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Faster, Safer and Greener

The Potential Impact of Delivery Drones in the Dallas-Fort Worth Metroplex

Commissioned by Wing

Important Notice on Contents – Estimations and Reporting

This report was prepared for Wing by Accenture in February 2021.

The amounts in this report are estimated and specified in 2020 United States dollars. Where conversion rates have been used, these are stated in the footnotes.

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Benefits of drone delivery in the Dallas-Fort Worth Metroplex

Retail sales are expected to grow by 35% in the next 5 years, increasing the demand for pick-up and delivery transportation over the "last mile".[1] However, current last-mile transportation is time-consuming, costly, and adds congestion to our roads. Drones could provide cost-effective delivery of small and urgent items, helping to support this growth in retail demand. Even by delivering 2% of purchases in the Dallas-Fort Worth Metroplex, drones could generate significant benefits for consumers, businesses and society.

Benefits for consumers

TIME SAVINGS

Drones could save active user households[2] **39 hours** per year (equivalent to a full-time work week) or **22 million** hours for the Metroplex overall through avoided pick-up journeys.

GREATER FOOD ACCESS

Drones could help improve food access for the **982,000** Metroplex residents who live in **food deserts** (representing **1 in 8** residents).

GREATER CHOICE

Drones could allow households to access up to **3-4x more retailers.**[3]

Benefits for businesses

INCREASED SALES

Drones can help participating businesses increase annual sales by **$26,000** per business or **$197 million** for the Metroplex overall.

GREATER MARKET REACH

Drones could help local businesses to reach up to **3-4x more consumers** as more households come into range.[4]

Benefits for society

HEALTHCARE SAVINGS

Drones could generate **$330 million** p.a. in healthcare savings by increasing medication adherence for **275,000 patients**.

REDUCED CONGESTION

Drones could remove the equivalent of **11,000** cars from the road, saving up to **800,000 hours per year** for drivers and passengers through reduced traffic congestion and helping to avoid **190** road accidents each year.

LOWER EMISSIONS

Drones could eliminate **49,000 tons** of annual CO_2 emissions – equivalent to the carbon storage of **1.7 million trees** across **44,000 football fields**.

Note: Benefits displayed above are estimated at scale after 5 years.

1. The "last mile" refers to the movement of goods from retail outlets or transportation hubs to a final destination. Retail forecasts obtained from Businesswire (2020) 'Global e-Commerce Analytics Market Set to Reach $22.4 Billion by 2025'.
2. Active user refers to consumers who use drone delivery services at least once a month.
3. For example, drones could increase access from 53 to over 183 restaurants per consumer.
4. For example, drones could expan reach from 41,000 households to 139,000 households.

Executive Summary

Drones have the potential to transform delivery by enabling fast, reliable and efficient transportation over the last mile. Even by delivering 2% of purchases in the Dallas-Fort Worth Metroplex, drones could provide benefits including greater choice for consumers, expanded reach for local businesses and reduced traffic, road accidents and emissions.

Retail is growing rapidly in the United States (US), driven by the emergence of online shopping. In the five years to 2019, US online sales doubled. Online sales grew another 32% during the first three months of the COVID-19 pandemic. Almost 5 in 6 consumers are expected to shop online by 2024.[5]

As retail continues to grow, the pick-up and delivery of goods from stores to homes is a critical challenge for consumers, businesses, and the public. For consumers, existing delivery options are costly (up to 35% of the item for delivered meals), infeasible, or unavailable.[6] Local businesses need timely delivery options to remain competitive.[7] For the public, efficient delivery is essential to avoid the congestion, emissions, and economic costs of increased road use from pick-ups and deliveries. This is a particular challenge in the Dallas-Fort Worth Metroplex, which is one of the least-densely populated metropolitan areas in the US but has some of the country's most congested roads.[8,9]

Drones can help to provide a timely and efficient delivery option across the last mile. Drones are particularly well-suited to small and time-sensitive deliveries. By filling the current gap in the delivery market, drones can support the sustainable growth of delivery without disrupting existing delivery models and the jobs they support.

The following report models the potential benefits of drone delivery in the Dallas-Fort Worth Metroplex within five and ten years at scale. Based on existing drone delivery operations, drones could deliver around 2% of retail purchases in the Metroplex within five years and around 6.5% within ten years at scale.[10]

For consumers, drones can improve access, choice, and convenience in purchasing essential supplies. For local businesses, drones can help to reach more potential customers, increase sales, and explore new business models. Finally, for the public, drones could help to reduce the significant road use associated with pick-ups and deliveries, reducing congestion, emission, and road accidents in the Metroplex.

5 Statista (2020) 'Digital Market Outlook: eCommerce United States'; BCG (2020) 'Can Delivery Companies Keep Up with the E-Commerce Boom?'; US Census Bureau (2020) 'Quarterly retail e-commerce sales 2020' - Seasonally adjusted retail e-commerce sales grew 31.8% between the first and second quarter of 2020.
6 Accenture (2020) 'Reinventing the last mile: win the race to the top'; McKinsey (2016) 'Parcel delivery – the future of last mile'; Kinetic (2018) 'Consumer Fee Comparison: Food Delivery Companies'.
7 Accenture Logistics Platform (2020) 'How could last mile delivery evolve to sustainably meet customer expectations?'.
8 US Census Bureau (2016) 'Population Division'; Texas A&M Transportation Institute (2019) 'Urban Mobility Report 2019'. Dallas-Fort Worth has about 7.6 million people but covers 9,000 square miles. However, the Metroplex is the 10th most traffic-congested city in the country and drivers spend the equivalent of three days (67 hours) a year stuck in traffic.
9 In 2019, the Metroplex incurred approximately $5.8 billion in congestion-related costs. Estimated cost of congestion in 2019 based on $2020 dollars using data from Texas A&M transportation Institute (2019) 'Urban Mobility Report'; Accenture analysis.
10 Current drones can carry up to about 5 pounds per trip.

EXHIBIT 1

The potential impact of drone delivery in Dallas-Fort Worth Metroplex was analyzed across three areas

Expected benefits for consumers

- **Time savings and greater convenience**
- **Greater access to services for underserved communities**
- **Greater choice**

Expected benefits for local business

- **Greater market reach**
- **Increased sales through improved delivery options**
- **Facilitation of new business models**

Expected benefits for society

- **Healthcare savings**
- **Reduced traffic congestion**
- **Safer roads**
- **Reduced greenhouse gas emissions**

Expected benefits for consumers

Drone delivery has the potential to generate significant benefits for consumers in the Metroplex. These include:

- **Time savings and greater convenience** – At scale, drone delivery will save each active user household 39 hours per year by reducing the need to travel to the store to collect purchases. In aggregate, this represents 26 million pick-up journeys and a saving of 22 million hours, worth about $305 million when valued at today's average earnings.[11] Drones are also unaffected by road traffic and offer shorter, more reliable delivery timeframes, allowing consumers to have greater control over their time and reducing the risk of parcel theft.
- **Greater access for underserved communities** – In the Metroplex, there are around 128,000 households that do not have a car, 982,000 people who live in food deserts with limited access to healthy food options and 838,000 people without close access to prescription medication.[12] Drone delivery could improve the accessibility of food, medicines and other products for these residents.
- **Greater choice** – Retailers may use drones to offer instant or same-day delivery to a larger geographical area. Customers in the Metroplex would thus have 3-4x as many delivery options to choose from. For example, a consumer in Little Elm who is currently able to receive deliveries from around 53 restaurants within 40 minutes could access over 183 food outlets over the same delivery period with drones.[13]

11 See Appendix A.6 for methodology.
12 Food deserts are low-income census areas (20% poverty rate and/or median income lower than 80% of statewide income), where at least 33% or 500 households live further than one mile of a supermarket or large grocery store. US Department of Agriculture (2012) '; US Census Bureau (2020) 'Vehicle statistics and disability data' Consumers who do not have close access to pharmacies are defined as consumers who live further than one mile away from a pharmacy. Accenture analysis, using pharmacy distribution adapted from Pednekar et al. (2018) 'Mapping pharmacy deserts and determining accessibility to community pharmacy services for elderly enrolled in a State Pharmaceutical Assistance Program'.
13 Accenture analysis based on Uber Eats delivery range and food outlets 1531 Brandywine Ln Little Elm TX 75068 and 1001 Waterview Drive Little Elm TX 75068.

Expected benefits for local businesses

Drone delivery could result in several important benefits for businesses in the Metroplex:

- **Greater market reach** – Drones can deliver further within a short timeframe than other forms of last-mile delivery. This response time enables businesses to offer instant or same-day delivery to customers in a wider geographical area.[14] The delivery radius for restaurants, for example, could increase from today's average of 3-4 miles to 6 miles with current drone technology.[15] For a typical business in downtown Dallas, this would increase their consumer reach from about 41,000 to 139,000 households.[16]
- **Increased sales** – Drone delivery is expected to generate additional sales by making it more convenient, reliable and affordable for consumers to shop online. Each participating business could make on average $26,000 worth of additional sales (or 480 transactions) per year. At scale, drone delivery could facilitate at least $197 million in additional sales across the Metroplex, rising to $762 million in 2030.
- **New business models** – Restaurants are increasingly exploring the new 'virtual kitchen' business model. Virtual kitchens are restaurants without a storefront that only handle delivery orders. They are often located in areas with more affordable rent such as industrial parks in order to unlock cost savings. Drone delivery can facilitate the transition to this new model for more businesses by allowing them to serve a broader geographical area while meeting consumers' expectations of speed, quality and price.

Expected benefits for society

Drone delivery can deliver a range of societal benefits for the Metroplex. These include:

- **Healthcare savings** – Consumers abandon up to 3 million prescriptions each year in the Metroplex, due in part to transportation issues. By increasing accessibility, drone delivery could improve medication adherence for 458,000 patients in the Metroplex, which could generate around $330 million of annual healthcare savings within five years of launching at scale (and $610 million within ten years).[17]
- **Reduced traffic congestion** – By replacing traditional forms of delivery for certain types of transactions, drone delivery can reduce the number of motor vehicle journeys on Metroplex roads. At scale, drone delivery could cut the total distance driven by vehicles performing local pick-ups or deliveries by 120 million vehicle miles traveled (VMT). This is equivalent to 11,000 cars off the road, saving 800,000 driver and passenger hours through improved road congestion.
- **Safer roads** – In 2019, there were an estimated 128,000 motor vehicle accidents on roads in the Metroplex.[18] At scale drone delivery can reduce road usage by 120 million vehicle miles traveled (VMT) , which could result in 190 fewer road accidents per year.
- **Reduced greenhouse gas emissions** – Drones emit less greenhouse gas per package than road-based alternatives. At scale, delivery drones could eliminate about 49,000 tons of CO_2 emissions annually. This impact is equivalent to the carbon storage of around 1.7 million trees across 44,000 football fields.

