implementation of Drone Delivery Services

A Design Thinking Approach to "Last Mile" Drone Delivery

Purpose

With the rapid advancement in technology, IoT has greatly transformed everyday life by making it more convenient, efficient, and connected. E-commerce has revolutionized the way businesses operate and interact with customers. It has made it easier for customers to shop from the comfort of their own homes and provides businesses with an efficient way to reach out to a larger audience. Last mile delivery is the crucial step in the e-commerce process which involves getting the goods to the customers' doorstep. It is important to ensure that the goods are delivered at the right time, in the right condition and with the right customer experience. Last mile delivery has become an increasingly important part of the e-commerce process and businesses need to ensure that they have an efficient and cost-effective last mile delivery system in place.

The "last-mile" delivery is the last stage of a supply chain that is thought to be the least efficient owing to its unique characteristics, including a geographic distribution of relatively tiny reception locations, need for more frequent but smaller shipments, delivery time windows, etc. The "last-mile" delivery carried out by common delivery vehicles for an inner urban supply is thought to be significantly ineffective insofar as its ecological aspect is concerned, particularly in cities that are faced with modern distribution practises as well as increasing urbanisation and the development of e-commerce. This supports the conclusion that new delivery vehicle types must be developed in order to increase company performance while minimising the detrimental effects of transportation on the environment and societal functions in inner cities. With relation to this, the article discusses cutting-edge transportation innovations used in "last-mile" deliveries in industrialised European nations, which promote social and ecological sustainability as well as greater supplier competitiveness.

Many digital solutions provide products and services that were developed to satisfy changing consumer trends, better user experiences, and customer preferences. For both physical and intangible goods, the community is steadily building an online buying habit, and the service industry is not an exception. Last mile delivery has a lot of room to develop in that market. It is required to transport packages more efficiently and more quickly. Customers are unable to quickly purchase a product online and have it delivered to their home.

The goal of this study is to use design thinking to examine BMT's effectiveness in creating and introducing a new good or service into the market for delivery service using their creative and better function distribution between the drone and the winch. It's an opportunity to learn more about how innovation in goods and services may make it easier

for customers to get their packages by boosting delivery effectiveness, cutting costs, and attaining faster speed.

Design/methodology/approach

Applying Service Design Process in Drone delivery service
The innovative SPARROW concept, which addresses the Last Mile Delivery issue, is the foundation of the project. The project will be successful if the relevant underpinning theories are fully explained. The technique of double diamond design thinking is used to systematically build the user personas, customer journey, information architecture, and user flow. We used both quantitative and qualitative approaches to understand the user's needs and desires in order to produce a solution that perfectly satisfies their requirements. The author performed two concurrent surveys and interviews with potential clients to get more data for the design process.

Findings

According to the research, last-mile logistics firms would deploy SPARROW, a lightweight, nimble suspended robot, in conjunction with outside drones to transport products to the ground. Since then, the last mile delivery issue has been handled, greatly impacting end consumers' minds. By using the SPARROW idea in the drone delivery service, the project work made use of design thinking concepts to increase delivery efficiency in the last mile delivery process. However, using design thinking process will allow us to identify customer needs, develop creative solutions, and test them through prototyping and experimentation. This process should help us to gain insights into customer preferences and behaviours, allowing us to design a service that meets their needs and expectations. Ultimately, the success of our delivery service will depend on how well it meets customer needs and preferences.

Originality/value

The design thinking approach is utilised to understand customers' expectations and to understand the business opportunities for the BMT's SPARROW project. The analysis assessed to fill the gap between user experience and companies offerings.

Keywords

Design Thinking, Last- mile delivery, UAV, Service design, e-commerce.

Paper type

Hybrid Research paper. A consulting project for BMT company.

Introduction

E-commerce and online delivery services are disruptive innovations that have completely changed how businesses function and engage with their customers. Customers now find it simpler to shop from the convenience of their homes (Pai, J. C., & Yeh, C. H ,2008, and it gives businesses a productive opportunity to reach out to a wider customer base.

Due to Covid-19, the entire world saw enormous changes and especially with business and bigger companies, the internet played a vital role, from small business to bigger enterprises changed their business models and made it completely digitized (Asdecker, B, 2021). Online delivery was a saviour during tough times, it started from food, groceries, medicines and slowly people got convenient ordering everything they needed from online. Although online delivery and E-commerce has existed for more than a decade now, the last three years, the industry saw a huge transformation. Around 40% of people in UK prefers shopping online especially after Covid(IBISWorld, 2021).

Last mile delivery is the crucial step in the e-commerce process which involves getting the goods to the customers' doorstep. It is important to ensure that the goods are delivered at the right time, in the right condition and with the right customer experience (Joerss, M., Neuhaus, F., & Schröder, J, 2016). Last mile delivery has become an increasingly important part of the e-commerce process and businesses need to ensure that they have an efficient and cost-effective last mile delivery system in place.

Drone delivery technology is the latest innovation supporting the last mile delivery to provide efficient services to the customers, digitisation of the process is key to ensuring successful drone delivery. Digital transformation is seen in every industry, it enables businesses to gain a competitive edge, increase customer engagement, and drive innovation. Digitisation of drone technology enhances the performance, it provides insights about the customer data, destination and eases the process.

BMT's SPARROW drone delivery technology is used for last mile delivery to satisfy the needs of the customers by enhancing their experience in online delivery service mainly for commercial use. This is a case study consulting project for the company BMT pertaining to their innovative drone delivery system innovation.

The report provides insights about the BMT's SPARROW drone systems background, technology and how it will impact the drone technology trends for efficient services.

Further, the report shows the research regarding market demands, user needs and pain points. By using a Design thinking process, the drone delivery service is implemented by considering all the factors. The approach is to fill the gap between the company's innovation and the customers' expectations.

Context and Background

Online delivery and E-commerce have transformed the businesses and helped the businesses to gain profitability. There is a need for faster delivery on the market since online shopping for groceries, retail, and medicines has increased over the last several years. As users got used to the system, problems are identified, and users seek more convenience. In traditional delivery, using freight transportation there are major drawbacks. The demand for quick, easy and efficient delivery is high, but customers are concerned about the freight transportation as they prefer faster, trustworthy, hassle-free delivery, and few users are also concerned about the environmental impact it has.

Drone delivery systems are innovated to dominate the “last mile” logistic industry. Drone delivery technology enhances efficient delivery services by overcoming most of the drawbacks of traditional delivery services. This has created a demand for drone delivery services in the market. Although there are a number of companies providing drone services, there are limitations in terms of functioning, thus users are hesitant to try the service. The downside of the drone delivery services at present are,

1. Restricted landing zone which leads to limited access to deliver to all the locations.
2. Payload capacity issue, noise created while landing and privacy issues.
3. Unexpected obstacles and accidents due to weather conditions and lack of human control.

BMT’s sparrow concept overcomes most of the issues as it is a lightweight and agile suspended robot. SPARROW addresses most of the limitations, allowing drones to stay safely at 400 ft+ above the ground, unseen and unheard and thus avoid obstacles and noise. It can access precise target locations, remaining stable in proximity to obstacles in windy conditions with ideal payload capacity.

The objective of the research project is to use BMT's SPARROW (Survivable, Precise, Autonomous, Rapid Resupply and Observation Winch) drone delivery technology, which allows rapid, inexpensive aircraft drones to deliver products safely, precisely, and efficiently.

The initiative is centred on BMT's capacity to develop and launch a new product or service. This is a chance to learn more about how improving delivery efficiency, reducing expenses, and achieving quicker speed may make it simpler for consumers to get their shipments (Waschull, 2001). When entering a new market with a new item or service, understanding the market and customer demands is critical. As a result, the objective is to appreciate the project's scope from the perspective of consumers and enterprises.

Service design is utilized and implemented in the analysis. Gaining a competitive advantage in the market and causing a disruptive change in the way services are offered are the goals. The company anticipates that this consulting project will help it grow its market share, generate long-term profitability, and satisfy client requests. In order to help the BMT

company introduce drones to the delivery service sector, which help with last-mile delivery, it is required to understand customer needs, attitudes, and behaviour. In-depth information on the project's aims and objectives will also be included in the report.

Research Goals

1. To implement design thinking approach and custom tailor to the BMT context.
2. Empathize with the customer, end user, or other stakeholders in the value network to uncover meaningful tensions and opportunities for service innovations.
3. Define and reframe customer-centric problem statements.
4. Examining the end-users' experiences and pain points before the unique technology SPARROW idea is released to the market.
5. Introducing a new delivery service using the Design Thinking Process in the last mile sector.

Literature review

Design Thinking

Design thinking has been touted as an effective technique for coming up with ideas, particularly during the early stages of innovation. There are several correlations between design thinking and innovation, as well as elements that influence the expansion of innovation. Both designers and non-designers should use Design Thinking as a helpful strategy for a variety of business difficulties (Chasanidou, Gasparini & Lee, 2015).

From the realm of designers and architects, interest in how designers think, and work gradually expanded into management and business administration. Both groups place a significant focus on iterative methods, teamwork, rapid concept modelling and testing through prototyping, and user engagement (Panke, 2019). Design Thinking has been discussed and studied more recently than design thinking as the cognitive processes that designers utilise, according to Wrigley and Straker (2017).

Even though design researchers have been studying the process for decades, Rowe (1991) popularised the phrase "design thinking" to describe how designers approach design difficulties. Despite these varied purposes and uses, design thinking may be seen as a fundamental framework that enables interdisciplinary teams to communicate and coordinate their efforts (Lindberg et al., 2010).

Design thinking offers plenty of guidance in solving vicious issues of the kind that allow for trial-and-error learning in order to increase success later. It accomplishes this by forming mindsets and providing tools that spare you from having to locate "the optimal view."

Instead, attention is focused on needs that still need to be met (Gestwicki & McNely, 2012). Since the old problem views turned out to be dead ends, new problem interpretations that consider the opinions of many stakeholders are put out to look at the situation from a fresh perspective. Finally, a variety of tools are offered to help the problem-solving process move in a constructive direction, ensuring that it is free from arbitrary formalisations and can stay flexible and playful (Panke, 2019).

Design thinking has different models, Brown describes a nonlinear process as consisting of three interconnected phases: inspiration, ideation, and execution (Brown & Martin, 2009). Additional segmentation into smaller actions and reflection questions are also possible for these phases.

In Fierst et al. (2011)'s five-step model, iteration is reserved for the last stage, evolution. The iterative, non-linear process of design thinking has five phases. In that order: empathise, define, brainstorm, prototype, and test. The major objective of the process is to provide the opportunity to develop and put into practise original ideas while working flexibly (Razzouk & Shute, 2012).

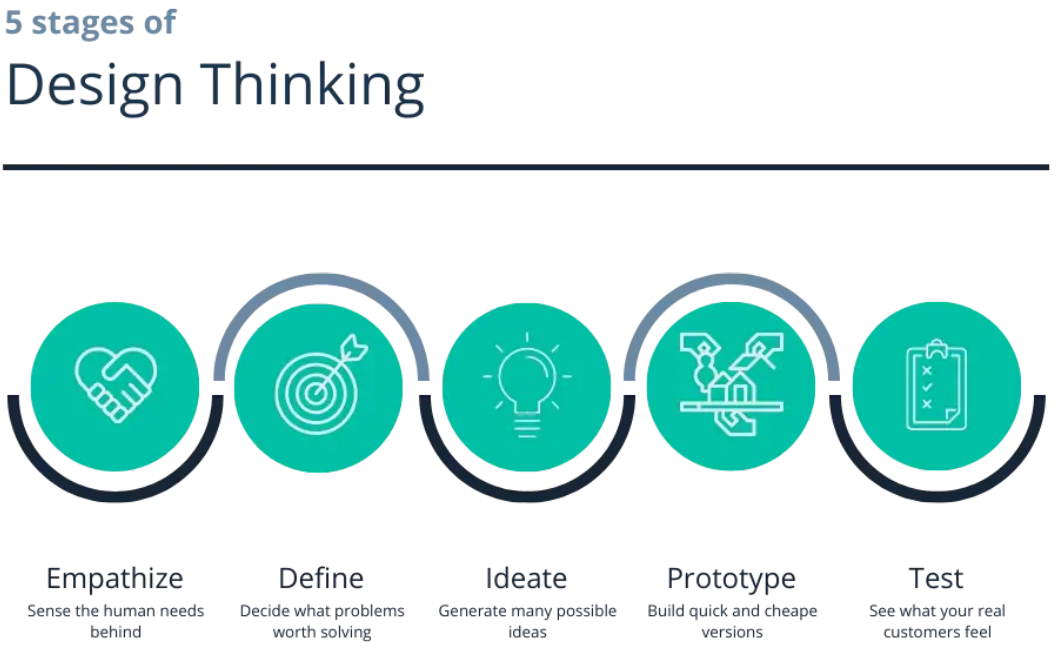


Figure 1

Design thinking may support the development of more effective, affordable, and user-friendly solutions by taking into consideration the demands and context of the user. Furthermore, the collaborative aspect of design thinking inspires participants to work together and develop solutions that are suited to the requirements of the user (Buchanan, 1992). Design thinking also enables fast iterations of ideas in order to continuously enhance and streamline the delivery process.

Last Mile Delivery

Over the past few years, demand for online shopping and deliveries has skyrocketed, but so has the need for excellent services. Users have higher expectations for quality service. Punctuality is one of the main criteria in determining the quality of the service. It is essential to get the products within the predetermined delivery window and interval between the customer order and the delivery. However, customers typically aren't prepared to pay for such expensive logistical requirements (Borsenberger, 2016). Due to the difficult target service levels, the small size of orders, and the high degree of dispersion of destinations, last-mile delivery is seen from the perspective of the companies as the least efficient and most expensive part of the delivery process (Macioszek, 2017). Its cost can reach up to half of total logistic costs (Vanelslander et al., 2013).

Last mile delivery is the last step of the logistics process to deliver the package to the customer. The rapid evolution of technology in the sector is ushering in a potential rise in the number of new entrants. Both parcel delivery players and commercial vehicle players must make sure they equip themselves with the necessary resources and skills if they want to make successful plays as competition increases (Schröder, Heid, Neuhaus, Kässer, Klink & Tatomir, 2018).

Businesses are looking into various ways to enhance last mile delivery as demand for the service rises. One viable solution is to engage third-party delivery services; few businesses use crowd-sourced delivery services. The environmental sustainability is negatively impacted by last-mile delivery freight activity. Congestion, carbon emissions, and pollution all rose. After the percentage of first-time deliveries that fail increases, the carbon emission increases (Tiwapat, Pomsing & Jomthong, 2018).

Using drones and driverless vehicles is another strategy for last-mile delivery which can also have positive impact on sustainability. Drone technology is being developed by businesses like Amazon and UPS to increase the effectiveness of last-mile deliveries (Yoo & Chankov, 2018).

Drone technology in last mile delivery

Drone use has been heralded as a possible disruptor to the parcel delivery sector and could significantly lower labour costs. Given that same-day or instant delivery is anticipated to increase in the coming years, McKinsey sees autonomous unmanned aerial vehicles (UAVs) as a prominent alternative for last mile logistics, notably of parcels for rural areas and emergency deliveries like medicines and other products. A rising number of businesses are promoting and researching drone home delivery. Drone delivery has been tested by businesses including Amazon, Google, UPS, DHL, and others for years, some since 2005, as a potential replacement or addition to traditional delivery (Aurambout, Gkoumas & Ciuffo, 2019).

Most problems with traditional delivery, including punctuality, speed of delivery, and product safety, are resolved by drone technology. Compared to the conventional method, drones have

an impact on reducing carbon emissions as well (Tiwapat, Pomsing & Jomthong, 2018). Chiang et al. (2019) explored how drones affect CO2 emissions and costs. By creating a genetic algorithm to solve their model, they suggested a mixed-integer (0-1 linear) green routing model for drones to discover the best routes and delivery methods for parcels using drones.

Overall, the drone technology dominates the last mile delivery and is a solution for most of the traditional delivery issues. BMT's SPARROW model utilises drone technology and the model overcomes general issues of drone system which is discussed further in the report.

Value co-creation

According to Baldwin and Clark (2006) Value co-creation is a term used to describe how a company and its customers collaborate to produce value. This can be accomplished through developing a new product or service, or by identifying methods to enhance the consumer experience. The importance of value co-creation stems from the fact that it fosters customer loyalty, promotes customer involvement, and distinguishes the organisation from the competitors. Engagement, engagement, self-service, and experience are acknowledged as crucial factors in the co-creation of value. (Bendapudi and Leone 2003).
Customer input is essential to co-creating value. Businesses must ensure that they are listening to and promptly responding to client feedback. Additionally, they should be receptive to new suggestions and client input in order to constantly enhance their goods and services.

By including consumers in the co-creation of value, organisations may improve the customer experience and increase customer loyalty. Customers are more likely to remain loyal to a company if they believe their opinions and suggestions are respected. This fosters a feeling of community and deepens the business's interaction with its consumers.

Methodology

Mixed methodology

In order to achieve the better understanding of the users' needs and perspective towards the drone delivery system, the problem needs to be explored by considering multiple perspectives to get an optimal solution. In this research, mixed methodology is used where both qualitative and quantitative research approaches are used to gain a comprehensive understanding of research problem. It includes both primary and secondary data in order to reduce bias and increase reliability.

To clearly comprehend the prospects in the drone delivery business and the customer expectations, data is taken from databases, academic publications, and other sources. To explicitly gather user demands, use statistics, and feedback in order to close the gap between

the innovation and consumers' expectations, a survey of more than 200 people was conducted.

In an iterative process known as design thinking, we seek to understand the user, question presumptions, and reframe hurdles in order to unearth alternate approaches and solutions that might not be immediately evident given our current understanding. A problem-based approach for simultaneously tackling issues is Design Thinking. Understanding the people for whom we are creating the goods or services is at the heart of design thinking (Tschimmel, 2012). It strengthens our capacity for observation and fosters empathy for the target audience. This process of challenging the issue, the underlying presumptions, and the repercussions is encouraged by design thinking. The actions that make up the design thinking process include discovering, defining, prototyping, testing, and delivery (Razzouk & Shute, 2012).

In this section of the paper, the application of design thinking to the last mile delivery process will be discussed and supported. The components of design thinking, such as collaboration and empathy, and how they might be utilised to enhance last-mile delivery are elaborated on.

Design thinking is predicated on understanding the user's circumstances and empathising with their demands. This empathy assists in the creation of innovative solutions by facilitating a deeper understanding of the issue at hand. In addition, design thinking encourages stakeholder participation to ensure that all perspectives are included (Dam & Siang, 2020). Design thinking permits rapid iterations of ideas to continuously enhance the product or service until it fulfils the consumer's needs.

Empathize – sense the human needs behind

The User-Centric Research stage of design thinking is where it all begins. The goal of this step is to develop an empathetic awareness of the problem with the last-mile delivery customer experience. The survey was conducted at this stage to comprehend the user's perspective, gather feedback on the existing delivery services, and empathise with the users to understand the problems more intimately. Additionally, to better understand customer

motivations and underlying prospects for the drone delivery services market, secondary research is conducted and compared.