The overall impacts on businesses, consumers and society of drone delivery within five and ten years of launching at scale are summarized in Exhibit 2.

14 Instant delivery refers to on-demand delivery within one hour, while same-day delivery refers to deliveries fulfilled after one hour but no longer than one-day after collection.
15 Current range of around 3-4 miles based on the current Uber Eats and Postmates delivery radius on 24 September 2020 from Downtown Dallas, estimated based on the furthest restaurant delivery destination available from central Dallas. 6-mile range for drones based on conservative estimate of current technology.
16 Calculated based on average population density in downtown Dallas and Fort Worth, obtained from DFW Maps (2020).
17 Building off the methodology introduced in Lyon-Hill et al. (2020) 'Measuring the Effects of Drone Delivery in the United States'.
18 There are about 440,000 crashes in Texas in 2019 and total distance traveled by all motor vehicles in Texas is about 286,000 million miles. Source: Texas Department of Transportation (2019) 'Crashes and Injuries Cities and Towns'; Texas Department of Transportation (2020) 'Comparison of motor vehicle traffic deaths, vehicle miles, death rates and economic loss 2003-2019'.

EXHIBIT 2

The potential per-annum impact of drone delivery for consumers, businesses and society in the Dallas-Fort Worth Metroplex

Benefits	Description	Unit	Time horizon (years after drone delivery is launched at scale) Five years	Ten years
For consumers				
Greater choice	Increased number of businesses from increased delivery radius	Additional businesses accessible to a consumer	Approx. 130	
Pick-up time savings[1]	Number of pick-up trips replaced by drone deliveries	Million trips p.a.	26	102
	Total time saved from avoided pick-up trips	Million hours p.a.	22	86
	Total value of time saved valued in 2020 dollars	$ Million p.a.	305	1,180
For businesses				
Increased sales	Increased number of transactions due to drone delivery	Million transactions p.a.	3.6	14.1
	Increased revenue from increased sales transactions	$Million p.a.	197	762
Increased market reach	Increased reach in customers from increased delivery radius	Additional households accessible per business ('000)	Around 98	
For society				
Healthcare savings	Value of improved medication adherence from timely and reliable drone delivery of prescriptions	$ Million p.a.	330	610
	Number of patients who benefit	Number of patients ('000)	275	458
Total distance of avoided travel	Total deliveries and pick-up distance replaced by drone deliveries	Million vehicle miles traveled p.a.	120	470
		Equivalent number of cars removed ('000)	11	41
Total avoided accidents	Reduction in motor vehicle accidents from less travel	Number of accidents p.a.	190	725
Total reduction in carbon emissions reduced	Carbon emission reduction from deliveries and pick-up replaced by drones	Tons p.a. ('000)	49	189
		Equivalent no. of trees (million p.a.)	1.7	6.7

Note:
1. *Pick-up time includes distance-varying drive time, fixed time to park and go to and from a vehicle and waiting time at shops. Consumer pick-up time savings contribute to increased sales for businesses.*

Source: Accenture analysis.

1.

The role for drones in last-mile delivery

1.1 The last mile is a costly challenge

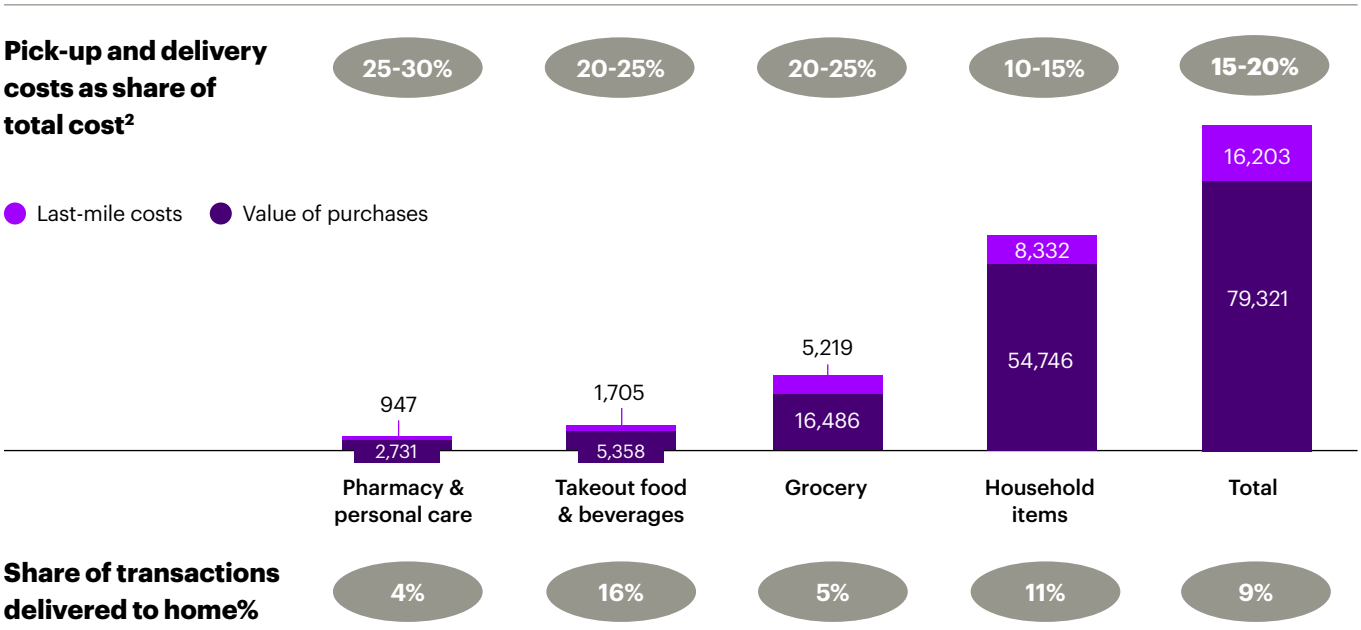
Last-mile delivery from the store to the home is one of the costliest segments of the retail supply chain. Total last-mile transportation includes both consumers taking the time to pick up their own goods (around 91% of all transactions) and paid delivery services (around 9% of all transactions).

Consumers who pick up their own goods incur costs of time and a range of other potential expenses such as fuel, parking and other vehicle costs. For products delivered by retailers or delivery services, consumers can incur both explicit fees (such as the additional cost of delivery paid by the consumer) as well as implicit delivery costs (such as costs that are absorbed by the retailer or passed onto the restaurant). As shown in Exhibit 3, last-mile delivery and pick-up often accounts for a large share of a total transaction cost, in the form of either delivery fees or the time and other costs of consumers picking up their goods.

The cost of last-mile transportation – including pick-ups – in the Metroplex was $16.2 billion in 2019. By reducing these costs, drones have the potential to create significant value for both retailers and consumers.

EXHIBIT 3

Total retail trade in the Dallas-Fort Worth Metroplex including last-mile pick-up time and home delivery costs in 2019[1]



Notes:
1. Retail trade excludes food consumed on-premise at restaurants/cafes; but includes household goods, clothing & footwear, department stores newspapers/books, other recreational goods and other retailing.
2. Pick-up trips include the average wage cost, and are equivalent to around $11-12 for an average trip.

Source: Bureau of Labor Statistics (2019) Consumer Expenditure Survey, Texas Comptroller retail data, Census Bureau Quarterly E-Commerce Report, Accenture Transportation Cost Model.

1.2 Drone delivery could fill the gap in current last-mile delivery options

Investment in drone technology has grown rapidly, driven in part by retail and logistics giants seeking to improve their operations and provide a differentiated service, and in part by technology companies hoping to provide third-party drone delivery services to other businesses.

The shift towards drone delivery of household goods is already underway. Queensland, Australia was home to the world's first delivery by Alphabet's Wing drone in 2014. In 2019, Wing began delivery trials in Finland and also became the first drone operator to be certified as a commercial air carrier by the US Federal Aviation Administration (FAA). Wing has successfully trialled delivery services in Virginia. In 2020, other operators including Amazon and UPS received FAA air carrier approval.

Drone technology has the potential to become an important part of the US delivery sector, particularly in fulfilling the last-mile component of deliveries.[19] An analysis of the current delivery landscape shows that there are gaps in the market for fast and cost-effective delivery which can be addressed by drone delivery (see Exhibit 4):

- **Delivery of basic staples or single items –** Food delivery services provide fast delivery, but fees can be costly. Food is usually delivered in about 40 minutes for an average fee of $3 to $8.50, plus taxes and service costs. The sum of markups could add up to 91% compared to the price for the meal bought directly at the restaurant, and smaller deliveries of basic staples such as fresh pastries and coffee tend not to be viable for current methods of delivery.[20] Consumers may choose to abandon these orders, resulting in missed opportunities for businesses.

  Analysis of grocery delivery services shows that chains can provide 1-hour delivery but have restrictions such as requiring a minimum spend and/or imposing fixed delivery fees. Such conditions limit the viability for single-item transactions.[21]

- **Delivery of prescriptions and urgent medications –** 95% of prescriptions were picked-up in 2019 because there were limited instant and same-day delivery options[22]. Consumers who are homebound (e.g. due to illness or mobility issues) may have to rely on others to help deliver prescriptions, which could be highly inconvenient. Pharmacy delivery services offer low-cost (or free) delivery options; however, many require subscriptions and/or are not nationally available.[23] Same-day options are also limited and could cost up to $8 per delivery.

- **Delivery by small businesses –** Small businesses currently have limited ability to provide instantaneous or same-day deliveries and face high delivery costs to compete with large retailers. While pick-up and delivery startups offer cheaper instant delivery options compared to conventional parcel services, they still charge high service and delivery fees.[24] Drone delivery could provide small local retailers with cost-effective and fast delivery options; and empower them to participate in a competitive delivery market.

In this report, drones are assumed to be able to complement current delivery methods where:

- **The item and location satisfy physical limitations –** Based on an analysis of existing operations, it is assumed for this study that drones could carry a maximum weight of 5 pounds and travel at a maximum speed of 65 miles per hour for a total round-trip distance of 12 miles.[25] However, physical limitations can be potentially overcome if the item can be packaged into smaller parcels and transported via multiple trips.

- **The delivery is time-sensitive in nature** (needed either instantly or on the same day).

The result of applying these criteria is that drones are most likely to be used for small item deliveries made on an instant or same-day basis. For these time-sensitive transactions such as food and medicine delivery, drones are significantly less expensive ($1-2 per delivery compared to $10-15) and faster than other methods (more than twice as fast compared with current methods of instant delivery such as DoorDash and Uber Eats).[26] Standard, less-urgent and heavy deliveries will likely still be fulfilled by road vehicles by 2025, which can achieve higher efficiency if they can batch parcels and deliver them along an efficient route. These economies of scale are difficult to achieve for time-sensitive purchases. Instead, drones facilitate the atomization of parcel flows, enabling efficient and cost-effective delivery within short time frames.

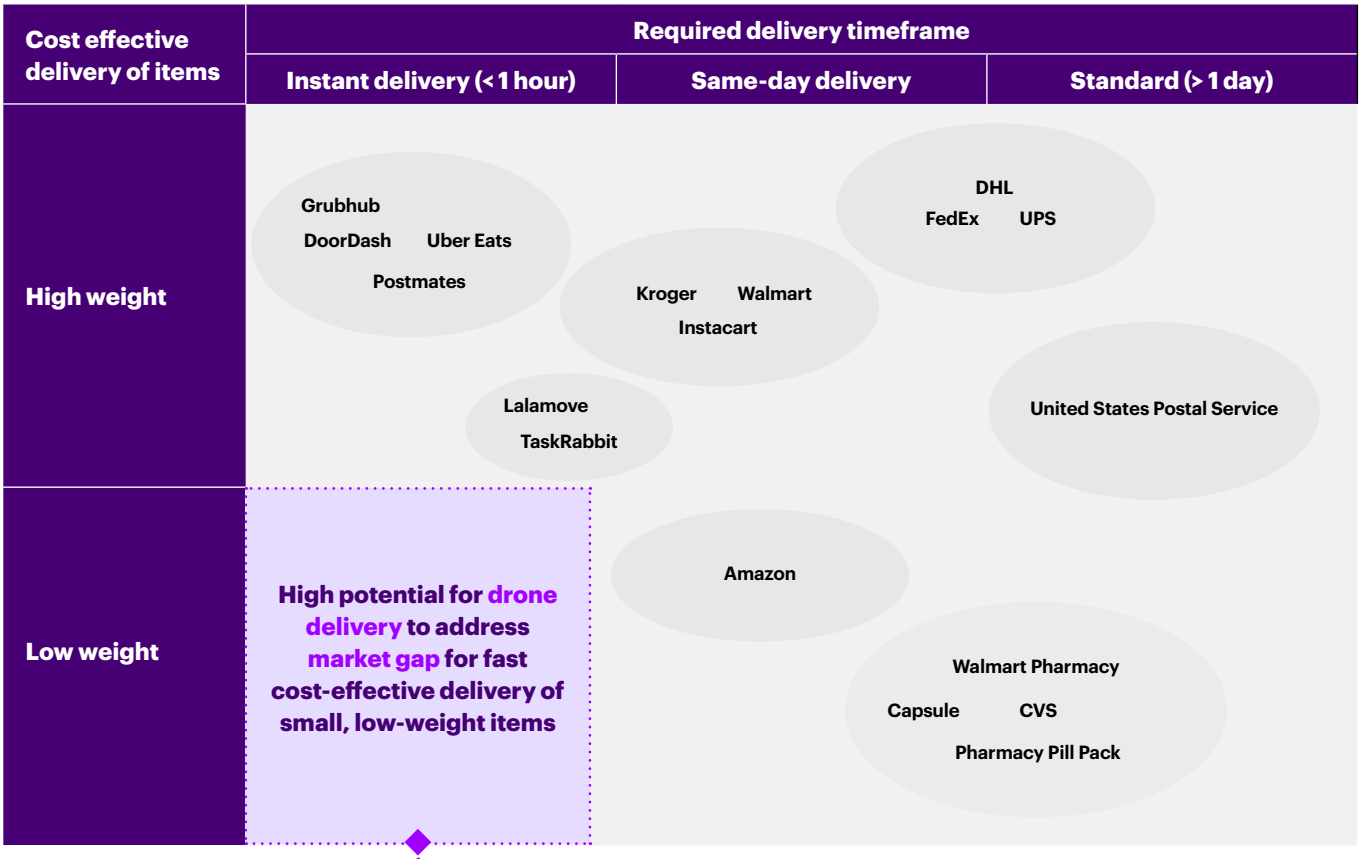
19 Last-mile' deliveries include transporting an item to the customer's location from the retailer (if close) or local distribution center.
20 New York Times (2020) 'Up to 91% More Expensive: How Delivery Apps Eat Up Your Budget'; Kinetic12 (2019) 'Consumer Fee Comparison: Food Delivery Companies'; Accenture analysis.
21 Kroger charges a delivery fee of $9.95 for instant (within 1-hour), standard delivery is free on orders of $35 or more. Source: Kroger (2020).
22 IQVIA (2020) 'Medicine Spending and Affordability in the United States'.
23 Pharmacy services could offer free delivery, however some services (e.g. PillPack) do not include temporary and urgent medication, while others (e.g. Capsule) do not operate nationwide.
24 Lalamove charges $15 for an instant delivery within 6 miles; FedEx would charge more than $50. Source: Lalamove (2020) and FedEx (2020).
25 The 12-mile round-trip range allows drones to deliver packages at up to a 6-mile radius but not beyond. While large drones could service larger distances and carry heavier packages, these aircraft were not considered as part of the study due to their different cost structure and concept of operations.
26 The $1-2 cost of drone delivery and $10-15 cost of instant delivery refer to the underlying cost to the operator.

EXHIBIT 4

Current delivery landscape and market gaps that can be addressed by drone delivery

Illustrative and non-exhaustive

Market gap for fast and low-cost delivery



Use case 1:
Delivery of daily basic staples
Delivery of single items such as hot coffee and fresh pastries or a bottle of milk, where current delivery cost could easily exceed item cost.

Use case 2:
Delivery of prescriptions and urgent medications
Consumers who are sick at home who require medication quickly and unable to leave home.

Use case 3:
Empowering small local retailers to remain competitive
Local businesses have limited ability to provide same-day deliveries and face high delivery cost to compete with large retailers.

Note: Weight is considered high when; parcel weighs over 5 lbs, low weight is under 5 lbs. Instant delivery takes less than 1 hour. Mark-up on food delivery is the difference in total price of delivered order versus the price of the same order in a restaurant (New York Times (2020)). Pick-up and delivery start-ups (e.g. Lalamove, TaskRabbit) offer on-demand and same-day delivery services at a lower price than conventional companies (e.g. DHL, FedEx), but are still charge high delivery costs. Pharmacy services could offer free delivery, however some (e.g. PillPack) do not include temporary and urgent medication, others (e.g. Capsule) do not operate nationwide.
Source: Kinetic (2019), New York Times (2020), Kroger (2020), Instacart (2020), Insider (2020).

The potential cost savings from drone delivery to consumers on daily purchases could be significant. Pick-up and delivery costs for transactions in scope for drone delivery are currently estimated to be between $4.50-11.40, adding 6-35% to the average transaction value (see Exhibit 5).[27] Specifically, direct delivery costs range between $4.50-9.20, while indirect pick-up time costs are valued at around $11.40.[28] Pick-up time costs can be higher than delivery costs because consumers face fixed time-costs in parking, shopping and checking out in addition to the time spent traveling to and from the shop.[29] However, consumers often undervalue their time. Drone delivery could reduce delivery costs to around $1.40 per transaction, which represents a cost reduction of up to 85% ($7.80) compared to current instant and same-day delivery and the benefits would be greater if compared with pick-up time savings.

1.3 At scale, drones could support around 2% of all purchases in the Dallas-Fort Worth Metroplex

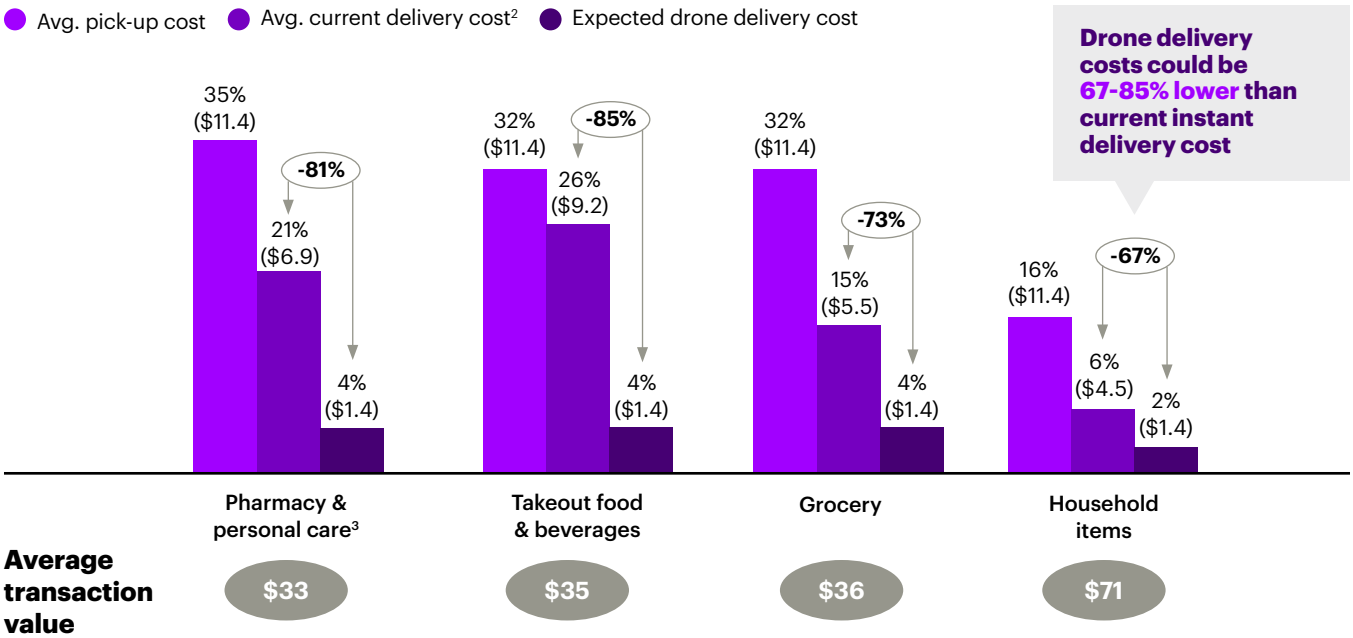
In 2019, households in the Metroplex made an estimated 1.5 billion retail transactions, including groceries, pharmacy goods, takeout food and household items. Around 9% of those purchases were delivered to customers, while the remainder were picked up by customers traveling to the retailer's outlet.