Define – State your User's Needs and Problems

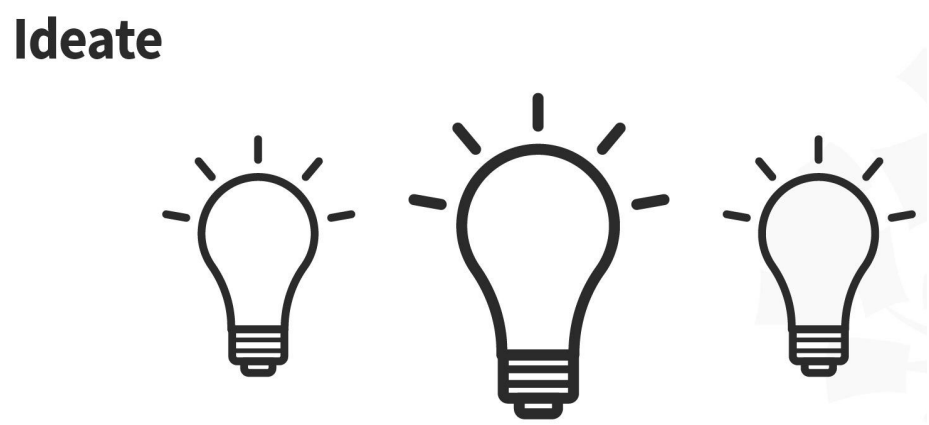
"A Problem well-stated is a problem half-solved."

The information obtained during the define stage is organised to analyse the primary issues. The problem definition and problem statement must be developed in a human-centred way (Wolniak, 2017).

Defining the problem

Customers are segmented using cluster analysis. Few user personas are established to capture users' objectives, motivations, and behaviours in respect to the last mile delivery service once the difficulties have been recognised. In the subsequent step, the problem statement is developed based on the survey results, giving the designer with an overview of the difficulties that must be solved in order to develop an improved system. After analysing the barriers, the author shows how the BMT's SPARROW concept may avoid them in the "How we might" statement. The empathy map is constructed based on the survey results and secondary research findings. This instrument facilitates the comprehension of user requirements and the development of a visual journey of the customer's path and demands, hence facilitating designer acknowledgment.

Ideate – create many ideas and build on each other

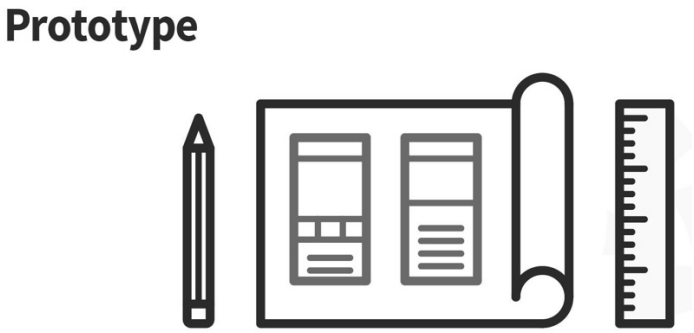


Ideation stage is one of the vital phases as the designer understands the user requirements and identifies the problems statement and come up with different approaches to provide propitious resolution (Kumar, Lodha, Mahalingam, Prasad & Sahasranaman, 2016).

Brainstorming

During this phase, the team, the director of BMT company, and the author collaborated to develop an optimum approach. The discussion included a variety of obstacles and solutions for the problem statement. Existing drone delivery approaches were examined to create inspiration and a diversity of possibilities. Finally, BMT's SPARROW idea was developed to address existing flaws of last mile delivery and drone delivery service and meet user requirements.

Prototype – Start to Create Solutions



During the brainstorming process, one of the solutions chosen was BMT's drone delivery technology. The BMT's design team has created a final prototype considering the previous inputs, which is explained in depth in the report, after examining several technologies during the prototyping process.

Test – Try Your Solution Out

Testing is the last phase in the design thinking process, and this step of testing is also completed by BMT's testing team. After putting the SPARROW through its paces in the real world, the team found that it met most of the analytical requirements outlined in the earlier stages of the design thinking process and meets all the user needs.

The final phase in the five-stage paradigm, however in an iterative process like design thinking, the outputs are frequently used to redefine one or more new problems. This increased understanding may allow designers to investigate use scenarios and how people interact with the product. It may even encourage the designer to return to an earlier stage of the design thought process. The designer may then proceed with more iterations, revisions, and adjustments to rule out other viable options. The key goal is to understand the product and its users as thoroughly as possible.

Research Structure

A (actual or fictitious) customer provides a briefing to start the process. Typically, this is a very generic explanation of a certain subject or problem area that omits identifying the precise nature of the issue. In first step we tried to gather as much as information about the topic, as possible. This is achieved through secondary research, such as internet, newspaper, TV, or book research. Facts, statistics, and background stories are collected and shared among the team. The second step aims at gathering insights from prospective users. Through qualitative research we collected facts about the users and tried to interpret those. The goal of this step is not to ask the users about their needs directly. Usually, the users are not aware of

drawbacks or needs they might have. Therefore, to find the user's needs we conducted an online survey and interviews. The third step is to define the problem area and the end user needs. From this step the insights from the research are clustered according to specific themes, to identify patterns. During the synthesis these insights are condensed into a visual framework or into user – related persona (such as user persona or a user journey map). Then is then transformed into the Point of view, which is usually verbalized description of the specific identified problem and contains a addresses exactly this user need. The brainstorming question usually starts with "How might we….?", to trigger a solution-oriented idea generation. In the ideation phase, ideas are generated using classical brainstorming techniques. These are then clustered according to different criteria, such as the 'realistic' ideas, the 'wildest' ideas, or the 'most useful' ideas. By voting or using concept selection matrix. This idea is then built as a prototype. To test the idea the prototype will be shown to potential users or to other stakeholders. Their feedback can be then used to iterate the prototype or to improve the concept. The iteration might be executed several times, until the user feedback is positive.

Data Collection

In our study data was collected by sending an online survey to nearly 500 people in UK and a total of 200 responses were gathered. The variables used in our research are age, gender, employment status, location, income, and other variables which denotes the experience of the customers facing in the current online delivery service. Data was analysed in R studio and clustered the customers based on their overall satisfaction in the online delivery service to find their pain points and their needs.

Market Research

The E-Commerce industry has developed over the last ten years from a straightforward brick-and-mortar retail model to a shopping ecosystem that includes a variety of devices and store designs. Numerous retailers, both online and offline, are embracing multi-channel strategies and are constantly reimagining how we purchase online. Customers are discovering greater convenience on all levels, whether it is product personalization, mobile-optimized search, speedy checkout procedures, or hassle-free shipping, and expectations are rising quickly as a result.

In 2021, 74% of Americans, 81% of Britons, and 69% of Chinese customers said they had made at least one online purchase in the preceding year(Statista, 2021a). The industry is reaching maturity in industrialised nations, and there is fierce and expensive rivalry among eCommerce firms. While online marketplaces like Amazon and AliExpress are thriving, many independent businesses are finding it difficult to differentiate themselves in a market where cart abandonment rates are high, and brand and store loyalty are declining. Through

community creation (like ASOS Marketplace), loyalty programmes, and a seamless mobile and desktop user experience, brands may increase brand engagement.

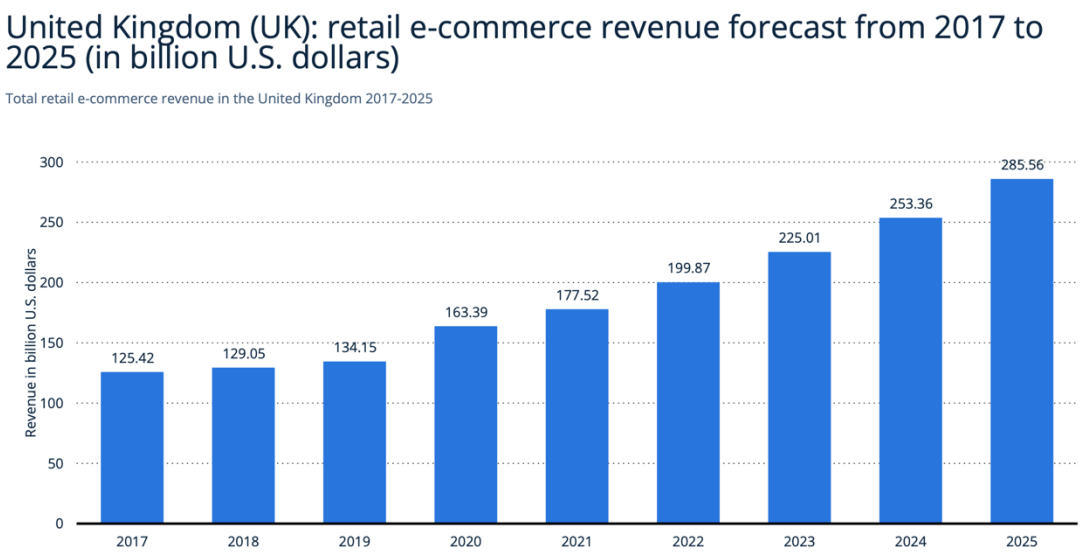


Figure 2

Within the next several years, it is expected that the UK's eCommerce sector would constantly generate 85.7 billion US dollars (+42.88%) in revenue. This prediction states that by 2025, revenue will have climbed for eight straight years, reaching 285.56 billion US dollars(Statista, 2020b). Notably, during the last several years, the eCommerce sector's income has been steadily rising.

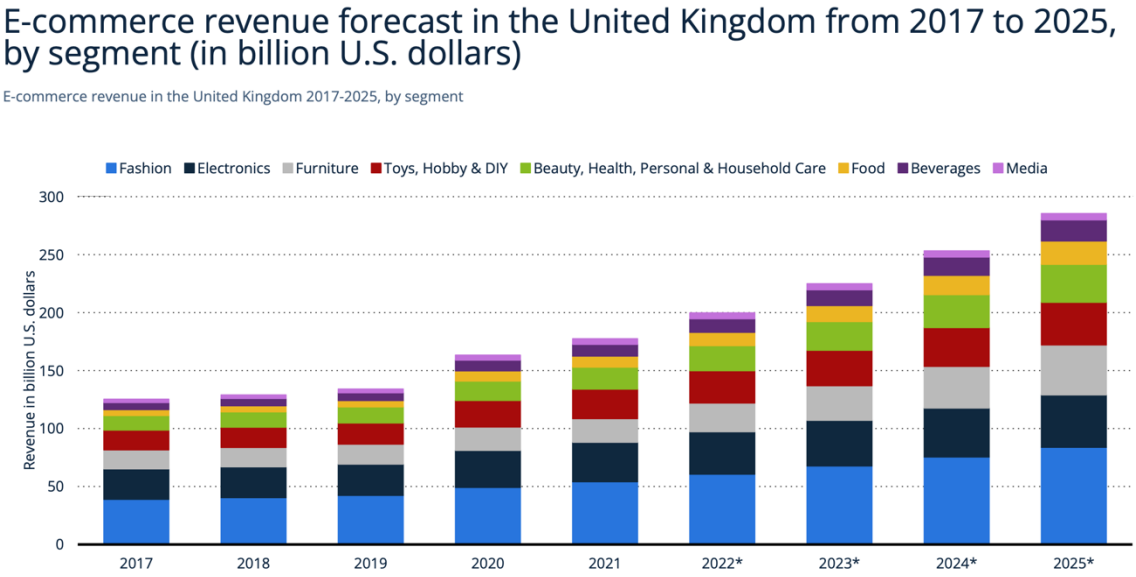


Figure 3

In 2021, the e-Commerce sector in the United Kingdom generated a total of 199.9 billion dollars in sales. Up to 2025, it is predicted to rise to 285.6 billion dollars. It is anticipated that the fashion category would continue to dominate the market with 83.8 billion US dollars.

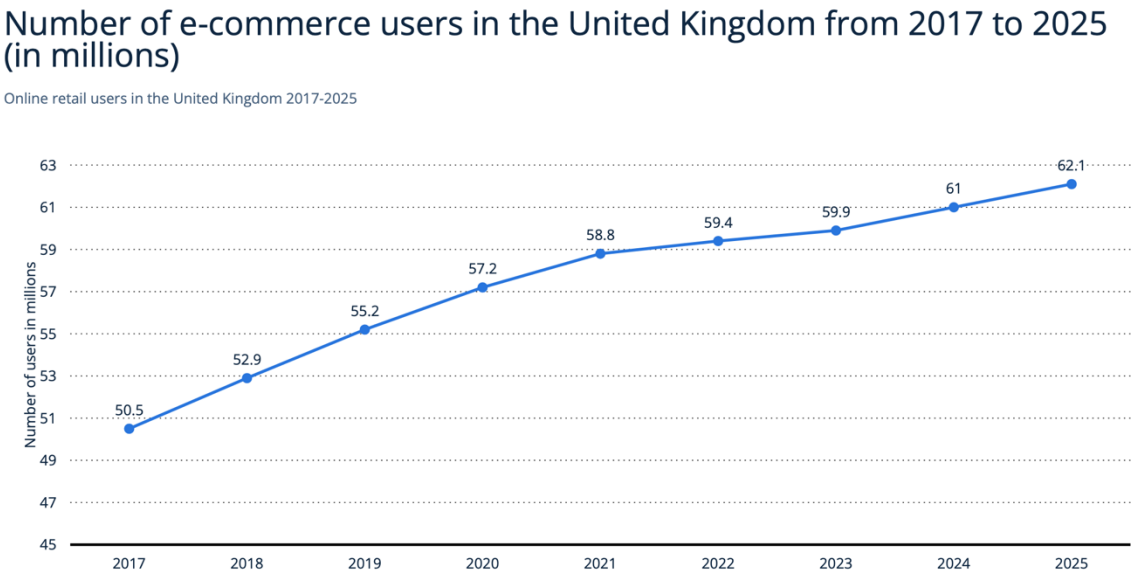


Figure 4

The number of e-commerce users in the UK in 2017 is shown in this figure, along with a projection through 2025. In 2025, there will be 62,1 million e-commerce consumers in the United Kingdom, predicts the Digital Market Outlook (Statista, 2020c).

Figure 5

In a 2019 study, 90% of participants chose to have their orders delivered to their homes, reflecting the preference of the majority of online consumers in the United Kingdom (UK). A secure spot agreed upon with the carrier was the second most favoured location for online shopping package delivery, according to 16% of respondents (DPD, 2020a). Getting a delivery delivered to a central pickup facility was on the lower end of the spectrum. But just 3% of customers said they liked this.

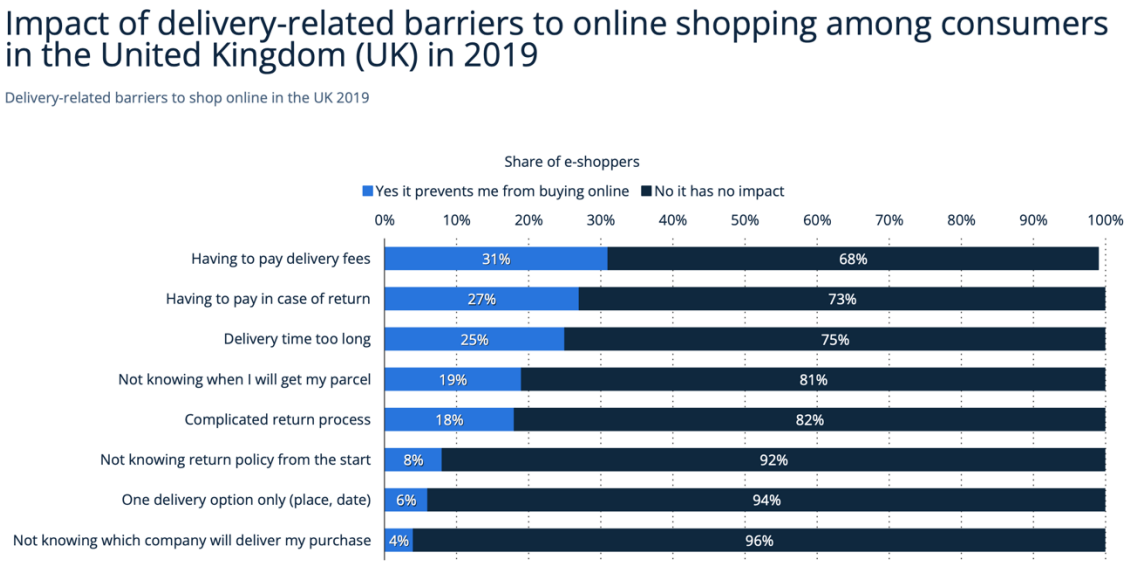


Figure 6

Limited, expensive, or confusing shipping and return procedures were seen as major deterrents to online purchasing by UK consumers. According to statistics gathered in 2019, 31% of customers said that having to pay delivery costs was a barrier that had the greatest influence on their decision to make an online purchase (DPD, 2020b)

Findings

Empathise stage

Key insights derived from the survey

The market analysis is done using the survey and secondary research, the findings is briefed below by comparing both the research and conclusion is made. The analysis provides an overall picture of opportunities in the market for SPARROW project to penetrate and gain competitive advantage over traditional and drone delivery services.

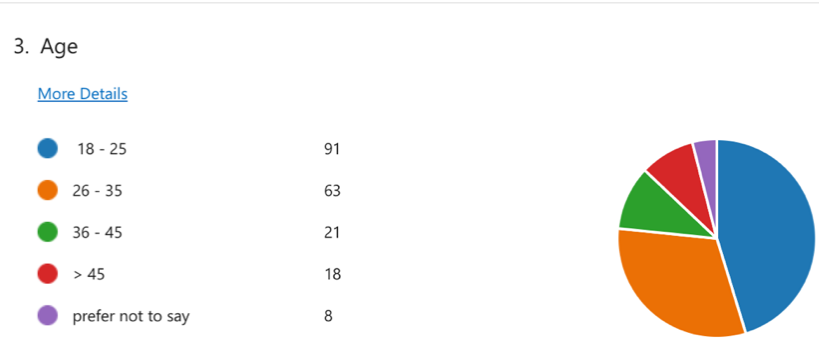


Figure 7

The target market is defined as the demographics between the ages of 18 and 25, which includes Gen-Z and early Millennials. According to the survey results and the cluster analysis, this cohort is likewise quite unsatisfied with the current delivery systems.

According to the Mintel report, 27.3% Millennials and 18.3% of Gen-Z prefer shopping online, post-covid, the demand for E-commerce has increased and this particular age group prefers the convenience. Thus, the target based on the survey and report is mostly Gen-Z, early Millennials and also the focus can be on older Millennials (Dixon, 2020).