EXHIBIT 5

Current pick-up and instant delivery costs add between 6-35% to the average retail transaction; drone delivery could reduce this to 2-4%

Estimated pick-up and delivery costs of transactions in scope by retail category[1]

% of transaction value ($ pick-up or delivery cost in parentheses)



Notes:
1. *Transactions in scope refer to transactions <5 lbs, purchased within 6 miles, and require instant/same-day delivery.*
2. *Estimates are based on underlying costs and do not include service and/or other fees.*
3. *The average prescription out-of-pocket share is around 14% (Consumer Expenditure Survey Public Use Microdata, Health Care Costs Almanac 2020), which For prescription medication, average transaction value for pharmacy transactions includes the out-of-pocket share only (14% obtained from Health Care Costs Almanac 2020).*

Source: Bureau of Labour Statistics (2019) Consumer Expenditure Survey; FMI (2019) US Grocery Shopper Trends; Vend (2018) Retail Data 2018: 30 Retailer Statistics You Need to Know; Texas Comptroller (2020) State Sales and Use Tax Quarterly Report; Accenture analysis.

27 Current instant and same-day delivery costs are based on operator cost and do not include additional costs and/or service fees incurred to consumers. Drone delivery fees are estimates.
28 See appendix for methodology on pick-up time cost valuation.
29 The aggregate fixed and variable time-costs are assumed to total around 50-60 minutes per pick-up for the average consumer journey.

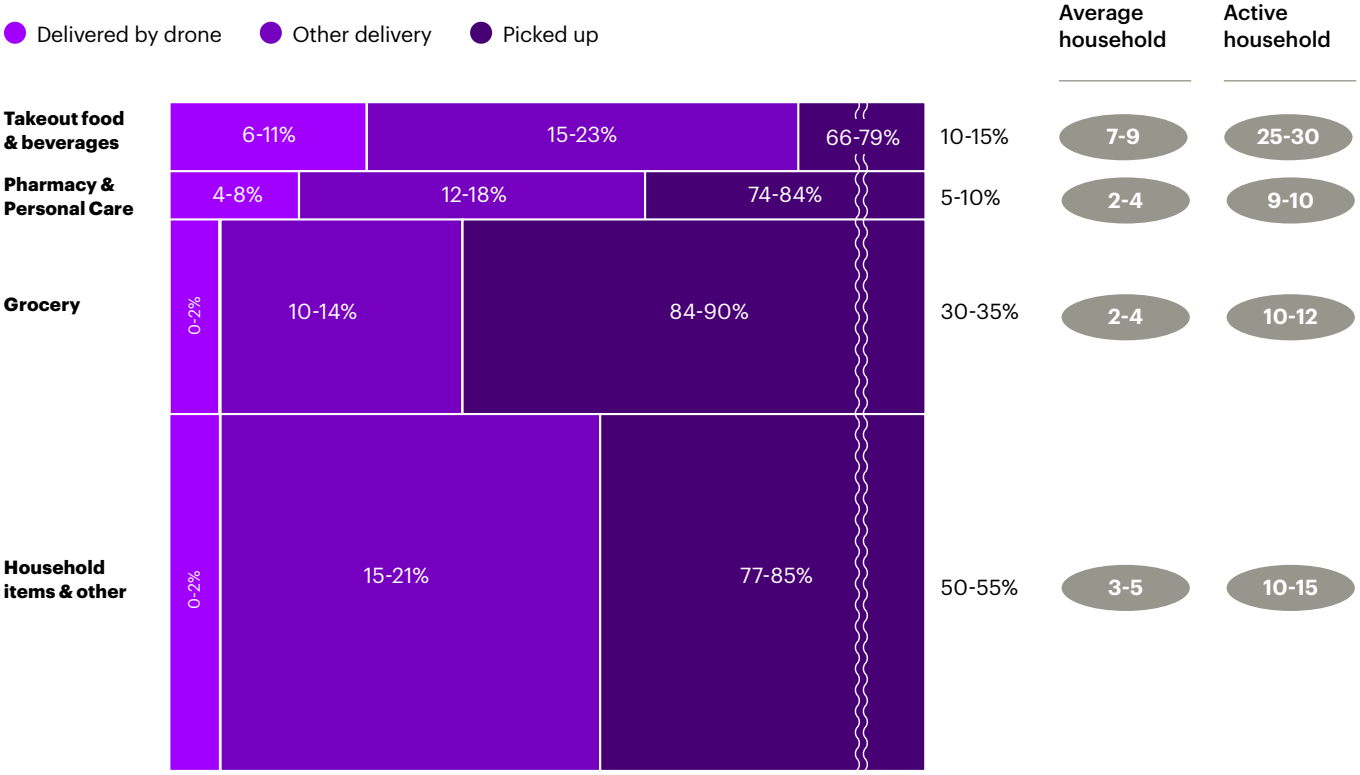
The future landscape will be different. For example, in five years' time, a greater share of transactions will be delivered.[30] This could include up to 20-25% of pharmacy and personal care products, 25-30% of takeout food orders, and 15-20% of transactions in other product categories. These shares would be even greater over a ten-year horizon.[31]

EXHIBIT 6

Within five years of launching at scale, drones could deliver around 2% of retail transactions, including up to 4-11% in some categories

Expected future share of retail transactions by mode of delivery[1]

% of Dallas-Fort Worth Metroplex retail transactions five years after drone delivery is launched at scale



Drone deliveries per household per annum (five years from launch)

	Average household	Active household
Takeout food & beverages	7-9	25-30
Pharmacy & Personal Care	2-4	9-10
Grocery	2-4	10-12
Household items & other	3-5	10-15

Takeout food & beverages	10-15%
Pharmacy & Personal Care	5-10%
Grocery	30-35%
Household items & other	50-55%

- **Five years after launch, ~2% of total retail transactions could be delivered by drone**
- **Ten years after launch, ~6.5% of total retail transactions could be delivered by drone**

1. *See Appendix A.3 for method and rationale. These estimates are based on assumptions and the represent an example scenario rather than a prediction of future uptake.*
2. *A higher share of deliveries in pharmacy & personal care is serviced by drone because the transactions are more likely to satisfy drone weight restrictions than grocery or household items.*
3. *Grocery includes convenience stores, which have a smaller average purchase weight than supermarkets.*

Source: Bureau of Labor Statistics Consumer Expenditure Survey, Texas Comptroller retail data, Accenture analysis.

30 Based on a conservative forecast retail GDP growth rate for Texas of 2.97% p.a. from 2020-30. Available at: https://comptroller.texas.gov/transparency/reports/forecasts/2020-07/

31 Based on compound growth towards long-run trends from various sources including Morgan Stanley, Nielsen & FMI, Census Bureau, Bureau of Labor Statistics, and IQVIA. See Appendix for details.

2.

Benefits for consumers

Drone delivery helps to save time, expand product variety and increase access to services for consumers, especially in underserved areas

Five years after launching at scale, drone delivery is expected to replace 26 million consumer pick-up journeys in the Dallas-Fort Worth Metroplex, saving consumers a total of 22 million hours that year. In this scenario, households in the Metroplex that actively use drone delivery services could avoid an estimated 46 pick-up journeys a year, freeing up around 39 hours of time per household that they could otherwise spend on work or leisure activities.

Drone delivery could also vastly improve the retail choices available to consumers, by putting the average household in range of 183 stores, compared to 53 stores today. Drone delivery would have a particularly significant impact on the range of goods and services available to underserved and vulnerable populations in the Metroplex.

EXHIBIT 7

The potential impact of drone delivery for consumers in the Dallas-Fort Worth Metroplex

Time horizon (years after drone delivery is launched at scale)	**Five years**		**Ten years**	
Consumer benefits	**All consumers**	**For an active user household[1]**	**All consumers**	**For an active user household[1]**
Pick-up trips avoided (trips p.a.)	26 million	46	102 million	57
Pick-up time savings (hours p.a.)	22 million	39	86 million	48
Pick-up time savings ($ p.a.)	305 million	530	1,180 million	650
Greater product variety (stores per consumer)	3-4x (increasing from around 53 to around 183 restaurants)			

Note:
1. *Active user refers to consumers who use drone delivery services at least once a month; drone delivery is assumed to cover 50-60% of the Metroplex within five years of launching at scale and the full region after ten years.*

Source: Accenture analysis.

2.1 Saving time and improving convenience

Drones are able to fly directly to their destinations without being affected by road traffic or detours. As a result, drones can significantly reduce instant delivery timeframes.[32]

Drone delivery will also improve the customer experience by allowing consumers to more reliably schedule their deliveries and track their orders through GPS. Reliable delivery is highly valued by consumers: up to 90% of consumers track their online orders and believe that deliveries need to fit into their busy lifestyles.[33] Shorter and more precise delivery timeframes can also reduce the risk of parcel theft.

In addition, drone delivery could save time for Dallas-Fort Worth Metroplex residents by replacing 26 million customer pick-up journeys annually within five years of launching at scale. As noted in Section 1, last-mile transportation costs, including the time it takes for customers to pick up items from shops and drive home again, account for 15-20% of the total cost of retail purchases. Replacing these 26 million customer pick-up journeys with drone deliveries can save 22 million person-hours each year, valued at about $305 million based on today's average earnings.[34] Drone delivery could save active user households an estimated 46 pick-up journeys a year, freeing up around 39 hours (equivalent to a full-time work week), or $530 worth of time.