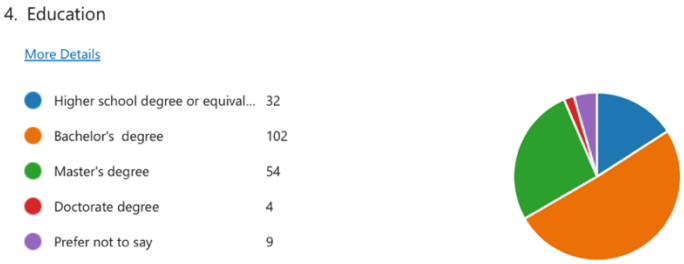


Figure 8

According to the poll, the majority of online shoppers and the target market are highly educated individuals with graduate degrees and some with master's degrees, therefore the target audience may fall into this group.

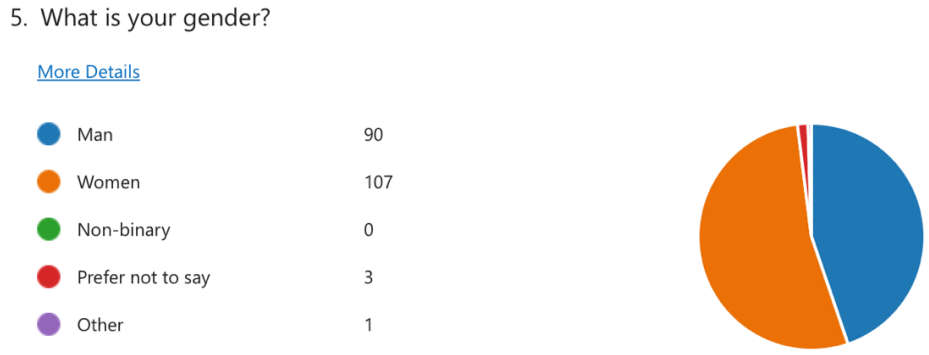


Figure 9

From the above figure, most of the online shoppers are women about 107 users and men are about 90 users. Overall, women are quickly becoming key players in the ecommerce space. With their increased purchasing power, tech-savviness, and entrepreneurial spirit, women are driving the future of ecommerce. Around market size of 11.5 billion sales were of women's clothing and accessories in the year 2022 whereas men's was 2.85 billion market shares. (IBISWorld, 2021).

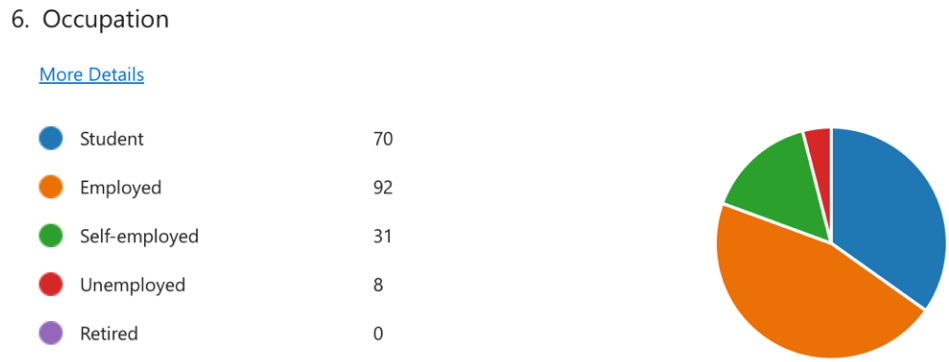


Figure 10

Figure 11

Coming to the employment factor, surveys clearly show, most of the buyers are employed and students, the income is lower than 1000 £ as they are mostly students and Millennials who has been employed with the income between 1000-3000 £, this category is ready to take a risk and adapt to a new innovation.

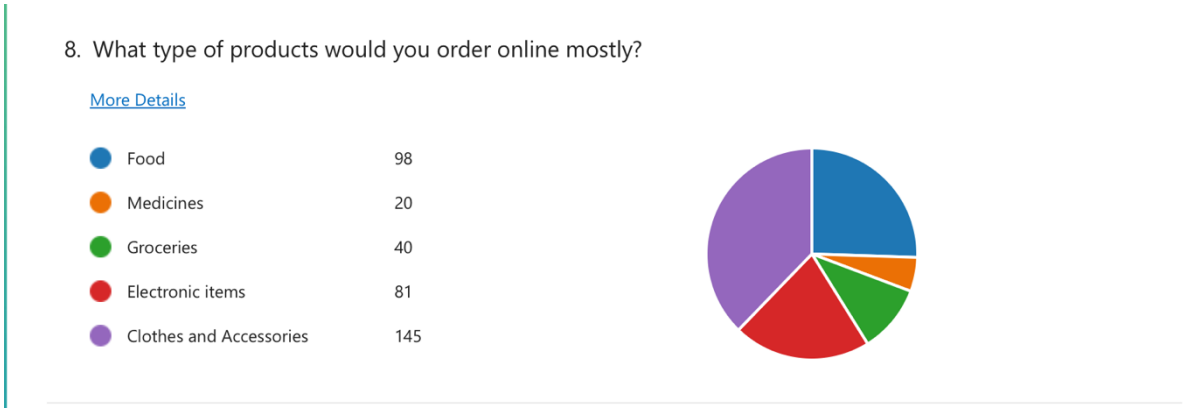


Figure 12

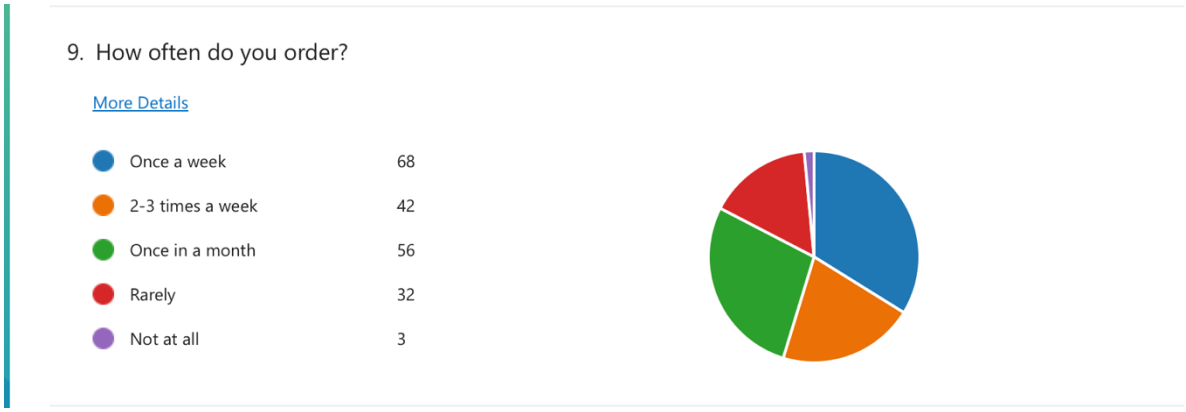


Figure 13

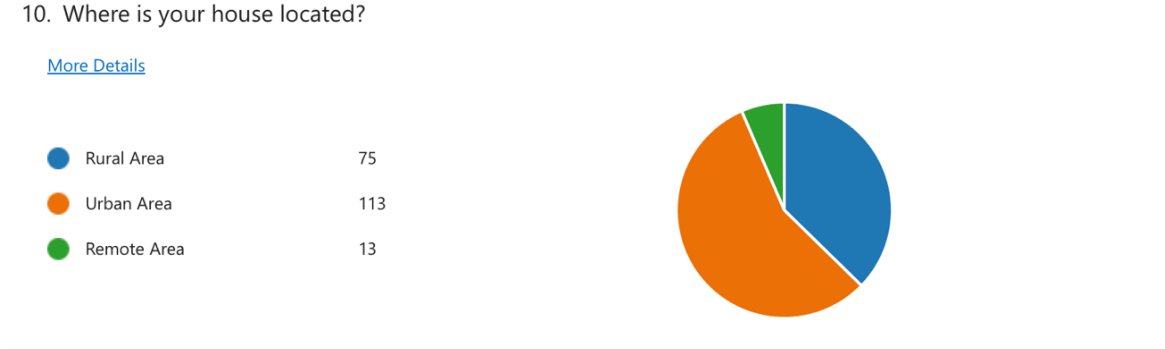


Figure 14

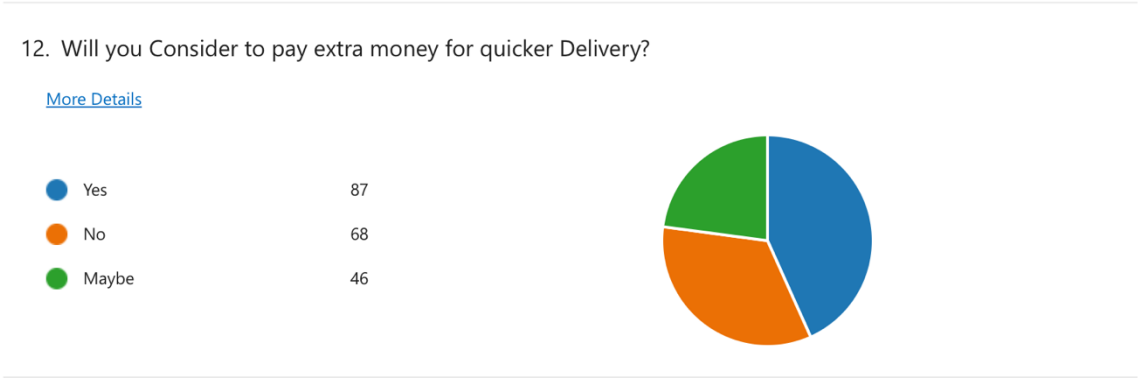
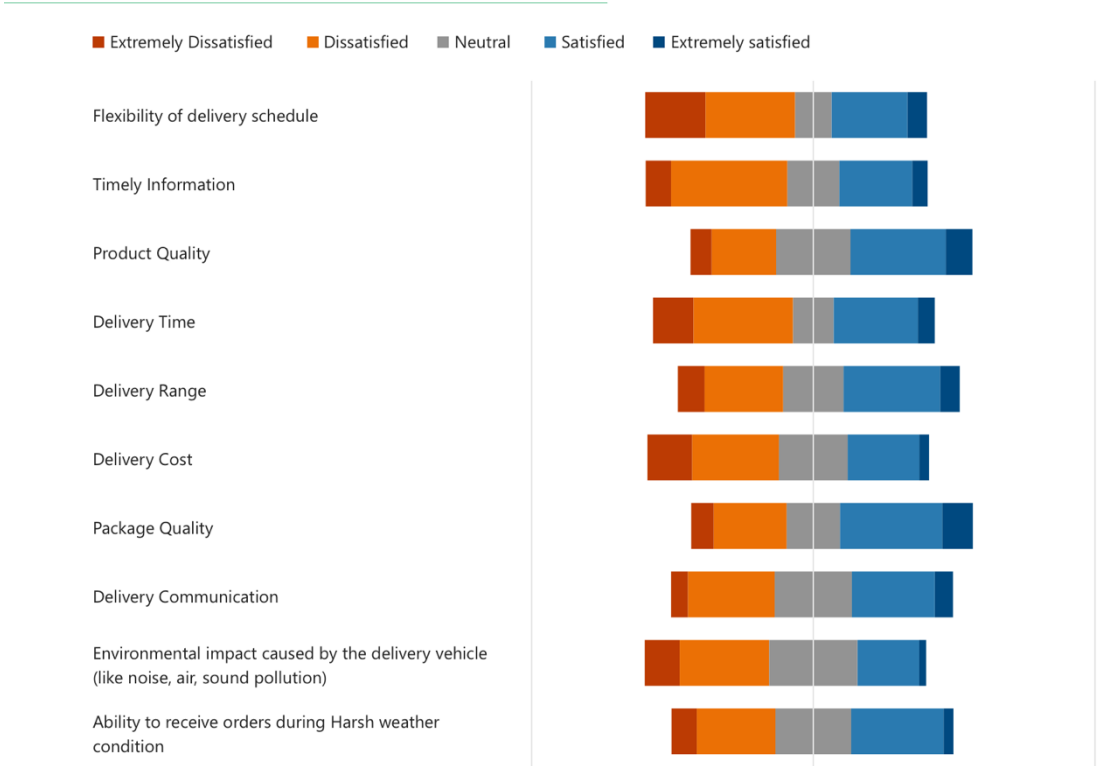


Figure 15

The above figures shows that according to the survey, users often order clothes & accessories category followed by food and electronic items. This depicts users prefer getting fast delivery of these categories. Most of the orders are from urban area, but rural area is also in higher demand as this region requires a lot of days to deliver a product, thus SPARROW can be suitable to satisfy the user needs. Also, the users do not mind paying extra if the deliver it quick and efficient.



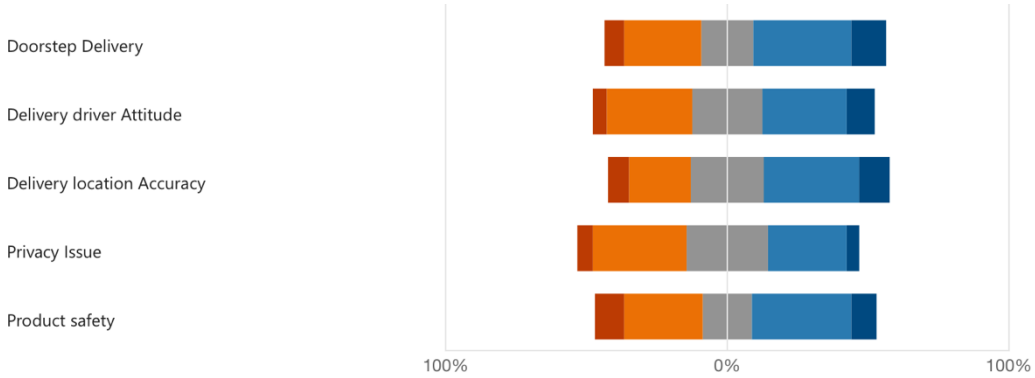


Figure 16

The fig is the result of customer satisfaction regarding the last mile delivery with traditional delivery service. According to the survey, the users are satisfied with the package quality, product safety delivery driver attitude and delivery range, but they show dissatisfaction in terms of punctuality, tracking, environmental impact, and delivery cost. Overall, the survey clearly depicts that the traditional delivery is an average service, and they expect a better service in last mile delivery. Thus, there is an opportunity in the market to penetrate with SPARROW as it solves most of the traditional delivery service and other drone delivery services drawbacks.

Empathy map

Empathy maps are a crucial aspect of the design thinking process since they assist organisations in understanding the consumer's perspective and developing solutions that fulfil their requirements. Customers' existing pain points, experiences, and demands will be leveraged to develop a progressive system, as depicted in the following figure.

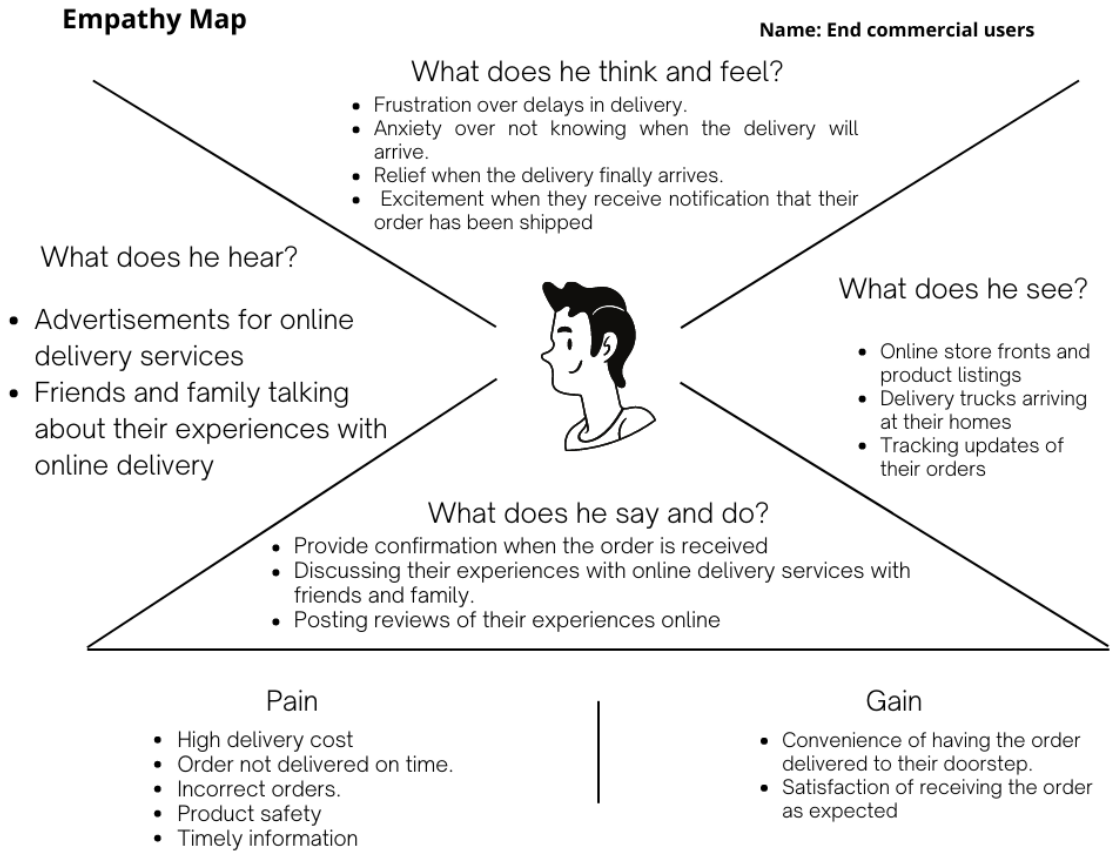


Figure 17

Define stage

Cluster analysis

Cluster analysis was performed to group the data set into clusters which has similar interests, feedbacks, and needs. As a result, each cluster has provided an insight about unique segmentation of the customers which can help to develop and design the required system. The following figure is the dendrogram which depicts five unique customer segmentations which will be utilised to find the natural patterns and relationships in data.

Customer segmentation is done through cluster analysis. Cluster analysis is a process for discovering and categorising similar entities into clusters. To design specialised service offerings, it is vital to analyse normal customer satisfaction and behaviour patterns. In addition, it may be used to identify customer groups who can be provided by certain services

(Kashwan & Velu, 2013). After collecting this information, customised services that meet the needs of the identified client groups may be developed.

Installing the essential packages, including readxl, tidyverse, gt, and cluster, is the initial step in cluster analysis. The packages are loaded in the next phase.

Data cleaning and pre-processing

The data collected from the survey has been converted into excel sheets and the following steps were performed.