2.2 Reducing household costs

Retailers typically pass on at least some part of delivery costs to their consumers. For instant or same-day deliveries, consumers typically pay a fee of between $4-7 for food delivery and up to $15-20 for a courier.[35] In many cases where a consumer wants to buy a single item such as a loaf of bread or cup of coffee, the delivery fee could easily exceed the price of the item, and consumers might opt to travel to make an in-store purchase instead.[36] Because drone delivery is more affordable, it enables consumers to make a greater range of purchases online.

Drones could reduce delivery costs by 80-90% compared to current methods, enabling consumers to spend more on products they want that are not capable of delivery today. Consumers in the Metroplex could save a total of around $18 million per year within five years of launching and $68 million within ten years, based on the share of costs they bear today. Consumers may choose to spend some of these savings on additional or higher-value purchases – this effect is described in Section 3.2.

2.3 Expanding choice

Drones can help increase the range of products available to individual consumers due to the speed at which they can cover large distances. This is most noticeable for food orders, which are highly time sensitive and are therefore restricted to a limited delivery range.

Food delivery is a large and growing market in the Dallas-Fort Worth Metroplex, and delivery speed has an enormous impact on customer satisfaction. Surveys show that most consumers want their food to be delivered within 40 minutes.[37] Drones travel faster than road delivery methods and are unaffected by traffic, so they can cover up to twice the distance within a 40-minute timeframe. Drones could thus enable consumers to access two to three times more retail outlets.

For a consumer in Little Elm, a city north of Dallas, there are currently around 53 food outlets that will deliver within 40 minutes.[38] Many of these options are national chains such as Taco Bell, McDonalds, Jack in the Box, Burger King, Panda Express and 7-Eleven. Drone delivery could bring the Little Elm consumer within a 40-minute delivery range of more than 183 food outlets, including fresh and fine dining options. It would be possible to deliver food from restaurants in Colony and Plano to Little Elm within 40 minutes, putting new steakhouses, seafood and sushi options on the menu for the first time.[39] Drone delivery can provide consumers with more options and increase the diversity from fast food restaurants to healthy food.

32 For some trips, drones could be 60% faster. See Appendix A.6 for detail on methodology.
33 Accenture Logistics Platform (2020) 'How could last mile delivery evolve to sustainably meet customer expectations?'.
34 See Appendix A.6 for methodology.
35 Delivery costs for instant delivery in the Dallas-Fort Worth Metroplex using online food delivery (e.g. DoorDash) or on-demand logistics startups (Lalamove or TaskRabbit) within a range of 0.6-3 miles.
36 A loaf of bread would cost $3-4 at 7-Eleven and the delivery cost is around $4. Source: Accenture desktop analysis of DoorDash delivery in Frisco in October 2020.
37 McKinsey (2016) 'The changing market for food delivery'; Berthiaume (2019) 'Survey: The most popular food delivery app is...'; The weighted average food delivery in the US across DoorDash, Uber Eats and Grubhub is 42 minutes. Source: Pomranz (2017) 'This Delivery App Has the Fastest Delivery Times'.
38 Accenture desktop analysis based on Uber Eats delivery range and food outlets that deliver to Brandywine Ln Little Elm TX 75068 and Waterview Drive Little Elm TX 75068.
39 With drone deliveries, it would be possible to deliver food from restaurants in the Colony, Frisco and Plano to Little Elm within 40 minutes. Examples include 'Hard Eight BBQ' in The Colony, 'Outback Steakhouse' in Frisco, 'Edoku Sushi' in Plano, and 'Rockfish Seafood Grill' in North Dallas.

CASE STUDY

Drone delivery is becoming a vital service for Walgreens customers in Christiansburg, Virginia

In Christiansburg, Virginia, customer ordering habits changed when the COVID-19 lockdown began in April 2020. Unable to leave their homes, many residents relied on the Wing drone delivery service for essentials such as food and cough and cold medicines. For families like the Merrills, it was the only way they could get essential supplies such as toilet rolls during the stay-at-home period.

The service quickly became vital for many Christiansburg residents, with a fivefold rise in Walgreens drone deliveries between February and April. In fact, 80% of Wing orders to date were placed during the lockdown period.

"When we first launched, we saw the possibilities for the service. For example, parents did not have to leave their sick child's side while still being able to get what was needed to nurse their little one back to health," says Andrea Farris, Walgreens' Vice President of Development for Solution Planning and Partnerships.

"This is more important today than ever before as we fight the COVID-19 pandemic, as it allows people to stay at home while still receiving goods."

Improving speed and convenience

Customers have embraced the drone delivery service – and nearly all of them would recommend it to a friend or colleague (reflected in its net promoter score[1] of more than 90). Many are also keen to get access to products such as prescriptions.

According to Walgreens, the tie-up with Wing has offered customers unparalleled speed and the convenience of "store to door" delivery. This type of innovation will ensure Walgreens can continue to meet customers' evolving needs and deliver greater value, convenience and accessibility.

1 Net Promoter Score (NPS) is the percentage of customers rating their likelihood to recommend a company, a product, or a service to a friend or colleague as 9 or 10 ("promoters") minus the percentage rating this at 6 or below ("detractors") on a scale from 0 to 10. The NPS metric can range from -100 to 100.

"This is more important today than ever before as we fight the COVID-19 pandemic, as it allows people to stay at home while still receiving goods."

2.4 Reaching underserved communities

Drone delivery could have significant benefits for underserved and vulnerable communities in the Metroplex, including people who live with mobility challenges or in areas without close access to essential goods and services.

In 2019, 4.9% of households in the Dallas-Fort Worth Metroplex (128,000) did not have access to a vehicle. Vehicle non-ownership is significantly higher in low-income areas, at 7.1%.[40] While some of these households may live without a vehicle by choice, a majority are forced to walk or rely on public transportation to purchase essential items, which is time-consuming and inconvenient.

Drones could significantly improve conditions in 'food deserts' and 'pharmacy deserts' across the Metroplex where it is difficult for consumers to access the food or medication that they need. Food deserts are generally defined as low-income areas where the nearest large supermarket is at least one mile away (or 10 miles away in rural areas).[41] More than 1 in 8 Dallas-Fort Worth residents live in these areas. Pharmacy deserts are generally defined as areas in which residents need to travel at least one mile to reach the nearest pharmacy (10 miles in rural areas), limiting their access to prescription drugs and impacting health outcomes.[42] These issues are discussed in more detail in Box 1.

In addition, more than 1 in 10 Metroplex residents (780,000) have some form of disability, including over 363,000 with mobility issues that prevent them leaving home without some form of aid.[43] While delivery does not replace the need for more inclusive public spaces and services, drones could provide an additional way for underserved people to purchase items conveniently and independently from the comfort of their homes.

40 Vehicle non-ownership in DFW 4.9%, low-income areas 7.1% (<20% poverty and/or median income below 80% of statewide income). Source: US Census Data and USDA Data.
41 USDA ERS (2019) Food Access Research Atlas Documentation.
42 Wisseh (2020) Social determinants of pharmacy deserts in Los Angeles County.
43 US Census Data (2018).

BOX 1

In Metroplex food deserts, drones could connect businesses with the consumers who need them

Food security is a major issue in large parts of the Metroplex. Approximately 982,000 people in the Dallas-Fort Worth Metroplex live in 'food deserts': low-density, low-income areas where a third of the population is more than a mile from a major grocer.[1] In these areas, there are no grocery stores, supermarkets, or farmers markets within convenient distance of many residents, which makes healthy food inaccessible. This is particularly challenging for about 70,000 food desert residents who do not own a car and more than 101,000 people who have some form of disability or mobility issues.[2]

Food deserts are a multi-faceted problem impacting the health of residents and exacerbating wealth inequality. In the absence of major grocery stores, residents rely more heavily on corner stores, where items are more expensive, and stocks are often limited to low-nutrient and highly processed food. As a result, people are often forced to spend a larger portion of their already limited income on groceries than those in wealthier regions.[3]

Limited access to healthy food appears to show some correlation with diet-related health problems and shorter life expectancy. In South Fort Worth and South Dallas, where more people live in food deserts, the average lifespan is 67-68 years which is significantly lower than the state-wide average of 79 years (see Exhibit 8).[4] While drones are unlikely to change the socioeconomic status of these residents (and life expectancies are influenced by a range of factors), drones could help by improving residents' access to affordable fresh food.