By either eliminating or replacing the NA values, the dataset has been examined for any missing values. By eliminating the outliers from the dataset since they can skew the results of the cluster analysis, all data types have been assured to be normalised. Each data point should have the same weight in the analysis since the whole data collection has been standardised. Finally, all punctuation and unusual characters have been removed from the dataset. After cleaning the data, it is extracted to Excel. Following are the characteristics that we utilised in our cluster analysis.

```
> names(imported)
 [1] "Age"                  "Education"            "Gender"                "Occupation"
 [5] "Income"               "Order_freq"           "Location"              "Flexibility"
 [9] "Timely_Information"   "Product_Quality"      "Delivery_Time"         "Delivery_Range"
[13] "Delivery_Cost"        "Package_Quality"      "Delivery_Communication" "Environmental_Impact"
[17] "weather_Condition"    "Doorstep_Delivery"    "Delivery_Driver"       "Location_Accuracy"
[21] "Privacy_Issue"        "Product_Safety"       "Extra_Money"           "Switched_Retailers"
[25] "Ratings"
```

Figure 18

Age, level of education, gender, employment, and income are the demographic characteristics. The last mile delivery service's other characteristics are all related to the client experience. The lowest value, first quadrant, median, mean, third quadrant, and maximum value are shown in the summary of the imported dataset below.

```
> summary(imported)
      Age          Education        Gender        Occupation        Income        Order_freq      Location
 Min.   :0.000   Min.   :1.00   Min.   :0.000   Min.   :1.000   Min.   :1.000   Min.   :1.00   Min.   :1.000
 1st Qu.:1.000   1st Qu.:2.00   1st Qu.:0.000   1st Qu.:1.000   1st Qu.:1.000   1st Qu.:1.00   1st Qu.:1.000
 Median :2.000   Median :2.00   Median :0.000   Median :2.000   Median :2.000   Median :2.00   Median :2.000
 Mean   :1.755   Mean   :2.29   Mean   :0.475   Mean   :1.885   Mean   :1.905   Mean   :2.31   Mean   :1.685
 3rd Qu.:2.000   3rd Qu.:3.00   3rd Qu.:1.000   3rd Qu.:2.000   3rd Qu.:2.000   3rd Qu.:3.00   3rd Qu.:2.000
 Max.   :4.000   Max.   :5.00   Max.   :2.000   Max.   :4.000   Max.   :4.000   Max.   :5.00   Max.   :3.000
  Flexibility   Timely_Information Product_Quality Delivery_Time   Delivery_Range  Delivery_Cost  Package_Quality
 Min.   :1.00   Min.   :1.00       Min.   :1.00    Min.   :1.000   Min.   :1.000   Min.   :1.00   Min.   :1.000
 1st Qu.:2.00   1st Qu.:2.00       1st Qu.:2.00    1st Qu.:2.000   1st Qu.:2.000   1st Qu.:2.00   1st Qu.:2.000
 Median :2.00   Median :2.50       Median :3.00    Median :2.500   Median :3.000   Median :3.00   Median :3.000
 Mean   :2.67   Mean   :2.78       Mean   :3.15    Mean   :2.775   Mean   :3.005   Mean   :2.69   Mean   :3.155
 3rd Qu.:4.00   3rd Qu.:4.00       3rd Qu.:4.00    3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.00   3rd Qu.:4.000
 Max.   :5.00   Max.   :5.00       Max.   :5.00    Max.   :5.000   Max.   :5.000   Max.   :5.00   Max.   :5.000
 Delivery_Communication Environmental_Impact weather_Condition Doorstep_Delivery Delivery_Driver Location_Accuracy
 Min.   :1.000          Min.   :1.000        Min.   :1.000     Min.   :1.00      Min.   :1.00    Min.   :1.000
 1st Qu.:2.000          1st Qu.:2.000        1st Qu.:2.000     1st Qu.:2.00      1st Qu.:2.00    1st Qu.:2.000
 Median :3.000          Median :3.000        Median :3.000     Median :3.00      Median :3.00    Median :3.000
 Mean   :2.995          Mean   :2.705        Mean   :2.945     Mean   :3.18      Mean   :3.09    Mean   :3.185
 3rd Qu.:4.000          3rd Qu.:3.000        3rd Qu.:4.000     3rd Qu.:4.00      3rd Qu.:4.00    3rd Qu.:4.000
 Max.   :5.000          Max.   :5.000        Max.   :5.000     Max.   :5.00      Max.   :5.00    Max.   :5.000
 Privacy_Issue  Product_Safety   Extra_Money    Switched_Retailers    Ratings
 Min.   :1.00   Min.   :1.000   Min.   :1.000   Min.   :1.00       Min.   :1.00
 1st Qu.:2.00   1st Qu.:2.000   1st Qu.:1.000   1st Qu.:3.00       1st Qu.:2.00
 Median :3.00   Median :3.000   Median :2.000   Median :4.00       Median :3.00
 Mean   :2.93   Mean   :3.055   Mean   :1.795   Mean   :3.83       Mean   :3.15
 3rd Qu.:4.00   3rd Qu.:4.000   3rd Qu.:2.000   3rd Qu.:5.00       3rd Qu.:4.00
 Max.   :5.00   Max.   :5.000   Max.   :3.000   Max.   :5.00       Max.   :5.00
```

Figure 19

The values are normalised in the segmentation process after investigating the dataset. Hierarchical clustering is the clustering technique that is used. Creating a hierarchy of groupings is the goal of the clustering method known as hierarchical cluster analysis (Köhn & Hubert, 2014). It is a specific form of unsupervised learning method that may be used to look at the underlying structure of data, identify patterns, and group items together that are related. After that, Euclidian distance is used to calculate the distance matrix. Now, a dendrogram that has been divided into five clusters is shown using the clustering technique.

```
> table(cluster)
cluster
 1  2  3  4  5
41 64 26 54 15
```

Then the clusters are added to the original dataset and the segment is calculated in percentages which is shown below

```
> percentages

   1    2    3    4    5
20.5 32.0 13.0 27.0  7.5
```

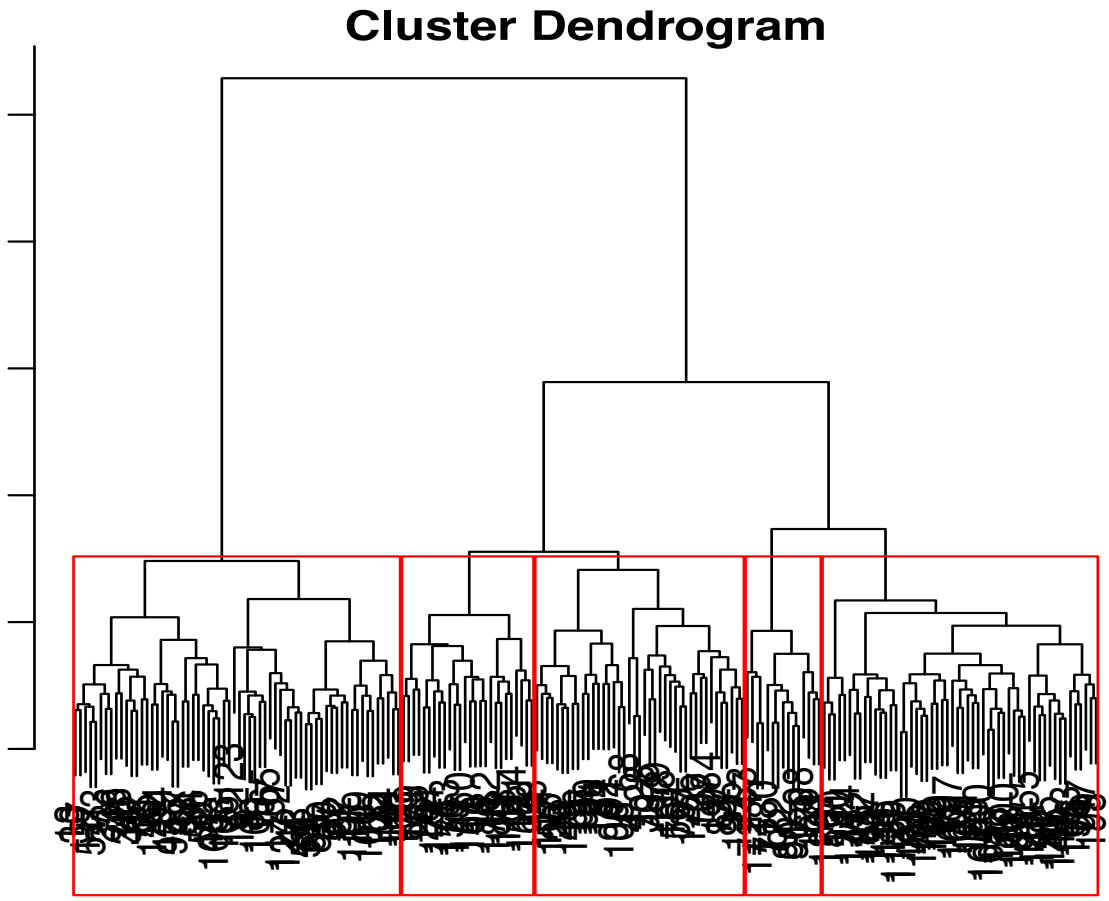


Figure 20

cluster	Age_M	Education_M	Gender_M	Occupation_M	Income_M	Order_freq_M	Location_M	Flexibility_M	Timely_Information_M	Product_Quality_M
1	1.780488	2.439024	0.8292683	1.780488	1.829268	2.560976	1.658537	2.731707	2.804878	3.195122
2	1.843750	2.359375	0.5000000	1.750000	1.734375	2.890625	1.625000	4.093750	3.984375	4.171875
3	1.846154	2.230769	0.3076923	2.307692	2.076923	1.384615	1.692308	1.500000	1.923077	3.461538
4	1.740741	2.240741	0.3333333	2.055556	2.222222	1.611111	1.833333	1.685185	2.000000	2.074074
5	1.200000	1.866667	0.2000000	1.400000	1.400000	3.266667	1.466667	2.000000	1.866667	2.000000

Mean Values for Clusters

Delivery_Time_M	Delivery_Range_M	Delivery_Cost_M	Package_Quality_M	Delivery_Communication_M	Environmental_Impact_M	weather_Condition_M
2.536585	2.853659	2.634146	3.146341	2.902439	2.731707	2.658537
4.125000	4.046875	3.593750	4.156250	4.062500	3.609375	3.796875
2.500000	3.615385	3.307692	3.846154	2.692308	1.730769	3.000000
1.685185	1.851852	1.629630	1.981481	2.277778	2.314815	2.370370
2.066667	2.066667	1.733333	1.933333	1.800000	1.866667	2.066667

Doorstep_Delivery_M	Delivery_Driver_M	Location_Accuracy_M	Privacy_Issue_M	Product_Safety_M	Extra_Money_M	Switched_Retailers_M	Ratings_M
3.317073	2.926829	3.073171	2.926829	3.024390	2.097561	3.536585	3.000000
4.281250	4.015625	4.203125	3.890625	4.140625	2.140625	3.531250	4.312500
3.192308	3.615385	3.461538	2.576923	3.038462	1.730769	4.000000	3.115385
2.129630	2.185185	2.277778	2.277778	2.111111	1.092593	4.703704	1.981481
1.866667	1.933333	1.933333	1.800000	1.933333	2.133333	2.466667	2.866667

Figure 21

The statistics presented above are the outcomes of the cluster analysis, which provides the mean value for each survey questionnaire. The results are transformed into segments with comparable patterns, which are then analysed in further detail.

Customer segmentation

Cluster 1: Convenience Seeker

Age 18 to 25, majority with bachelor's degrees, all actively enrolled in school, with an annual income of more than £1000, and mostly living in rural locations. Women make up around 82 percent.

The preference for ease is shared by frequent online buyers who place orders two to three times every week. With a mean rating of 2.73, these consumers find the ability to schedule a delivery to be a little unsatisfactory. With a mean value of 2.80, 2.53, 2.85, 2.63, 2.902, 2.731, 2.6585, 2.926, 2.926 respectively, they are somewhat dissatisfied with timely information, delivery time, delivery range, delivery cost, delivery communication, environmental impact caused by the delivery vehicle (like noise, air, and sound pollution), ability to receive orders during adverse weather conditions, the delivery driver attitude, and their privacy concern. A total of 2.097% of consumers are willing to pay more for faster delivery. When asked whether they have switched merchants in the past or would switch in the future if the delivery service is not supplied efficiently, around 3.53% of consumers respond "neutral." With a mean value of 3.19, 3.14, 3.31, 3.073, 3.024 correspondingly, these consumers' experiences with product quality, package quality, doorstep delivery, location accuracy, and product safety are rather indifferent. Customers from this cluster gave their whole experience a mean score of 3, or three out of five.

Cluster 2: Money Savers

Demographic: Age 26-35

Behaviour: Consistent internet consumer who values privacy above all else and wants packages delivered quickly. Customers from this cluster are mostly between the ages of 26 and 35, and 50% of them are female bachelor's students. Their annual income exceeds £1000, they value privacy highly, and they wanted to pay less for the delivery service. Additionally, some clients place orders a few times a week. With a mean value of 4.093,3.98,4.171,4.125,4.046,4.156,4.062, 3.79, 4.281, 4.015, 4.203,4.1406 the customers are somewhat satisfied with their delivery experience in terms of delivery flexibility, timely information, product quality, delivery range, package quality, delivery communication, ability to receive orders in adverse weather conditions, and product safety respectively.

Customers are concerned about their privacy and are anxious that they are paying too much for the delivery service given that they regularly make purchases. With a mean score of 3.59, these consumers are somewhat unsatisfied with the price they are paying for delivery service. With a mean value of 3.531, they are mostly content with the service process, but one or two points of frustration will cause them to switch merchants. A little more than 2.14% of consumers are willing to pay more for faster delivery. Customers from this cluster gave their delivery service an overall rating of 4 out of 5.

Cluster 3: Busy people
Demographic: Age 26-35
Behavioural: Online buyers that are picky prioritise convenience, quality, and value while also considering the environment. All of the cluster's clients have master's degrees and are highly educated. They are also all employed. The monthly income of the 30% of clients who are women ranges from £1000 to £3000. They all have weekly orders and are located in rural regions. With a mean value of 1.50, 1.92, and 1.73, respectively, their entire experience is quite unsatisfactory in terms of delivery schedule flexibility, timely information, and environmental effect. With a mean score of 2.50.2.69,2.57, they are somewhat unsatisfied with the cost of delivery, the communication during delivery, and the privacy concern. Regarding product safety, location accuracy, delivery range, pricing, package quality, weather, doorstep delivery, and delivery drivers' attitudes, they have no strong opinions. These clients are unwilling to pay more for a faster delivery. These consumers have evaluated their whole experience as a 3 out of 5, and they have firmly agreed that they would boycott the stores if they don't get quick delivery.

Cluster 4: Quality seekers
Demographic: Age 36-45
Behaviour: Occasional internet customers choose convenience above other factors including price, quality, and shipment security. Most of the clients in this cluster are employed and come from cities. Their entire experience has been quite unsatisfactory, with mean values of 1.83, 1.685, 1.65, 1.85, 1.62, and 1.98 for flexibility, delivery time, delivery range, delivery cost, and package quality, respectively. With a mean value of 2.0, 2.07, 2.27, 2.31, 2.37,2.12, 2.18, 2.27, 2,27, and 2.11, respectively, they are somewhat dissatisfied with timely information, product quality, delivery communication, environmental impact, ability to receive orders in harsh weather, doorstep delivery, delivery driver, location accuracy, privacy issue, and product safety. These clients are prepared to spend more, and they firmly agreed that if the shops cannot provide efficient delivery, they would move to another store. Their total satisfaction is 1.98% out of 5.

Cluster 5: Occasional buyers
Demographic: Age >45
The rare internet consumer appreciates a positive overall delivery service experience. 20% of women who are self-employed and have monthly incomes of more than £1000 seldom make purchases. These folks reside in isolated, rural places. With a mean score of 1.86, 1.73, 1.93, 1.80, 1.86, 1.86, 1.93, 1.80, 1.93, respectively, these customers are extremely dissatisfied

with the overall experience, including timely information, delivery cost, package quality, delivery communication, environmental impact, doorstep delivery, delivery driver attitude, location accuracy, privacy issue, and product safety. They evaluated their total delivery service at 2 out of 5 and may have considered paying more.

User persona's

Further, the user personas are examined in order to identify the primary difficulties that users face in general, as determined by survey and customer segmentation.

User persona 1

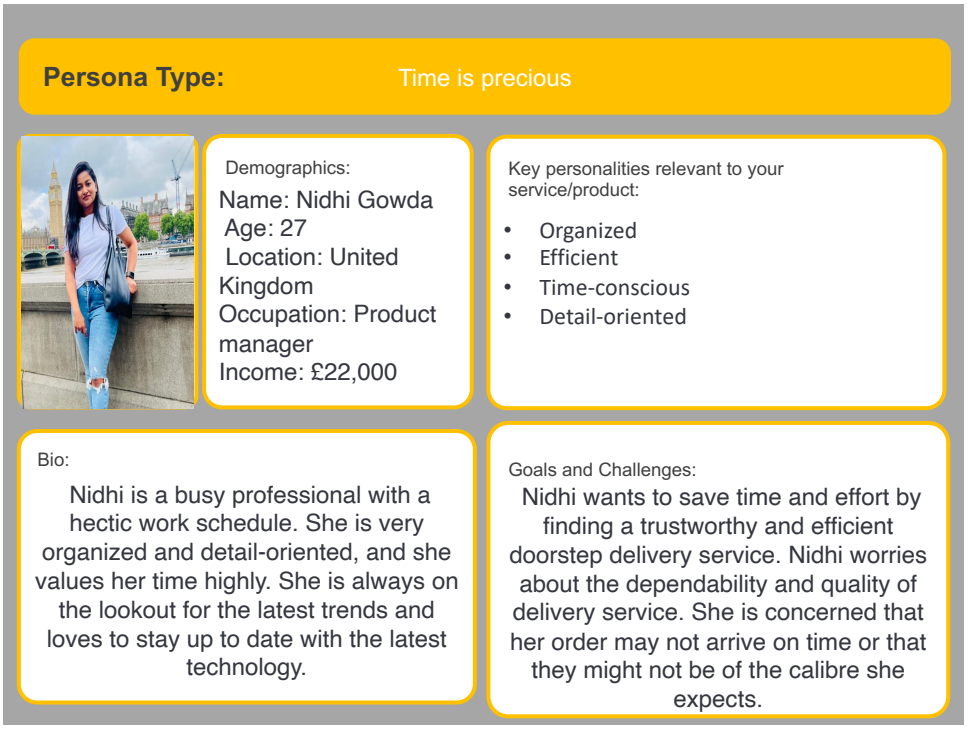


Figure 22

The delivery time is crucial for the first user persona. Since the user is a busy professional with no time to shop in person, she desires that her item be delivered as soon as possible. Nevertheless, she is disappointed with standard delivery services because of the lengthy shipment procedure.