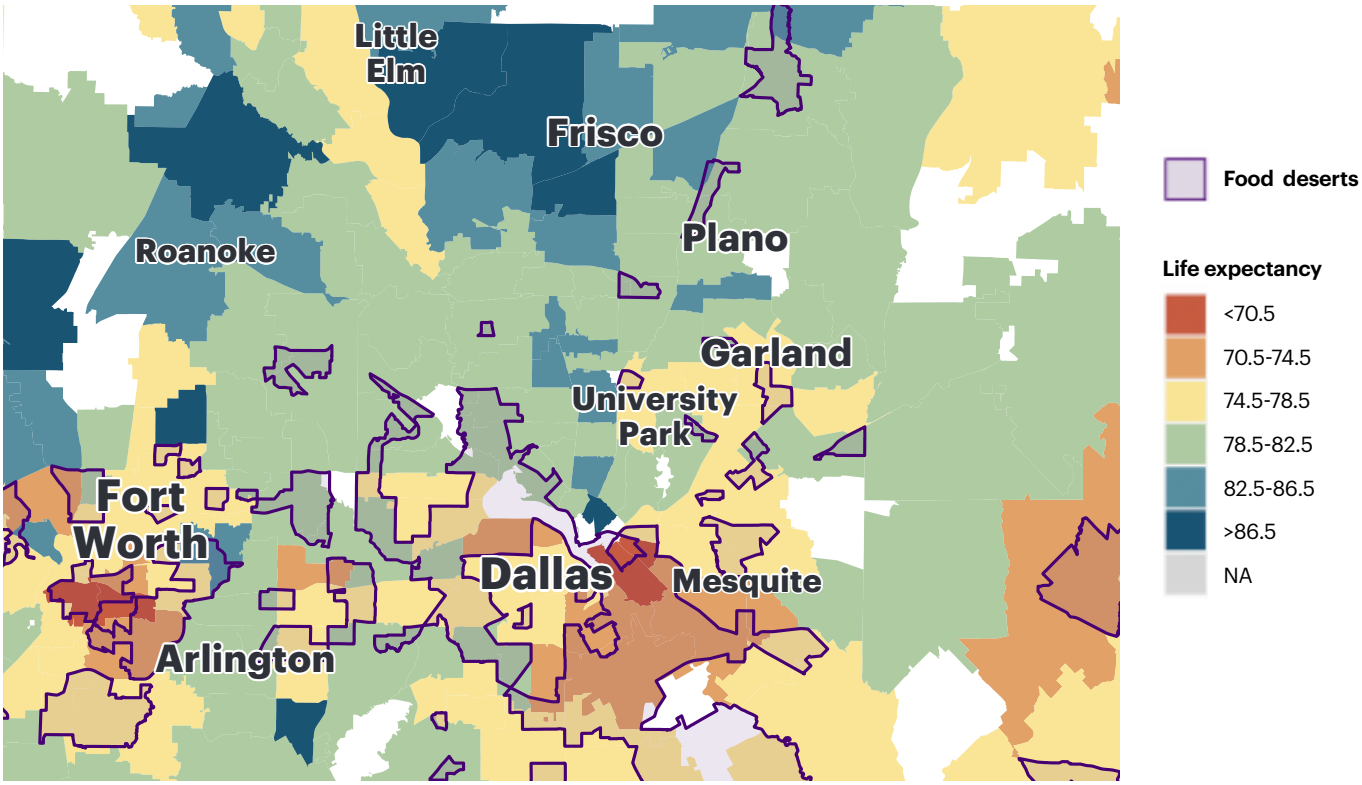
These food desert areas have been challenging to revive. Dallas City Hall offered a $3 million incentive for supermarkets to operate in food deserts, but chains such as Walmart have been unwilling to invest over concerns that their businesses would not be profitable in these low-income areas.[5] Save U More opened one store in Highland Hills under the scheme in 2016. However, by 2020 the store was struggling to continue operating due to limited revenue.[6]

Not-for-profit initiatives have been more successful. Baylor Scott & White Health have opened community pop up markets at seven different sites, bringing fresh, high-quality produce to food deserts.[7] Stands operate for at least one day a week at each site and provide 10,000 people with affordable fresh food annually, demonstrating the demand for convenient, affordable, fresh food.

Notes:
1 USDA (2011) Food Mapping Data; Dutko et al. (2012) 'Characteristics and Influential Factors of Food Deserts, Economic Research Report'; US States Department of Agriculture (2012) The United States Department of Agriculture (USDA) defines a food desert as a place with people who have limited access to healthy and affordable food, a poverty rate higher than 20 percent, and a third of the population that is more than a mile from a major grocer.
2 US Census Bureau (2019) 'Disability characteristics'.
3 Dallas Magazine (2019) 'The Case For Grocery Stores In Dallas' Many Food Deserts'.
4 The average life expectancy in Texas is 79 years, the life expectancy in south Fort Worth (ZIP 76104) is 67 and is 68 south Dallas (ZIP 75215). Source: University of Texas 'Life Expectancy At Birth in Communities Across Texas'.
5 Dallas News (2016) 'City Hall offered $3M to open a grocery store in a southern Dallas food desert and got no takers'.
6 Dallas News (2020) 'Dallas planning to buy grocery store in food desert and try something new'.
7 Dallas Business Journal (2019) 'Farm stands remain oases in southern Dallas food deserts'.

EXHIBIT 8

Locations of food deserts in Dallas-Fort Worth Metroplex and average life expectancy



Source: Texas Health Maps, USDA Food Access Research Atlas, Accenture analysis.

CASE STUDY

How drone delivery could impact West Mesquite and South Dallas food deserts

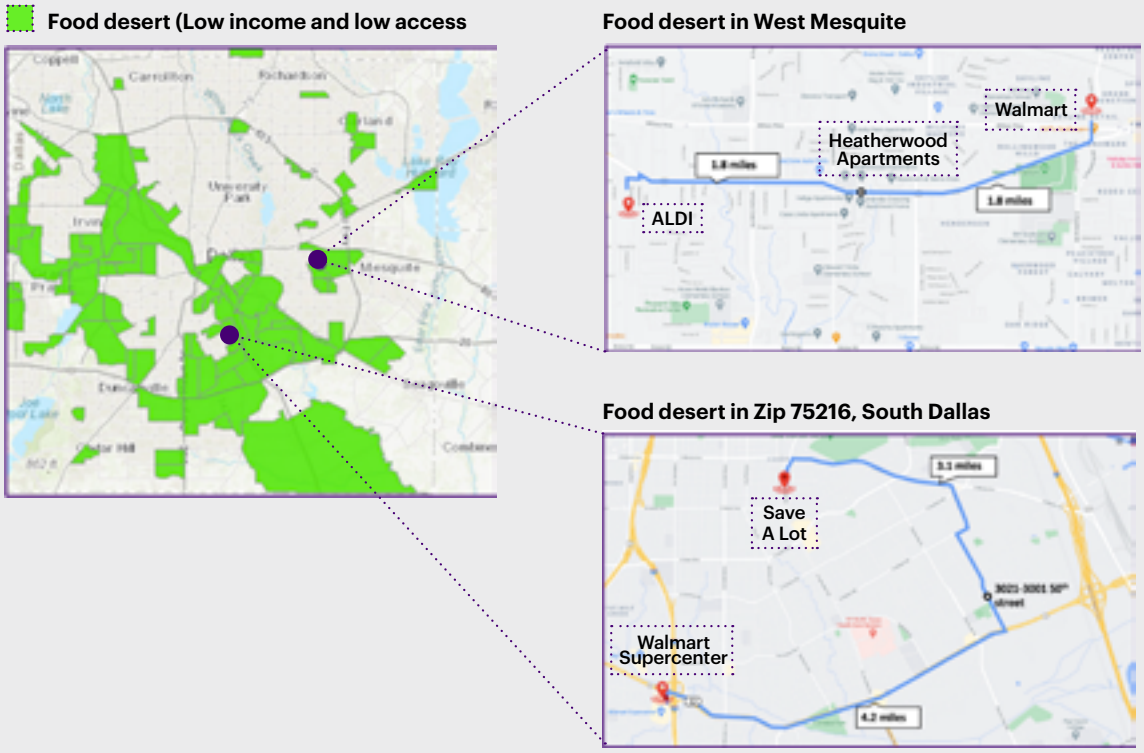
West Mesquite in North East Dallas and zip code 75216 in South Dallas are two examples of food deserts in the Metroplex. Households in these regions earn 40% and 70% less than the Dallas-Fort Worth Metroplex median of $60,000, respectively.[1]

In West Mesquite, residents must travel almost two miles to reach the closest Walmart or Aldi. South Dallas residents travel 3-4 miles to get to Walmart or Save A Lot (see Exhibit 9). For people without cars, walking or traveling by public transportation with groceries is often inconvenient and time-consuming. For example, Ms Laquita Hall lives in South Dallas and does not own a car. To buy groceries, she walks 3 miles to the closest Walmart, taking hours, while a bus trip would take at least 30 minutes each way.[2]

1 USDA Food Access Research Atlas (2020); US Census (2019) 'Income and Poverty in the US'.
2 Trevino (2019) 'Life in a Dallas-Fort Worth Food Desert'.

EXHIBIT 9

Consumers in West Mesquite and zip code 75216 (South Dallas) have to travel 2 to 3 miles to the nearest supermarket



Restaurants options within food deserts also tend to be limited to fast-food chains. In West Mesquite, for example, outlets include McDonalds, Dairy Queen, Subway, Whataburger, Taco Bell, and Chipotle.[3] Food delivery offers healthier options, such as McAlister's Deli, but these take 45-50 minutes to arrive.[4] Because drones can travel large distances quickly, they could allow residents in food deserts like West Mesquite to order healthy options from other parts of the city.

While health and life expectancy outcomes are influenced by a range of issues, limited access to healthy food options may be one contributing factor for food desert residents. Chronic conditions as heart diseases and diabetes in this area are twice as prevalent and life expectancies are lower than other districts. For example, the average life expectancy in West Mesquite and South Dallas is 75 and 70 years respectively, while in Uptown Dallas (just 10 miles away), residents can expect to live up to around 90 years.[5]

3 Maddox (2019) 'The Case For Grocery Stores In Dallas' Many Food Deserts'.
4 Accenture desktop research of DoorDash delivery on 2 October 2020 to 9755 Scyene Rd TX.
5 Texas Health Maps (2019).

Source: USDA (2020) Food Access Research Atlas, Accenture analysis.

3.

Benefits for local businesses

Drone delivery can help increase market reach, generate sales and facilitate new business models

Delivery drones can help businesses reach 3-4 times as many consumers, increasing the average market reach of Metroplex business from 41,000 households per business to 139,000 (see Exhibit 10). By enabling faster, longer-range and more affordable deliveries, drones could also generate 3.6 million additional sales a year, estimated to be worth $197 million. For the typical participating business, delivery drones could increase sales volumes by around 480 transactions per annum which would generate $26,000 in sales.[44]

3.1 Expanding market reach

Drones can help businesses in the Metroplex expand their delivery range and reach more customers. Local food delivery businesses are currently able to serve customers within a radius of 3-4 miles in 40 minutes, which is the maximum time that most customers are willing to wait for their food.[45] Drones will be able travel almost twice that distance, reaching up to 6 miles from an outlet in the same amount of time.

As shown in Exhibit 11, the increased range by drone delivery will bring 3 to 4 times as many households within range of a business. In the Metroplex, the average market reach of businesses will grow from 41,000 households to 139,000.[46]

EXHIBIT 10

The potential per-annum impact of drone delivery for businesses in the Dallas-Fort Worth Metroplex

Time horizon (years after drone delivery is launched at scale)	**Five years**		**Ten years**	
Business benefits	**All businesses**	**Individual business[1]**	**All businesses**	**Individual business[1]**
Total increased household reach per business	3-4x (increasing from around 41,000 to around 139,000 households)			
Increased sales volumes (transactions)	3.6 million	480	14.1 million	530
Increased sales revenue ($)	197 million	26,000	762 million	28,500

Note:
1 *Participating businesses were estimated by Accenture based on projected business counts from US Census Bureau County Business Patterns data, combined with assumptions on drone significance among participants; Dallas-Fort Worth Metroplex is estimated to have 8,000 (19%) participating businesses within five years of launching at scale and 27,000 (67%) within ten years.*

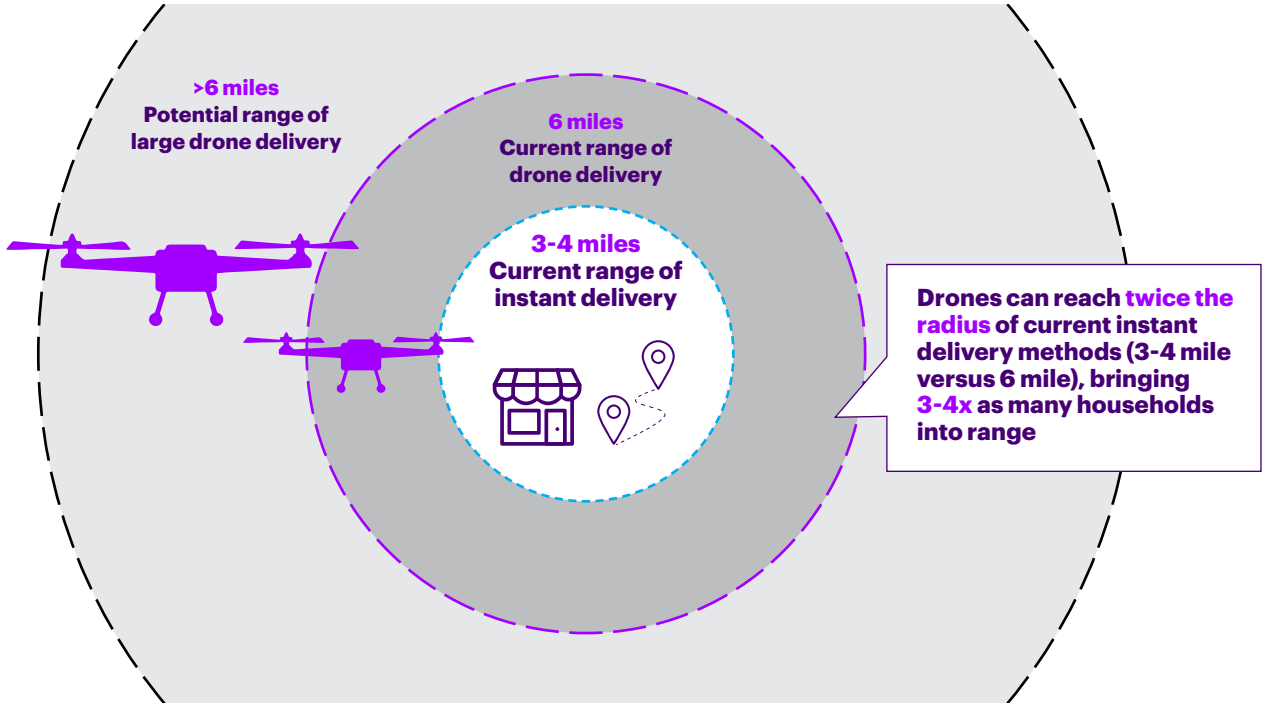
Source: Accenture analysis.

44 See Appendix A.5 for methodology.
45 The weighted average food delivery in the US across DoorDash, Uber Eats and Grubhub is 42 minutes from Food & Wine (2017) 'This Delivery App Has the Fastest Delivery Times'; McKinsey (2019) 'The changing market for food delivery'; Chain Store Age (2019) 'The most popular food delivery app is...'.
46 Calculated based on average population density in downtown Dallas and Fort Worth, obtained from DFW Maps (2020).

EXHIBIT 11

Drones can double the reach of instant delivery reach relative to current methods, bringing 3-4x more households into range

Range of current and future instant delivery methods[1]



Note:
1. *Current range up to 3-4 miles based on the current Uber Eats and DoorDash delivery radius in Downtown Dallas estimated based on furthest distance within 40 minutes delivery displayed on 2 October 2020. The maximum one-way delivery of current delivery drones is assumed to be 6 miles; and drones can reliably deliver that distance in 40 minutes or less.*

Source: Accenture analysis

For transactions within today's delivery range, drones can help businesses to better serve customers, as items can be delivered more quickly. This matters most for deliveries of food and medication. Today, an 'instant' delivery van takes about 15 minutes to complete a 6-mile trip (longer if the route is indirect). Drone travel could cut this time to less than 6 minutes – more than 60% faster.[47]

Drones could also unlock new markets, particularly in underserved food deserts across the Metroplex. Food deserts are sparsely populated, low-income areas where there is no fresh produce available, because of a lack of local supermarkets.[48] These areas encompass almost 15% of all residents in the Metroplex (see Box 1 for more details).[49]

However, there is strong demand for convenient, fresh and affordable produce in these areas. This is evidenced by the success of a weekly pop-up market started by Baylor Scott & White Health, which caters to over 10,000 customers in food deserts each year.[50] Drone delivery could expand the reach of similar initiatives and businesses, lower costs and make local operations sustainable. As such, drone delivery could help to sustain local fresh food and grocery suppliers while and alleviating food security issues in the Metroplex.

47 Based on an assumed average van speed of 25 mph, and a drone speed of 60 mph.
48 Dallas-Fort Worth Child (2019) 'Life in a Dallas-Fort Worth Food Desert'.
49 Dallas News (2020) 'Dallas planning to buy grocery store in food desert and try something new.'
50 Dallas Business Journal (2019) 'Farm stands remain oases in southern Dallas food deserts'.

3.2 Generating increased sales

Drones could generate $197 million of additional annual sales (within five years of launching at scale) by making it more affordable and more convenient for consumers to shop online. Of this figure, $25 million will be driven by delivery cost savings, while $172 million will be driven by time and expenses saved from consumer pick-up journeys.

Delivery costs are a significant expense for businesses in the Metroplex, especially for time-sensitive orders. Restaurants currently pay up to 30% of each order's value to food delivery providers.[51] Instant and same-day delivery of other purchases typically cost between $15-20 – these costs may be split between retailers and consumers.[52] Because of these costs, some businesses may find it unprofitable to offer last-mile delivery for some or all of their transactions, especially when they have to compete against free delivery services from e-commerce giants. In these cases, consumers are required to pick up their items in person, resulting in time, fuel and other expenses.

Current delivery methods are incompatible with customer demands, resulting in a significant missed opportunity to generate sales for businesses. Consumers expect their purchases to arrive promptly but they are also price sensitive: 41% are willing to pay extra for instant delivery, but close to 82% prefer free over fast shipping.[53] Many consumers say they do not buy online because delivery takes too long, with more than a quarter of consumers unable to order groceries and medications online because of long delivery times (Exhibit 12).[54] Delays also deter consumers from ordering online for small electronics, cosmetics and other items that could be delivered faster by drone. Drone delivery could unlock some of these sales opportunities as it could be 80-90% more affordable than current forms of instant and same-day delivery methods. For a local small business, this could bring average per-transaction delivery costs down from $5.80 to $1.30.

The availability of an efficient and affordable drone delivery option could help participating businesses to increase sales volume by 480 transactions per annum within five years of launching at scale, and up to 530 transactions per annum within ten years. For the average participating business, annual revenue could increase by around $26,000 in five years and $28,500 in ten years.

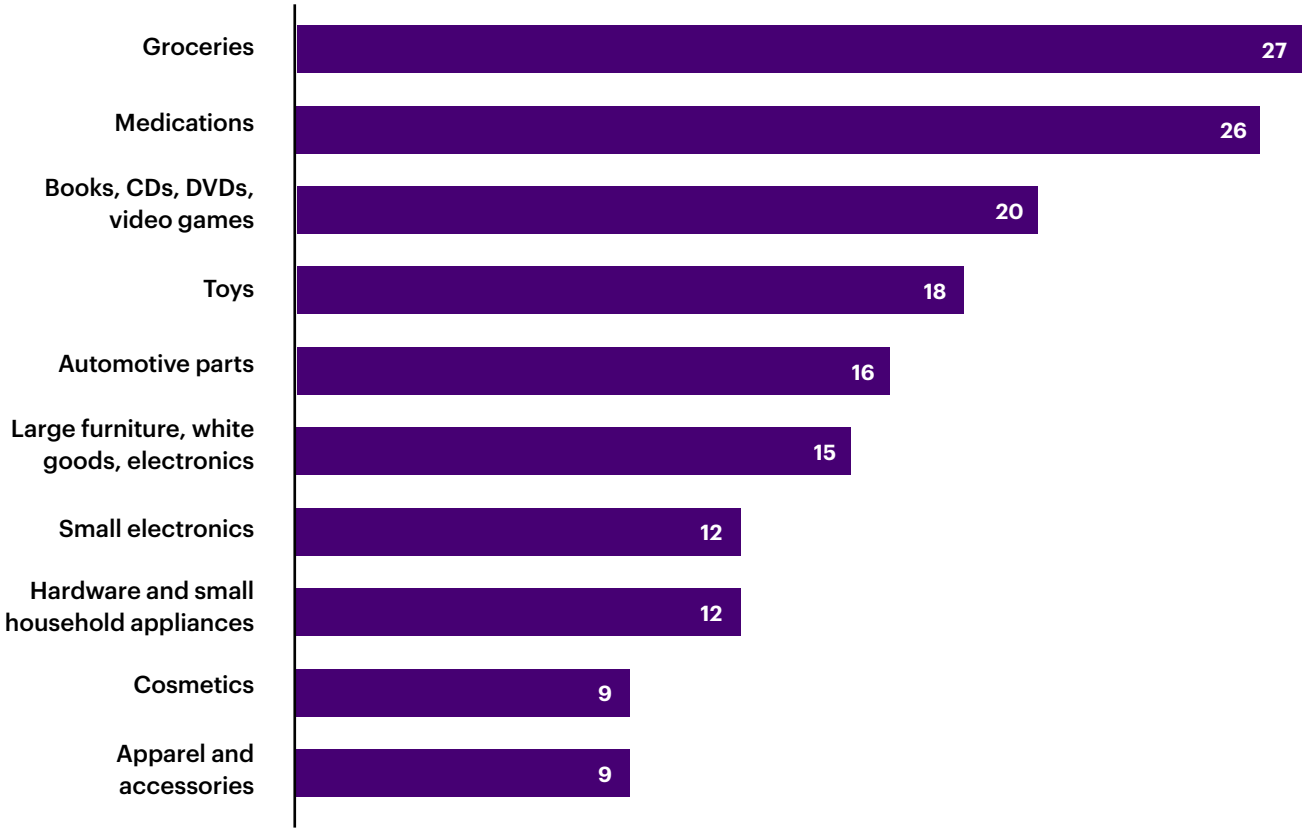
51 Based on pricing model of third-party aggregators. Uber Eats charges between 15% and 30% commission depending on delivery orders. Grubhub charges a minimum commission of 25%; and DoorDash charges about 20% of commission fees.
52 Accenture (2020) 'Reinventing last mile: Win the race to the top'.
53 PWC (2018) 'Signed, sealed, delivered (and regularly returned)'; Internet retailing (2017) 'When it comes to delivery, consumers prefer free over fast'; Digital Commerce 360 (2017) 'Consumers want free shipping, and they're not willing to wait very long for delivery'.
54 McKinsey (2016) 'Parcel delivery – the future of last mile'; Accenture Logistics Platform (2020) 'How could last mile delivery evolve to sustainably meet customer expectations?'.