User persona 2

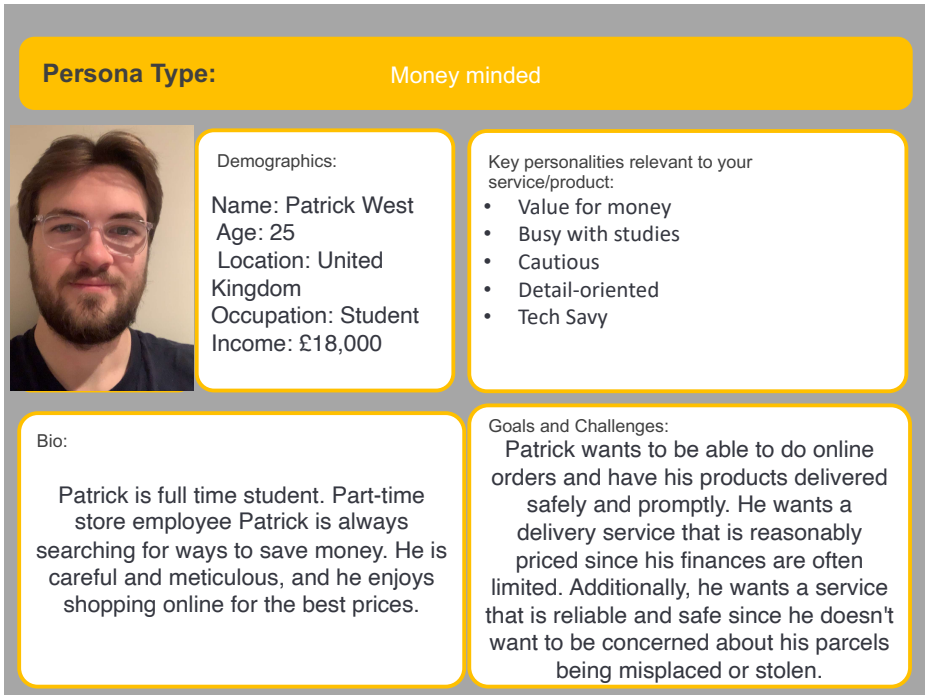


Figure 23

The second user persona is Patrick West, who is financially astute. Patrick is unwilling to pay a hefty fee for delivery service. Since last-mile shipping is expensive, merchants may lose this customer.

User persona 3:

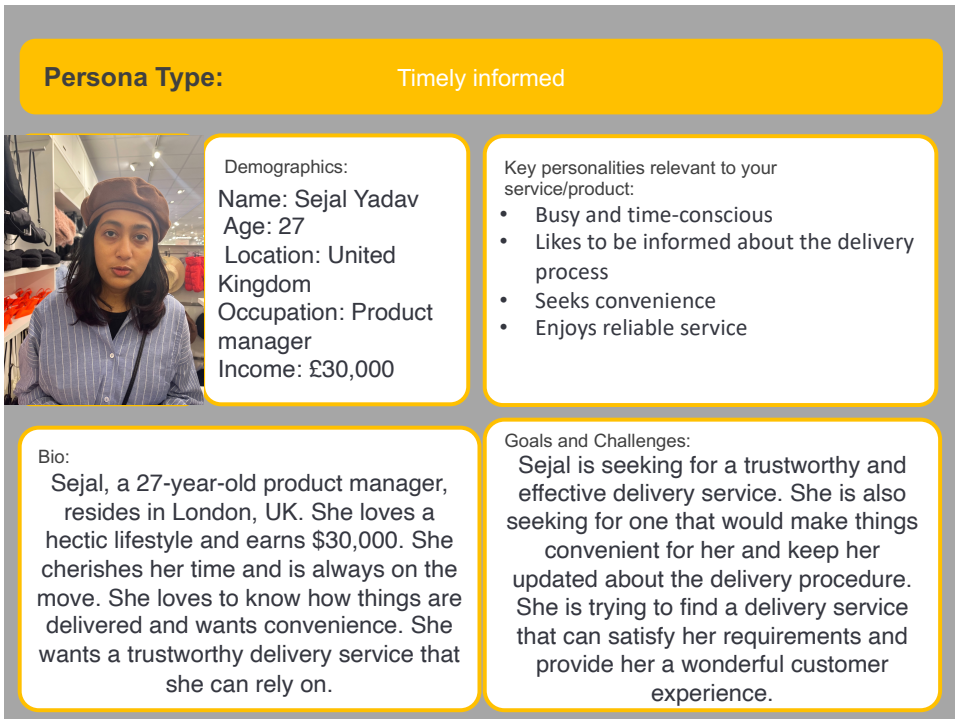


Figure 24

Sejal Yadav, our third user persona, expects timely information. Since this user is eager to follow her order in real time, she is concerned about the delayed delivery status update. If this consumer does not receive regular updates, she may stop purchasing items online and instead opt to purchase the identical goods at a shop.

User persona 4:

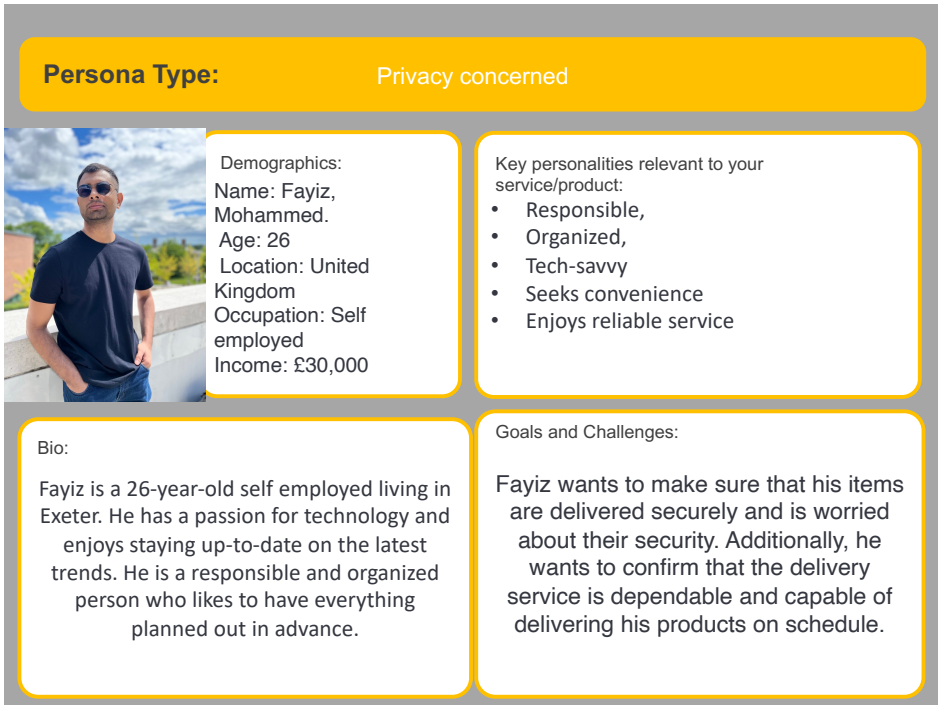


Figure 25

Mohammed Fayiz, our final user persona, is anxious about his privacy. He is concerned about the safety of delivery.

Customer Journey Map

During their customer journey, customers pay close attention to even the smallest details, and this may have a significant impact on how they evaluate the entire experience. (Bolton, Gustafsson, McColl-Kennedy, Sirianni & Tse, 2014). This highlights the need of seamless systems that allow users to navigate from touchpoint to touchpoint without meeting obstacles, hence promoting seamless flow (Tax, McCutcheon & Wilkinson, 2013). As part of service

innovation in e-commerce last mile delivery, all touchpoints up until the e-customer receives the item and the experience is complete must be considered.

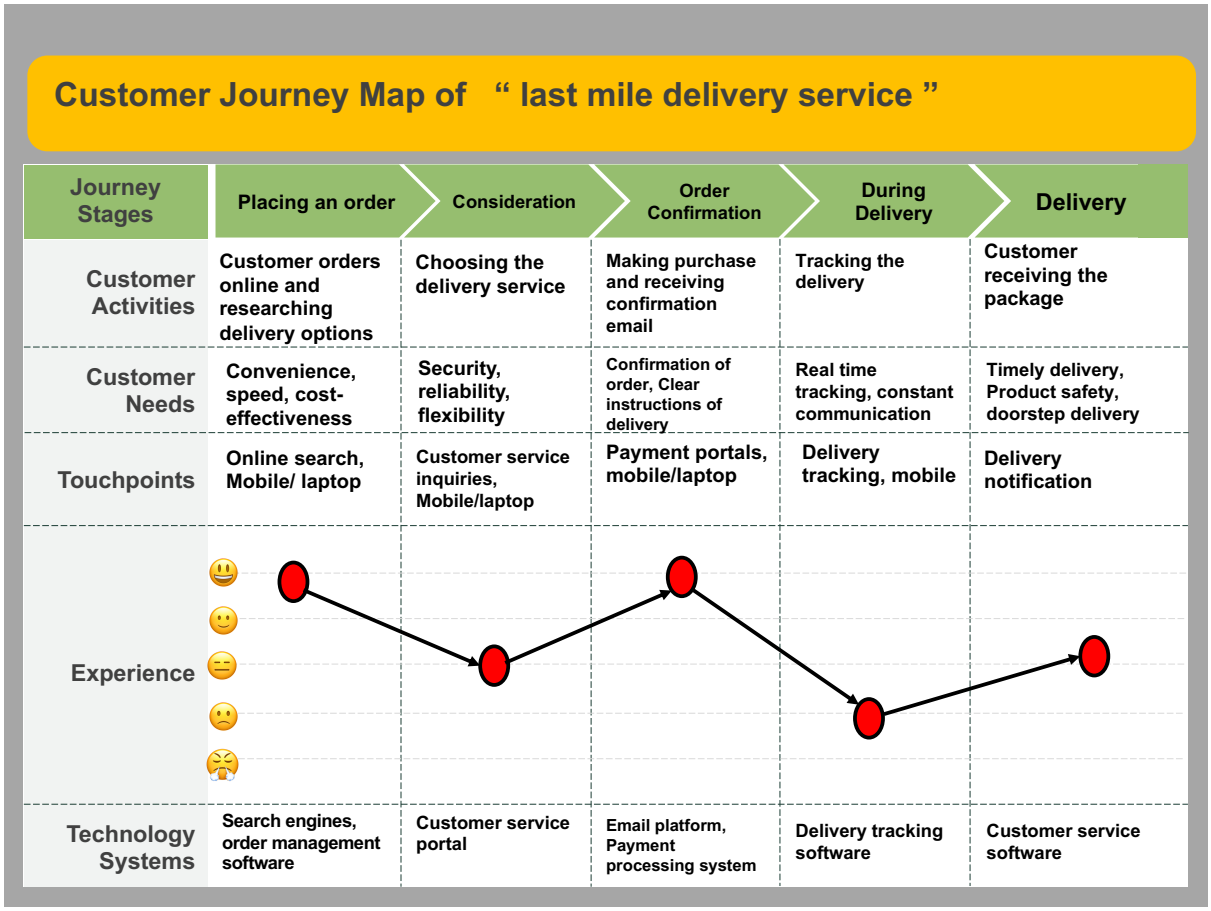


Figure 27

Current Service blueprint

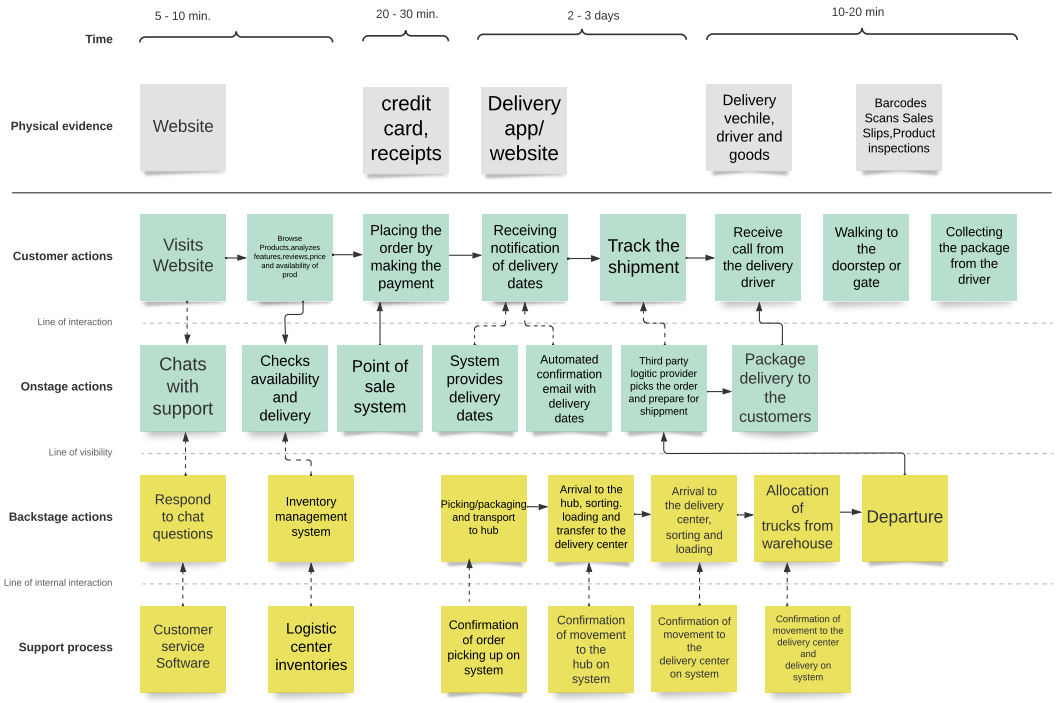


Figure 28

Figures 1 and 2 show the customer journey and service experience of existing last-mile delivery services. Customer journey map and service blueprint are briefed further.

Before buying online, shoppers evaluate pricing, availability, and delivery. Users give personal and delivery information. Buyers get purchase confirmation emails. From the above, consumers want economical, flexible, and dependable delivery choices. Shipping costs and projected arrival time disappoint them. Online ordering is solely done for quick home delivery. The confirmation email ensures that the money was received, and the transaction verified before the item sold out. Next is the hardest. Customers are concerned and dissatisfied since shipping statuses aren't updated for one or two days. Retailers ignore client orders calls. "Out for delivery" may appear after 4-5 days, leaving buyers nervous. Customers must reschedule their day to retrieve the items as there is no delivery window. After selecting a product, the delivery driver will make many stops before delivering it. If the customer's phone doesn't work or they're at work, the shipment may be returned to the warehouse. COVID-19 bans doorstep delivery. The client must pick it up from the delivery driver at the

front gate. In few cases, customers also receive package theft issues. After the delivery, typical delivery customers are unhappy with their last-mile delivery experience.

User Problem statement

1. **Late deliveries:** One of the most common complaints consumers have about last-mile delivery services is delayed deliveries. Several factors, including traffic congestion, wrong addresses, and poor route design, may contribute to this.

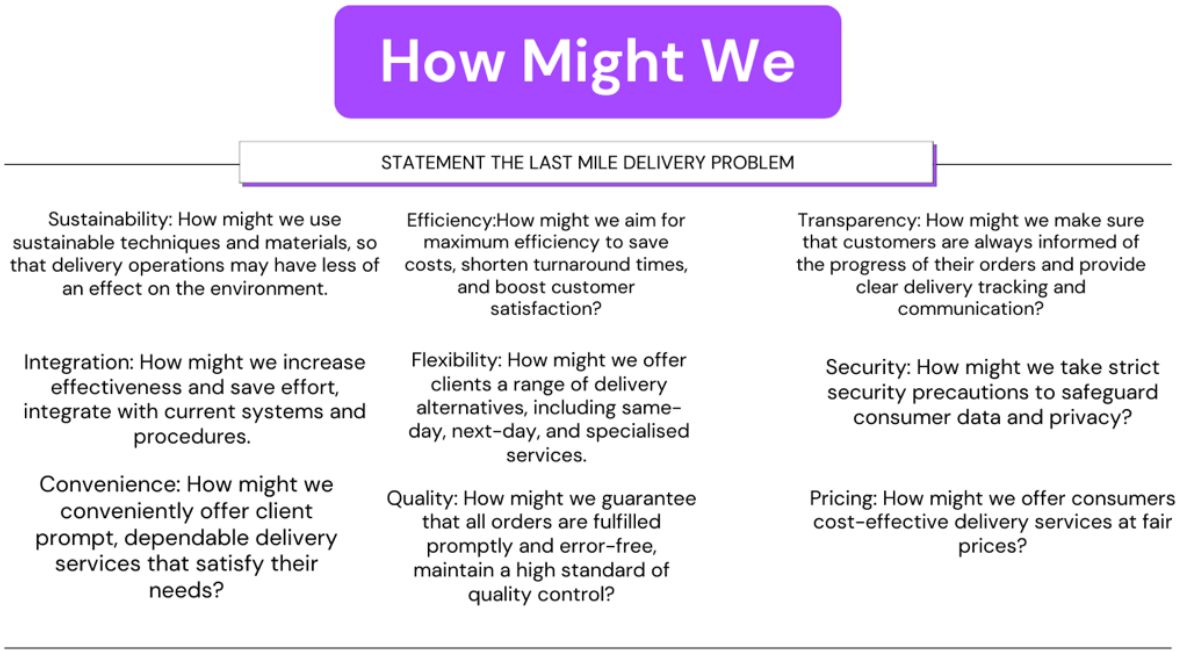
2**. Poor communication**: Poor communication is another issue clients have with last-mile delivery services. Customers often struggle to touch with a person when they have an issue or to seek updates on their delivery.

3. **Damaged goods**: Occasionally, customers receive their goods in terrible condition. This may be the consequence of improper handling, insufficient packaging, or a lack of quality control.
4. **Faulty tracking**: Due to erroneous tracking information, it may be difficult for clients to establish the whereabouts of their delivery at any given time.

5.High prices: Last-mile delivery services may be expensive, especially for small businesses. This may impede a company's capacity to offer inexpensive shipping rates.

How might we statement (Define)

According to Fessler (2017), the "How Might We" (HMW) method simplifies and makes understanding issue solving and coming up with answers easier. The following figure shows how the general problems of the existing last mile delivery can be satisfied.



Ideation stage

Brainstorming

After the define stage, the end users' primary problems were the previous delivery system, which emits carbon into the atmosphere, late delivery, lack of real-time tracking, exorbitant delivery prices, poor product safety, and privacy concerns. After brainstorming with Mr. James Campbell, managing director of BMT, we came up with many ideas. Due to price, speed, versatility, and safety, drones might transport packages. Drone last-mile delivery is cost-effective. Drone delivery is cheaper than truck or bike delivery since it requires fewer workers and resources. Drone delivery is also quick. Drones can deliver products faster and improve supply chains. Drones may carry several packages. Due to human error, drones are safer than conventional delivery systems.

S.W.O.T Analysis of drone delivery service

General problems faced in drone delivery service

1.**Safe dropping location**: Goods left outside front doors are susceptible to theft, but packages placed in the backyard are susceptible to animal damage. Cables, heavily populated urban areas, and trees all provide additional risks.
2. **Drone misuse:** Commercial drones are already being damaged by people. The techniques include firing, launching more drones, or even hurling rocks.
3.**Noise:** The noise of the drone as it flies past or lingers 20–30 feet above the ground while delivering has been one of the main public concerns throughout testing of drone delivery around the world.
4. **Range:** The weakest link in any electric system continues to be the batteries.
5. **Trees and power lines:** Drones must avoid obtuse telephone cables and tiny power lines.

Some companies have already found some common solution for this problem faced in drone delivery service like DHL, Alphabet, Amazon prime air etc the common solution is as follow,

1.Parachute—used in sparse terrain in poor nations (such as Zipline) but not accurate enough for commercial or residential package delivery and dangerous.

2. Drone theft and damage prevent domestic drone landings. DHL, Daimler, and Matternet deliver to vehicles and lockers, but Amazon wants designated landing zones.

3. Alphabet and others drop cargo with unguided winches. The drone had to hover, producing a lot of noise, and putting it at risk.

The only solution

SPARROW, a lightweight, agile hanging robot, is BMT's fourth option. Third-party drones can utilise it. SPARROW is the sole solution for unexpected, delicate situations.

SPARROW allows drones to fly silently and safely at 400 feet above ground level, far over objects and people. SPARROW rapidly and discreetly descends with the delivery from above by unwinding its strong, low-profile line, releasing the box, then "rewinding" back to the drone. Side-facing fans provide correct horizontal force to propel packages autonomously.

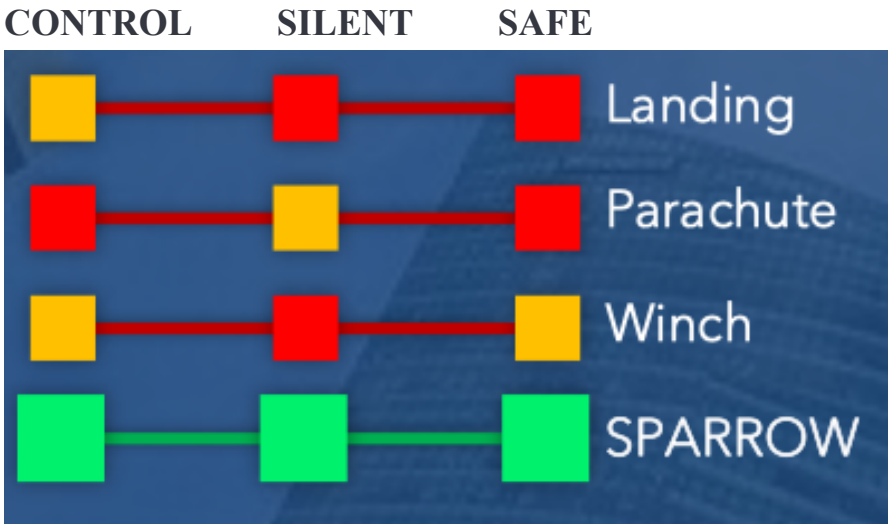
The technique combines the low-impact benefits of a micro-UAV at ground level with the ideal speed, range, and payload of the uncompromised UAV safely at altitude. SPARROW drone delivery is safer, quieter, and more controlled, lowering product prices and improving consumer experiences.

Concept selection matrix

Concept	**Weighting**	**Parachute**		**Landing**		**Winching**		**SPARROW**	
Criteria	**Mark**	**Score**	**Total**	**Score**	**Total**	**Score**	**Total**	**Score**	**Total**
Safe	**4**	**1**	**4**	**1**	**4**	**2**	**8**	**3**	**12**
Noise	**5**	**2**	**10**	**1**	**5**	**1**	**5**	**4**	**20**
Control	**3**	**1**	**3**	**3**	**9**	**2**	**6**	**2**	**6**
	Total		**17**		**18**		**19**		**38**

An approach for making decisions or assessing the possibilities of many choices is decision matrix analysis (Okudan & Tauhid, 2008). It is a quantitative approach that multiplies the weights and scores of the variables and alternatives to get the final score. From the above

table we can clearly see that SPARROW is standing out of all other concepts with a total score of 38.



Disruptive benefits

Safe: SPARROW may approach humans safely if the risky drone is maintained high enough to maintain communication and is equipped to drop a parachute if it fails.

Silent: SPARROW approaches target silently as the noisy drone hovers above.

Controlled: SPARROW can hit targets in windy conditions while staying steady near obstacles. This optimises the UAV for payload rather than size.

SPARROW can accomplish all three conceivable problems. The Sparrow unit is secure, compact, quiet, resistant to small-arms threat, and enables the noisy UAV to remain aloft (400 ft or higher). As the SPARROW does not require cameras (but rather LIDAR), the lowered noise reduces nuisance, is healthier for animals and birds, and enhances safety. Consequently, a prototype of this idea has been developed and tested with various stakeholders.

Prototyping stage

SPARROW prototype

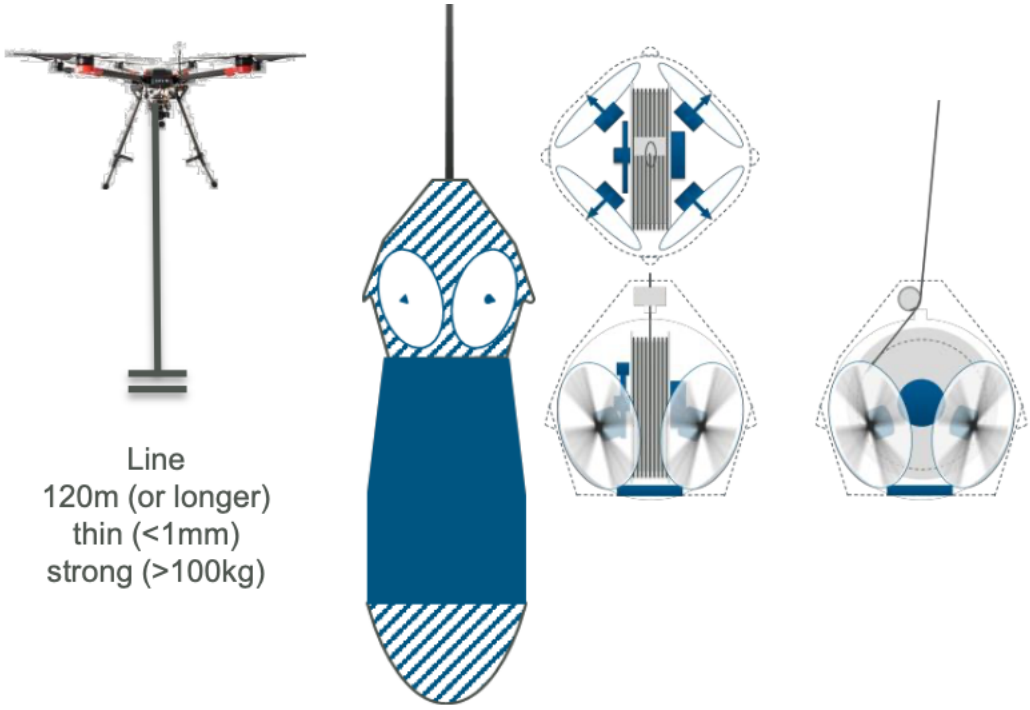


Figure 29

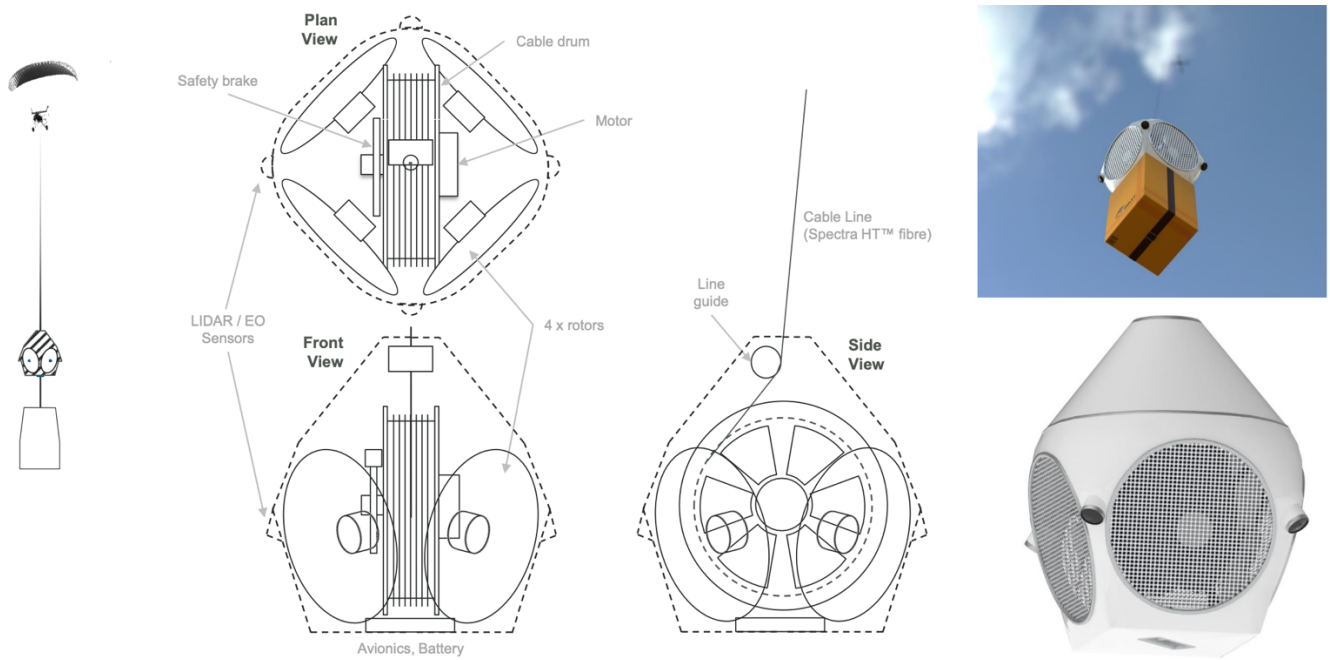


Figure 30

SPARROW's primary components are shown above. Safety brake, cable drum, motor, LIDAR/EO sensors, avionics, battery, line guide, and cable line are the essential components.

Honeywell International Inc. created Spectra fibre, a UHMWPE cable. The SPARROW's bottom holds the box instead of the drone. SPARROW uses innovative tactics to make window and post box delivery impossible (large drones landing, unguided winch drop, parachute). SPARROW hides drones from sight, sound, and range. SPARROWs are smaller and easier to ruggedize than UAVs. Instead of flying low, SPARROW keeps the drone high enough to avoid being heard. APARROW might deliver as efficient fixed-wing drones circle overhead. The drone may avoid obstacles while the payload descends and the SPARROW rises.

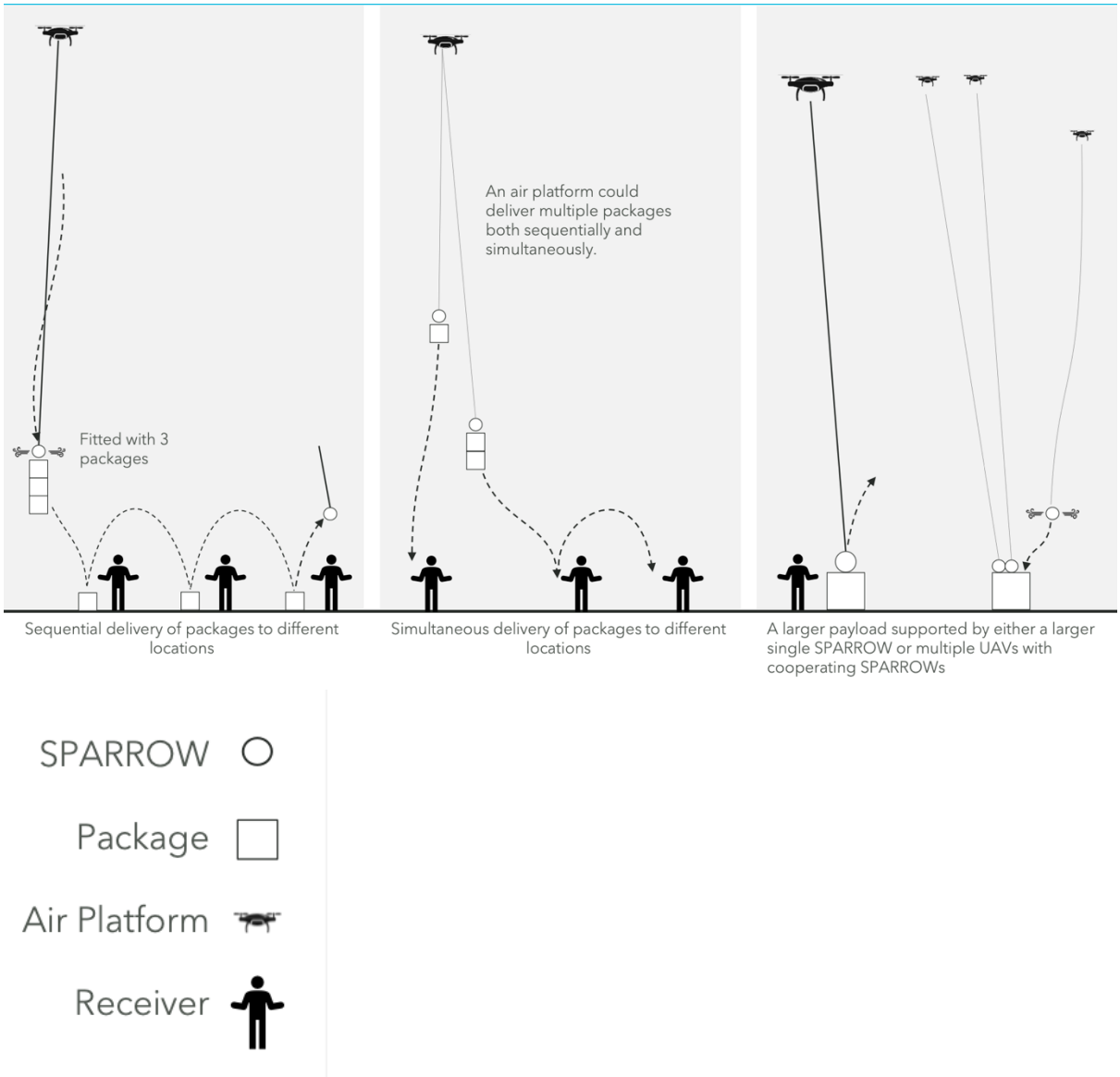


Figure 31

SPARROW distributes many deliveries as seen above. The SPARROW delivers three parcels sequentially. SPARROW helps drones deliver many products at once by boosting payload and delivery efficiency. Drones may also deliver many packages simultaneously. If the

product is heavy, a bigger SPARROW or numerous UAVs with collaborating SPARROWS may sustain it.

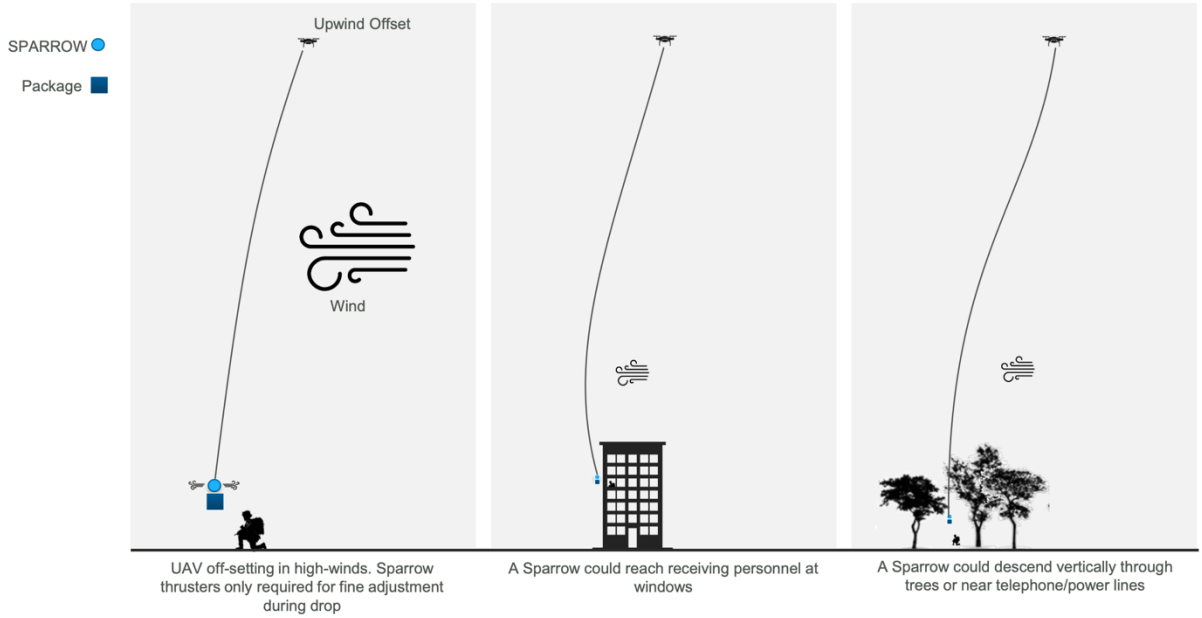


Figure 32

SPARROW must withstand 15m/s (30kts) at the surface and 30m/s (60kts) at height to be practical. The SPARROW idea uses wind to return the UAS and payload to the destination by offsetting the UAS upwind from the destination. Thus, only wind variability affects SPARROW horizontal thrust.

Testing stage

PROTOTYPE Testing

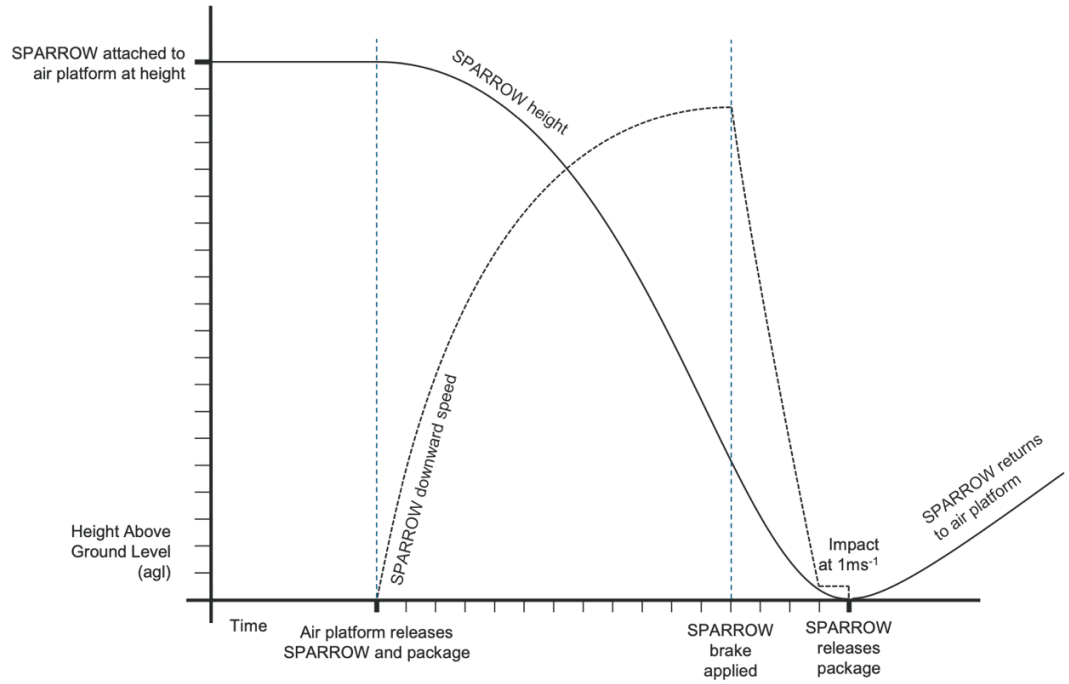


Figure 33

SPARROW drop profile seen above. X is time and y are height above ground level. The SPARROW is on a 400-foot air platform. The first blue dotted line depicts SPARROW and package air platform launches. The SPARROW releases the package 1ms after returning to the air platform after applying brakes at the second dotted line.

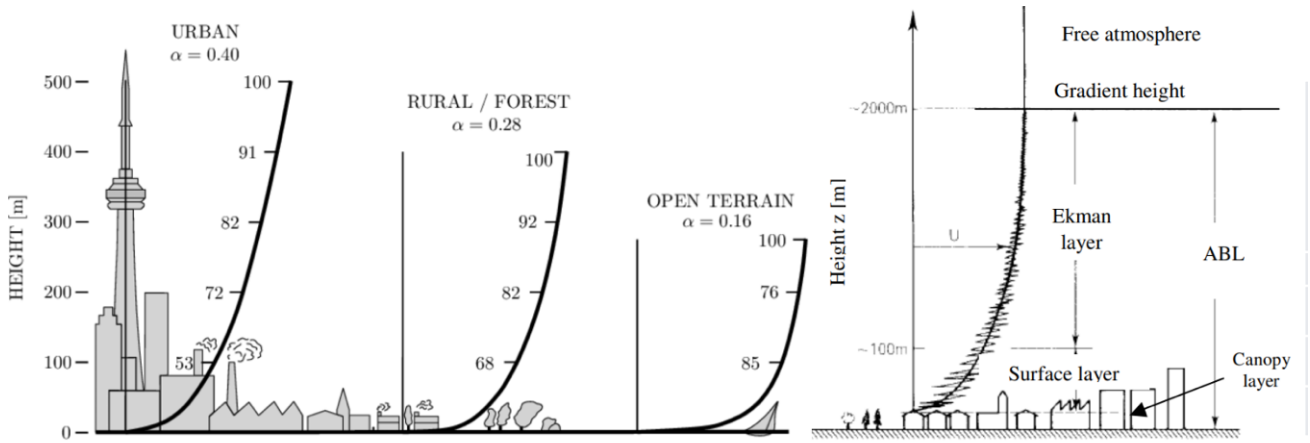


Figure 34

SPARROW drop profile seen above. X is time and y are height above ground level. The SPARROW is on a 400-foot air platform. The first blue dotted line depicts SPARROW and package air platform launches. The SPARROW releases the package 1ms after returning to the air platform after applying brakes at the second dotted line.

First prototype with 20cm diameter propellers will produce ~10N of thrust in any direction.

Surface Wind (m/s)	Drag on SPARROW (0.04m²) (N)	Drag on Package (0.08m²) (N)	***Mean wind up along length of line (160%)***	Mean Drag on 1m of line	*Max Height with Sparrow vertically below with 10N of thrust in any direction*
0m/s	0	0	*0m/s*	0	∞
5m/s (10kts) ***Median***	0.3	0.6	*8m/s*	0.038	***870ft***
10m/s (20kts) ***90% of conditions***	1.3	2.3	*16m/s*	0.1536	***215ft***
15m/s (30kts) ***98% of conditions***	2.7	5.2	*24m/s*	0.3456	***95ft***

The first SPARROW prototype with 20cm propellers generated 10N thrust in either direction. SPARROW and package have no drag at 0m/s, although this is unusual. If the surface wind is 5m/s (10kts) median, the drag on SPARROW was 0.3N thrust, drag on package was 0.6N thrust, mean wind up a long length of line was 8m/s, mean drag on 1m of line was 0.38 N, and maximum height with SPARROW vertically below with 10N of thrust in either direction was 870ft. In the above table, we tested for 10m/s surface wind, which is 90% of the wind condition, and 15m/s, which is 98%.

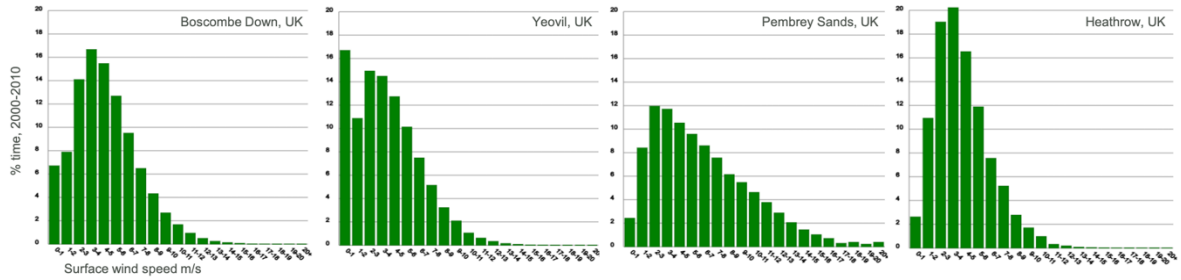


Figure 35

The above graph depicts the surface wind speed in metres per second for Boscombe down, Yeovil, Pembrey Sands, and Heathrow, United Kingdom, from 2000 to 2010.

To conclude, all the five stages of the design thinking process is vital and the whole purpose of the research is concluded. Ultimately, the BMT's SPARROW drone delivery technology is analysed to serve customer needs and expectations.

SPARROW system design and service

In addition, the report examines the service outcome as well as the manner in which the BMT SPARROW provides service to the customers. The system architecture and scenario are both drawn from the corporate report that was created by BMT.

Service scenario

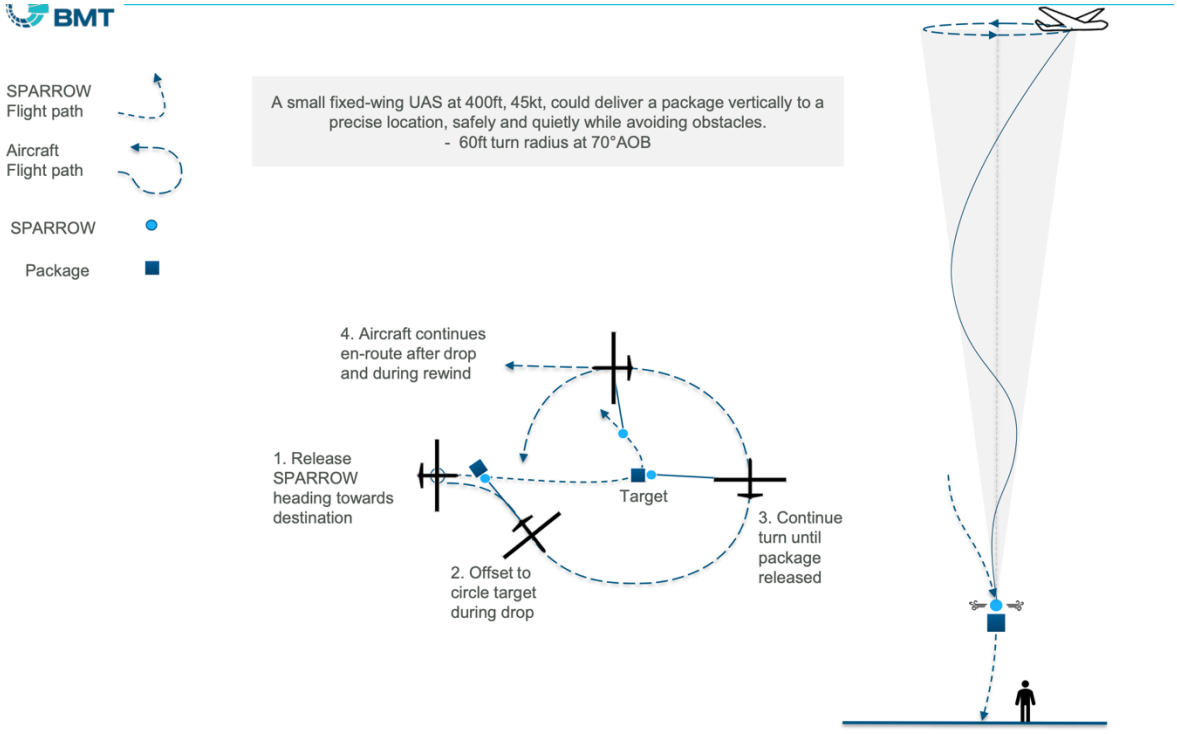
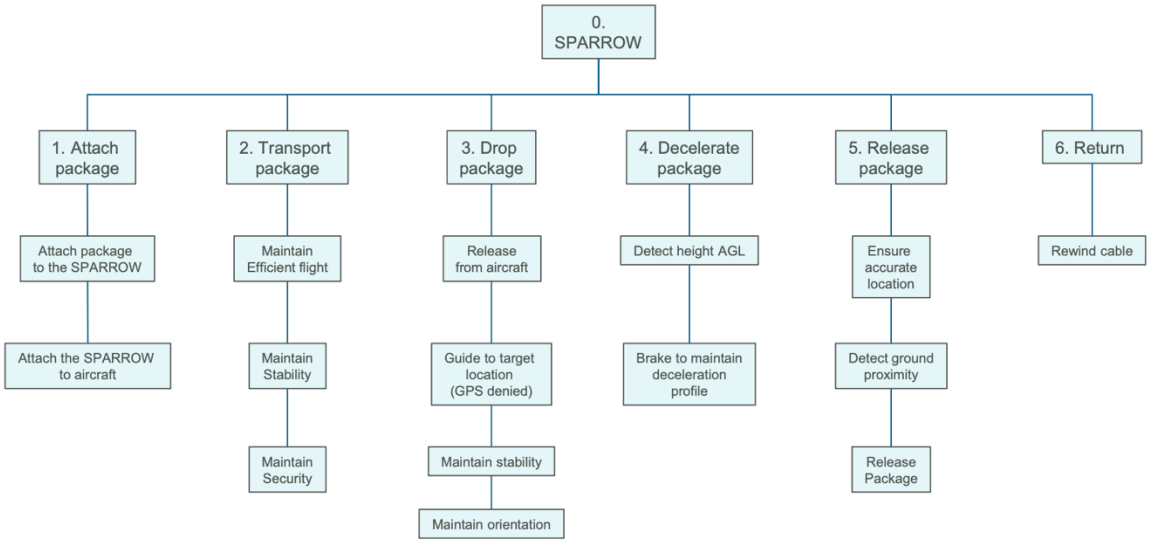


Figure 36

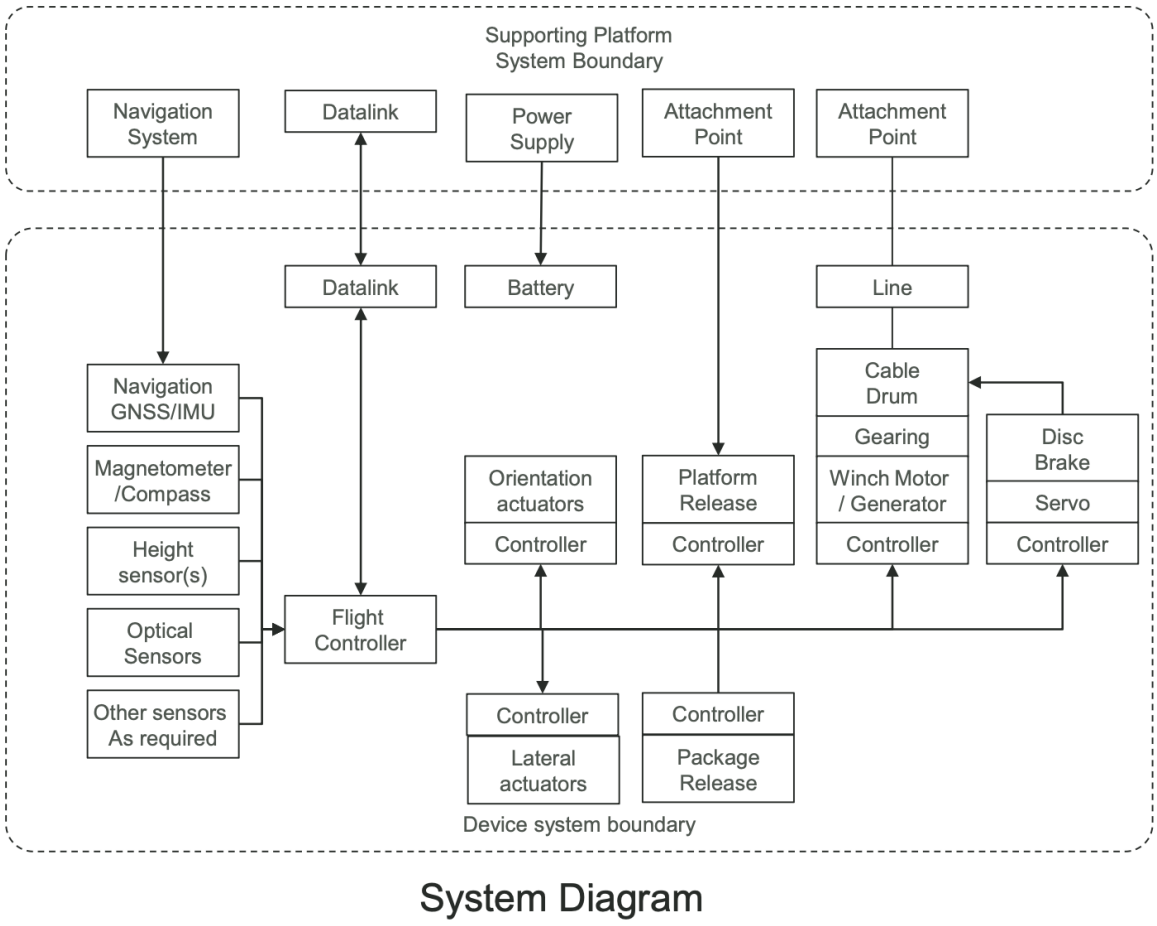
The above graphic shows how the SPARROW delivers packages to consumers. A 400ft fixed wing UAS could securely and discreetly deliver an item vertically. The winch motor, cable drum, gearing, brake, and height sensors are now placed in the SPARROW unit at the bottom end of the line, with the package, rather than under the aircraft, allowing the package to descend at high speed with a perfectly controlled approach to the ground. The aeroplane will release the SPARROW with the package to the location. In the second stage, the aircraft circles the target during the drop and continues to circle until it drops the cargo. At 70-degree AOB, the aircraft will turn 60ft.

SPARROW functional breakdown



This figure shows SPARROW's functional breakdown. Instead of the drone, the cargo is attached to the SPARROW and fastened to the plane. A flight controller safely delivers the merchandise from the warehouse to the client. The last step is to release the cargo from the plane and use a compass to guide it to its destination. After releasing the SPARROW and detecting height, the aircraft deploys disc brakes to maintain descent. After validating location and ground proximity, SPARROW will release the item. Finally, the connection will connect the sparrow to the aircraft and return to the home base.

SPARROW System diagram



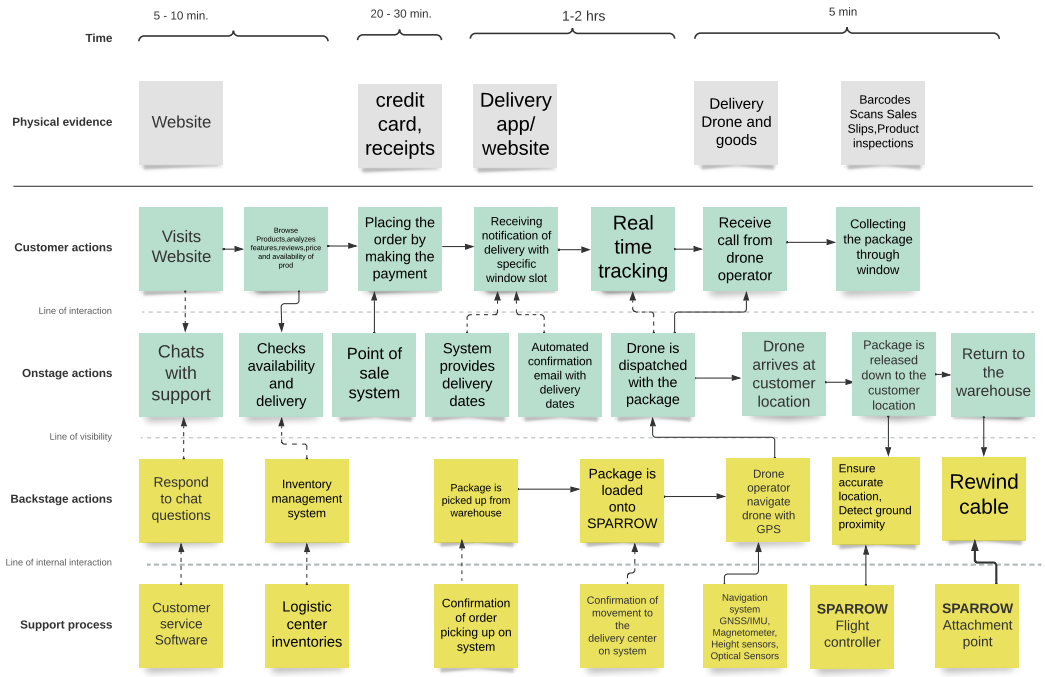
System Diagram

The SPARROW system schematic shown above. The supporting platform system boundary includes navigation, datalink, power supply, and attachment point. Navigation GNSS/IMU technology gives drone location, velocity, and attitude. GNSS receivers measure drone latitude, longitude, and altitude. IMUs track drone acceleration, angular rate, and direction. GNSS and IMU data allow accurate three-dimensional navigation in dynamic situations. Height sensors measure the drone's altitude using air pressure. Light-based sensors detect surfaces and impediments. Map, navigate, and avoid obstacles using them. The drone's flight controller connects all sensors. First are orientation and lateral controls. Orientation actuators govern drone pitch and roll, whereas lateral actuators control left and right motion. Both pilot the drone. Platform release and package release controllers use SPARROW. Attachment is the cable drum, gearing, winch motor, and controller line.

Result & Description of the model

In the subsequent report, the service plan, customer journey map, and ultimate solution that are provided by the BMT's SPARROW drone delivery system are detailed. The solution closes the majority of the loopholes that exist between the client and the delivery service.

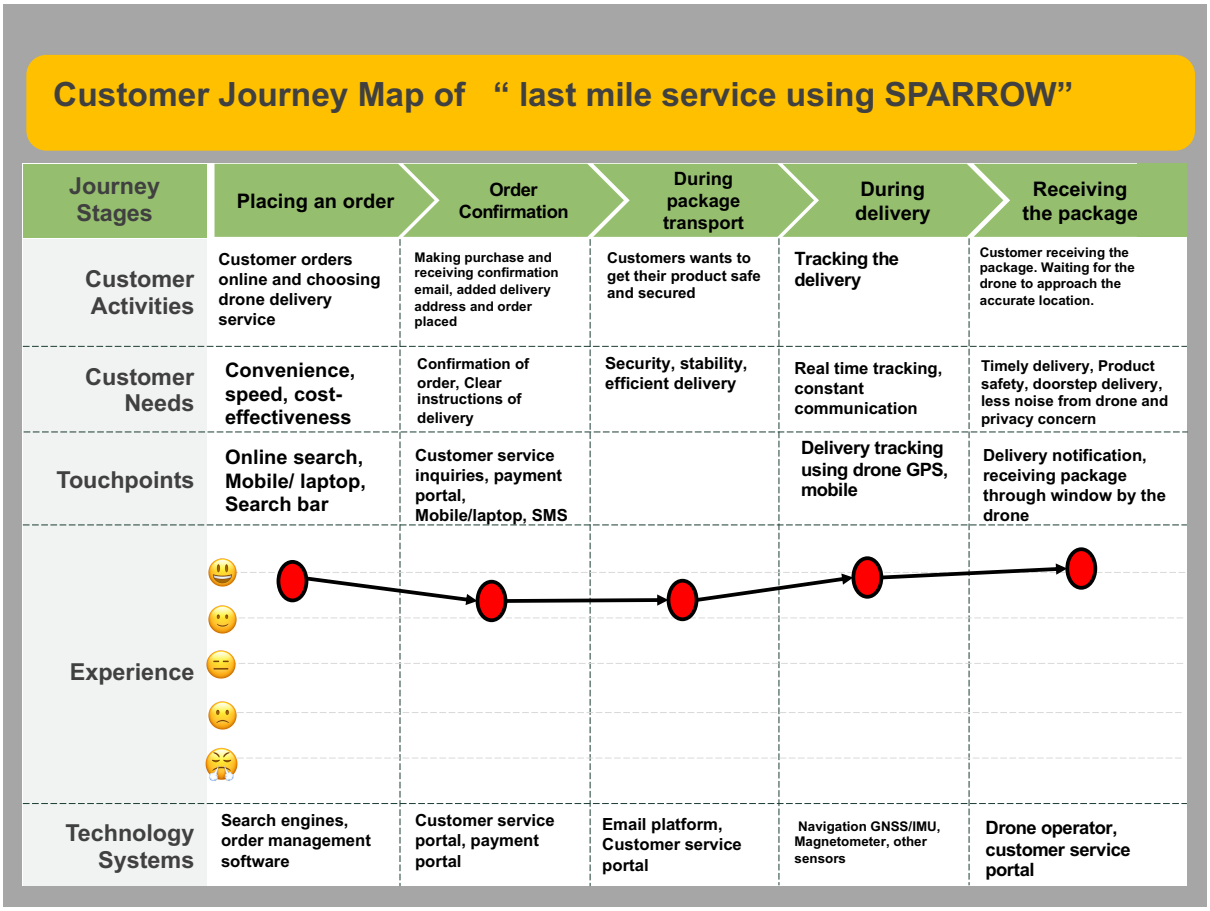
New proposed Service blueprint



The above picture shows the revised service blueprint if SPARROW is adopted. The consumer will explore and buy like before. Visit the website, buy anything, and get an order confirmation. After confirmation, the SPARROW performs. The store sends consumer data to the drone delivery logistics provider after order reception. After receiving confirmation, the warehouse worker loads the cargo onto the drone and the pilot launches it. One or two hours after the buyer confirmed their purchase, the shipment was going. The customer is happy to receive a tracking number and acquire their purchase within 3–4 hours. This service

package reduces shipping time and cost. SPARROW solved last-mile delivery problems including low prices, fast delivery, and product safety.

New Proposed Customer Journey Map



After introducing SPARROW package delivery, this is the customer path map. Drone delivery customer route maps begin with internet orders. Consumers are excited to get their purchases. After drone delivery launches, customers receive order progress updates. The smartphone software lets them obey orders. Due to real-time delivery tracking, customers are more excited.

The consumer is thrilled and relieved when the drone drops SPARROW gifts on their window. Safely watch the drone deliver their order. Consumers enjoy this experience. Delivery delights the customer. SPARROW's simplicity helped them obtain their item quickly. The customer may enjoy their order at home. Consumers adore the SPARROW. Easy, secure, and fast make it fun. Customers love their items and experience. Drone delivery customers may feel good about reducing environmental effect.

By following the design thinking approach, we have solved the following last mile delivery problems:

1. **Reduce Delivery Times**: SPARROW improves client happiness by reducing delivery times. This idea cuts delivery times significantly. SPARROW may deliver orders in hours or even minutes.
2. **Better Tracking:** Drones may improve shipping tracking. Customers can track their orders and shipments, reducing the likelihood of missing items and improving customer satisfaction.
3. **Cost savings**: Shipping expenses affect customer satisfaction. Drones may lower delivery costs since they consume less fuel. Cost savings passed on to customers may boost satisfaction.
4. **Greater Safety:** SPARROW may help secure deliveries. Using the SPPARROW and keeping drones 400ft above earth, drones can circumvent hurdles and deliver products safely. This reduces cargo damage and improves customer satisfaction.
5. **Eco-Friendly**: Drones provide sustainably. Since they utilise little gasoline, they release less CO2. This may reduce shipping's environmental impact and boost consumer satisfaction.

Service manual

This service manual is designed to provide operators with the necessary information to use drones safely and effectively for online delivery service. It outlines the safety procedures and regulations to follow, as well as the steps required to operate the drone correctly.

Safety Guidelines

Risk Assessment	Before flying a drone, operators must conduct a risk assessment to identify potential hazards and reduce the risk of injury. This includes inspecting the SPARROW for any mechanical or electrical issues, ensuring that the airspace is clear of other aircraft, and ensuring that the operator is familiar with the airspace regulations.
Pre-Flight Checklist	Operators must perform a thorough pre-flight checklist before flying the drone. This includes checking the drone's battery level, ensuring that the SPARROW is attached

	properly, and ensuring that the drone is within the legal weight limit.
Flight Limitations	Operators must adhere to all flight restrictions and limitations while flying the drone. This includes flying within visual line of sight, staying at 400 feet, and avoiding restricted areas
Emergency Procedures:	Operators must be familiar with the emergency procedures in case something goes wrong. This includes how to safely land the drone, how to safely shut it down, and how to contact emergency services for assistance.

Operational Procedures

Pre-Flight Set Up:	Before flying the drone, operators must ensure that the drone is calibrated properly, that the battery is charged, and that the SPARROW is connected properly.
Take-off	Operators must ensure that the take-off area is clear of any obstacles and people before taking off. This includes checking the area for any animals or other aircraft.
Flight	Operators must ensure that they are aware of their surroundings while flying the drone. This includes maintaining visual line of sight and avoiding restricted airspace.
Landing	Operators must ensure that the landing area is clear of obstacles before attempting to release SPARROW with the package.

Maintenance

Inspections	Operators must inspect the drone before and after each flight. This includes checking the propellers, battery, and SPARROW for any signs of damage
Cleaning	Operators must regularly clean the drone to ensure proper operation. This includes cleaning the propellers and body of the SPARROW.
Repairs	If the SPARROW becomes damaged during operation, operators must repair the drone as soon as possible. This includes ensuring that all parts are properly installed, and that the SPARROW is functioning properly

This service manual provides the necessary information to use SPARROW with drones safely and effectively for online delivery service. By following these guidelines, operators can ensure that their SPARROW is used safely and efficiently.

Ethical implications, risks, and limitations

The project is a hybrid research paper consisting of both research and case study consulting tasks for BMT. The data is taken from scholarly articles and other databases, such as Mintel, IBISWorld, HBR, as well as websites. The SPARROW project data was obtained from the BMT firm, which gave insights into the current drone delivery technology, its shortcomings, and the company's remedies. The objective of the study is to analyse the market in order to identify the target market and user expectations. The core research was done via a survey with over 200 replies; the questions were designed to glean information about the user requirements and expectations from the last mile delivery systems, as well as to identify the demographics of the target market.

The author compiled the study with the aid of the BMT company's director. The study is conducted using multiple websites and research papers that are properly cited. During the ideation phase of the project discussion, "Design Thinking" is picked based on research and the director of BMT.org's (Mr. James Campbell) recommendation.

The SPARROW project of BMT was tested and got input from several stakeholders in order to continue development. Although the test is being undertaken, there are only a few hazards associated with drone delivery, including technological faults, weather circumstances,

unanticipated impediments, and legal constraints. In spite of discovering and practically testing the answer, the project's execution will be subject to minimal risks.

The primary research question is to determine market demand, the target market, and eventually to gain a competitive advantage and make the project profitable, although the design thinking method has significant constraints.

Design thinking is a technique that does not produce precise outcomes throughout the design phase due to its iterative nature, which involves numerous feedback and prototyping. In addition, it fails to propose solutions that yield correct outcomes. The topic of when to repeat in a process and which step to return to appears to be confusing and vague. However, iteration can only occur after receiving input, and the sole feedback step in the design thinking process is the test phase. Therefore, we see the necessity to develop more testing phases earlier in the process, as opposed to testing solely at the conclusion.

An additional difficulty is correctly interpreting user input or eliciting organised user feedback. Users may not be able to articulate precisely why they dislike particular features of the solution, nor are they aware of the process phase at which the issue was initially identified. As the procedure relies heavily on user feedback, it is not entirely dependable. Despite the fact that customer requests will always be ideal, achieving that level of service may be impossible. Beneficial would be a methodology for structured analysis that bridges qualitative user input to the corresponding process phases. Such a framework for structured analysis might be created in future research.

Conclusion and Recommendation

Drone delivery services offer a potential solution to last mile delivery, allowing for faster delivery times and allowing for the delivery of packages to hard-to-reach areas. Although there are many obstacles to the implementation of drone delivery services, such as safety, regulatory, and cost constraints, the benefits of drone delivery services are undeniable. In the future, as technology advances and regulations are developed and streamlined, drone delivery services could become a reliable and efficient option for last mile delivery.
Drone delivery services provide a potential answer to last mile delivery, allowing for speedier delivery times and the delivery of products to difficult-to-reach locations. Despite several challenges to drone delivery service deployment, such as safety, regulatory, and financial limits, the benefits of drone delivery services are apparent. The SPARROW drone delivery service from BMT is an excellent solution for typical drone delivery challenges. There is a higher market opportunity for faster and more efficient last mile delivery. Design thinking is used in the project analysis, which is an iterative process. It will be a continuous process since users' expectations change as the service develops, and so this analysis will alter. According to the data, there is a definite need for the service in the clothes and accessories sector, followed by the electronics industry. Customers expect their orders to arrive as soon

as possible, which presents an opportunity for the SPARROW service. Thus, concentrating on and delivering services in these market categories can help the product gain awareness and a competitive edge, allowing the firm to gain market share. One critical advice is to upgrade the services and system architecture throughout, giving it a firm foothold in the market.

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Appendix

TITLE OF THE PROJECT

Revolutionising Logistics – The Implementation of Drone Delivery Services

A Design Thinking Approach to "Last Mile" Drone Delivery

Purpose:

The "last-mile" delivery is the last stage of a supply chain that is thought to be the least efficient owing to its unique characteristics, including a geographic distribution of relatively tiny reception locations, need for more frequent but smaller shipments, delivery time windows, etc. The "last-mile" delivery carried out by common delivery vehicles for an inner urban supply is thought to be significantly ineffective insofar as its ecological aspect is concerned, particularly in cities that are faced with modern distribution practises as well as increasing urbanisation and the development of e-commerce. This supports the conclusion that new delivery vehicle types must be developed in order to increase company performance while minimising the detrimental effects of transportation on the environment and societal functions in inner cities. With relation to this, the article discusses cutting-edg e transportation innovations used in "last-mile" deliveries in industrialised European nations, which promote social and ecological sustainability as well as greater supplier competitiveness.

Many digital solutions provide products and services that were developed to satisfy changing consumer trends, better user experiences, and customer preferences. For both physical and intangible goods, the community is steadily building an online buying habit, and the service industry is not an exception. Last mile delivery has a lot of room to develop in that market. It is required to transport packages more efficiently and more quickly. Customers are unable to quickly purchase a product online and have it delivered to their home. The goal of this study is to use design thinking to examine BMT's effectiveness in creating and introducing a new good or service into the market for delivery service using their creative and better function distribution between the drone and the winch. It's an opportunity to learn more about how innovation in goods and services may make it easier for customers to get their packages by boosting delivery effectiveness, cutting costs, and attaining faster speed.

Research Goals

1. To implement design thinking approach and custom tailor to the BMT context.
2. Empathize with the customer, end user, or other stakeholders in the value network to uncover meaningful tensions and opportunities for service innovations.
3. Define and reframe customer-centric problem statements.
4. Examining the end-users' experiences and pain points before the unique technology SPARROW idea is released to the market.
5. Introducing a new delivery service using the Design Thinking Process in the last mile sector.

Design/methodology/approach

Applying Design thinking Process in Drone delivery service. Design thinking approach is chosen to identify an opportunity for the innovation in the market and to understand user expectation.

Findings

According to the research, last-mile logistics firms would deploy SPARROW, a lightweight, nimble suspended robot, in conjunction with outside drones to transport products to the ground. Since then, the last mile delivery issue has been handled, greatly impacting end consumers' minds. By using the SPARROW idea in the drone delivery service, the project work made use of design thinking concepts to increase delivery efficiency in the last mile delivery process. However, using design thinking process will allow us to identify customer needs, develop creative solutions, and test them through prototyping and experimentation. This process should help us to gain insights into customer preferences and behaviours, allowing us to design a service that meets their needs and expectations. Ultimately, the success of our delivery service will depend on how well it meets customer needs and preferences.

Originality/value

The innovative SPARROW concept, which addresses the Last Mile Delivery issue, is the foundation of the project. The project will be successful if the relevant underpinning theories are fully explained. The technique of design thinking is used to systematically build the user personas, customer journey, information architecture, and user flow. We used both quantitative and qualitative approaches to understand the user's needs and desires in order to produce a solution that perfectly satisfies their requirements. The author performed two concurrent surveys and interviews with potential clients to get more data for the design process.

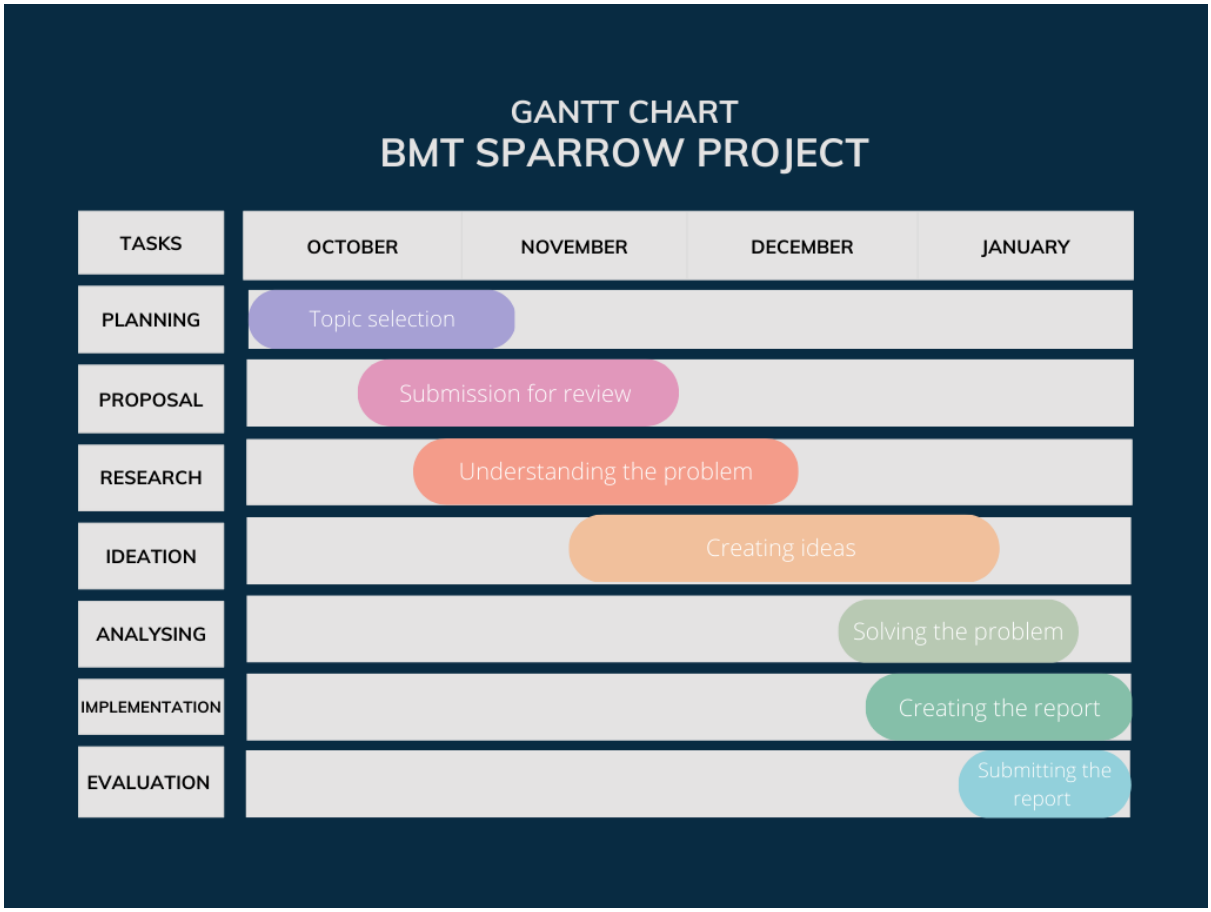
Keywords

Design Thinking, Last- mile delivery, UAV, Service design, e-commerce.

Paper type

Hybrid research paper, consulting project for BMT company

Gantt chart


GANTT CHART
BMT SPARROW PROJECT
TASKS
OCTOBER
NOVEMBER
DECEMBER
JANUARY
PLANNING
Topic selection
PROPOSAL
Submission for review
RESEARCH
Understanding the problem
IDEATION
Creating ideas
ANALYSING
Solving the problem
IMPLEMENTATION
Creating the report
EVALUATION
Submitting the report