EXHIBIT 12

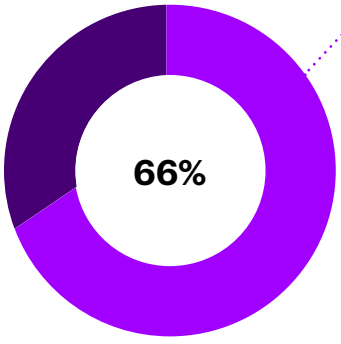
Faster delivery could lead to more purchases, particularly for groceries and medical items

Share of respondents who did not purchase an item online due to long delivery times[1]

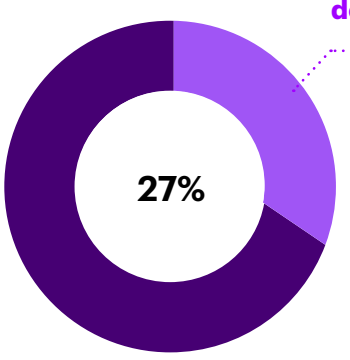
Percent of respondents



Respondents wanting 1-hour delivery options in metropolitan areas



Respondents abandoned an order because same-day delivery was not available



Note:

1. *Survey of 4,700 consumers in China, Germany and the US. Some of these purchases would be completed via in-store shopping and pick-up. Others would be abandoned altogether.*

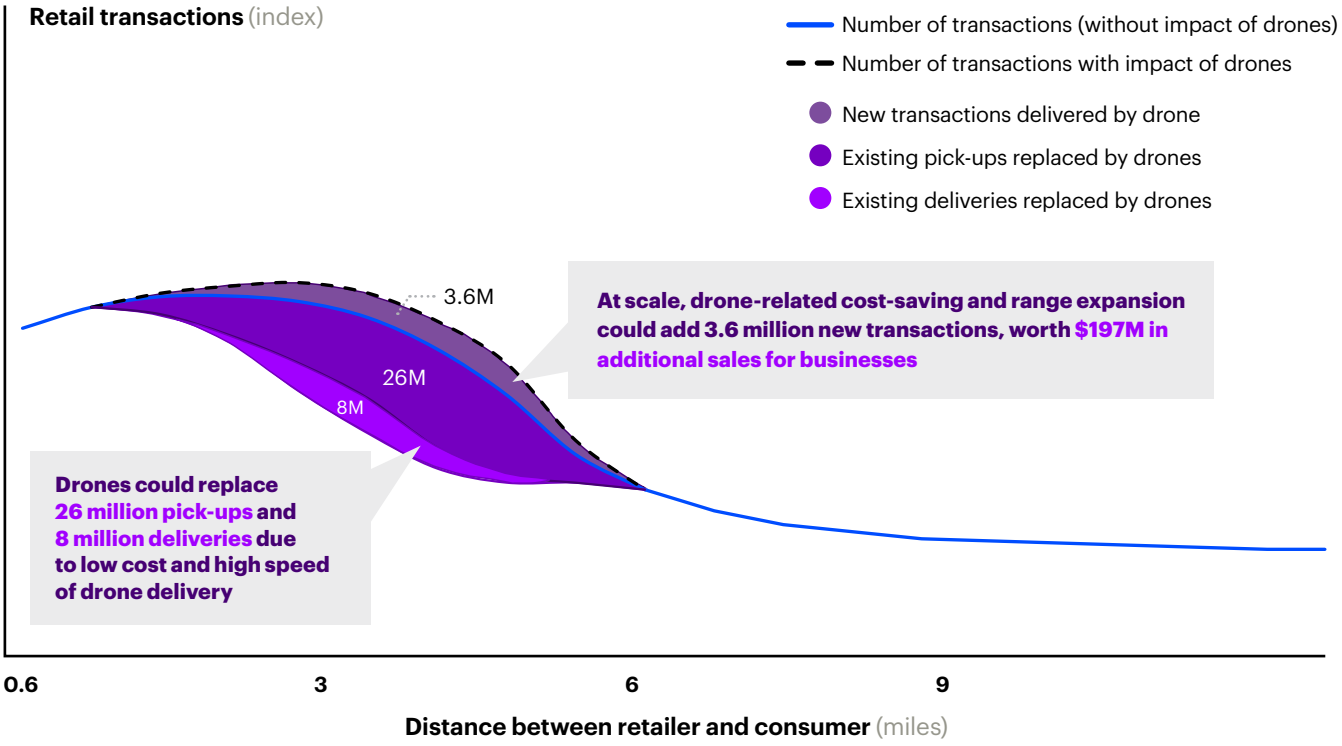
Source: McKinsey (2016) Parcel delivery – the future of last mile; Accenture Logistics Platform (2020) How could last mile delivery evolve to sustainably meet customer expectations?

EXHIBIT 13

Drones could generate $197 million in new retail transactions per year in the Dallas-Fort Worth Metroplex when at scale

Dallas-Fort Worth Metroplex transactions by distance between home and retailer

Estimated within five years of launching at scale



Note: Illustrative axis, retail transactions and distance between retailer and consumer are indicative.
Source: Accenture analysis.

3.3 Facilitating new business models

Restaurants and retail businesses are often located in premium locations with a high volume of foot traffic to attract sales. However, high rental costs put significant pressure on business margins and an increasing number of restaurants are exploring new business models. For example, virtual kitchens are delivery-only restaurants without a storefront. These restaurants are often located in peripheral locations with low rental costs, such as industrial parks. Virtual kitchens provide an opportunity to unlock underused real estate as landlords and food business operators grapple with the effects of the global COVID-19 pandemic. Several virtual kitchens have already begun operating in residential areas in the Metroplex. The New York initiative Kitchen to Kitchen recently launched two delivery-focused restaurants from a central commissary kitchen in Garland, northeast of Dallas. In a 2018 survey of restaurant operators, 7 in 10 respondents said they would be happy to adopt the virtual kitchen model, which could generate an estimated $7,000 increased profit per year.[55] Garland has emerged as an area of interest for virtual kitchen operators. Through greater coverage and higher delivery speeds, drone delivery can help to unlock these areas for the development of new businesses such as virtual kitchens. Drones allow restaurants to be located further away from consumers, while still meeting consumer expectations of receiving high-quality food within short delivery timeframes.

55 Colliers International (2019) 'Future of Food – How Ghost Kitchen Are Changing The Food Landscape'; Method Architecture (2020) 'Food from the Cloud'; US Census Bureau (2020) '2018 County Business Patterns'; Accenture analysis.

CASE STUDY

Drone delivery helps Brugh Coffee reach customers during the COVID-19 pandemic

At the height of the COVID-19 pandemic, Virginian authorities asked all residents to stay at home to slow the spread of the coronavirus. Dining and congregation areas – including café seating – was off-limits. Brugh Coffee was forced to close their door, the store grew quiet and sales slumped.

Fortunately, Brugh Coffee had drones.

Brugh Coffee is a specialty coffee roaster that serves local homes and businesses in Christiansburg, Virginia. The business has never before offered delivery, because road vehicles are too costly and too slow, according to co-owner Luke Brugh.

The speed and cost-efficiency of drones changed the game, allowing Brugh Coffee to offer delivery for the first time. Since the pandemic, Brugh Coffee has relied more heavily on a contactless business model involving online ordering, curb-side pick-up and drone delivery. Drone deliveries weren't the silver bullet to resolve Brugh' struggles during the pandemic, but they helped to relieve some of the financial burden. Some items sold 50% more on the first day of drone delivery.

The business currently supplies baked goods, cold brew and bags of coffee to households – cold brew sales are now doubled by drone compared to curb-side pick-up. Drones have typically been able to reach customers in half the time it would take to pick-up an order by road.

"Drone delivery makes it easier on those days where you really don't want to drive to get something and then you realize you can just order it using the Wing app and have it within ten minutes," Luke Brugh says.

"It's been nice during COVID-19, but I think it's a technology people will realize that they like having, that's useful to them."

"Drone delivery makes it easier on those days where you really don't want to drive to get something and then you realize you can just order it using the Wing app and have it within ten minutes."

4.

Benefits for society

Drone delivery could help improve population health outcomes and reduce congestion in the Metroplex

Timely, cost-effective and reliable drone deliveries can help improve consumers' access to prescription medication and make them more likely to take their medications as prescribed. Improving medication adherence in the Dallas Fort-Worth Metroplex will generate significant healthcare savings, estimated at $330 million per annum within five years and $610 million in ten years.

In addition, drones could replace 35 million motor vehicle journeys (120 million miles) otherwise needed to fulfil last-mile deliveries in the Metroplex – equivalent to removing 10,000 cars from the road. This could help avoid 180 road accidents in the area and cut 49,000 tons of carbon emissions. Due to reduced congestion, drivers and passengers will collectively save a total of 800,000 hours otherwise spent sitting in traffic.

EXHIBIT 14

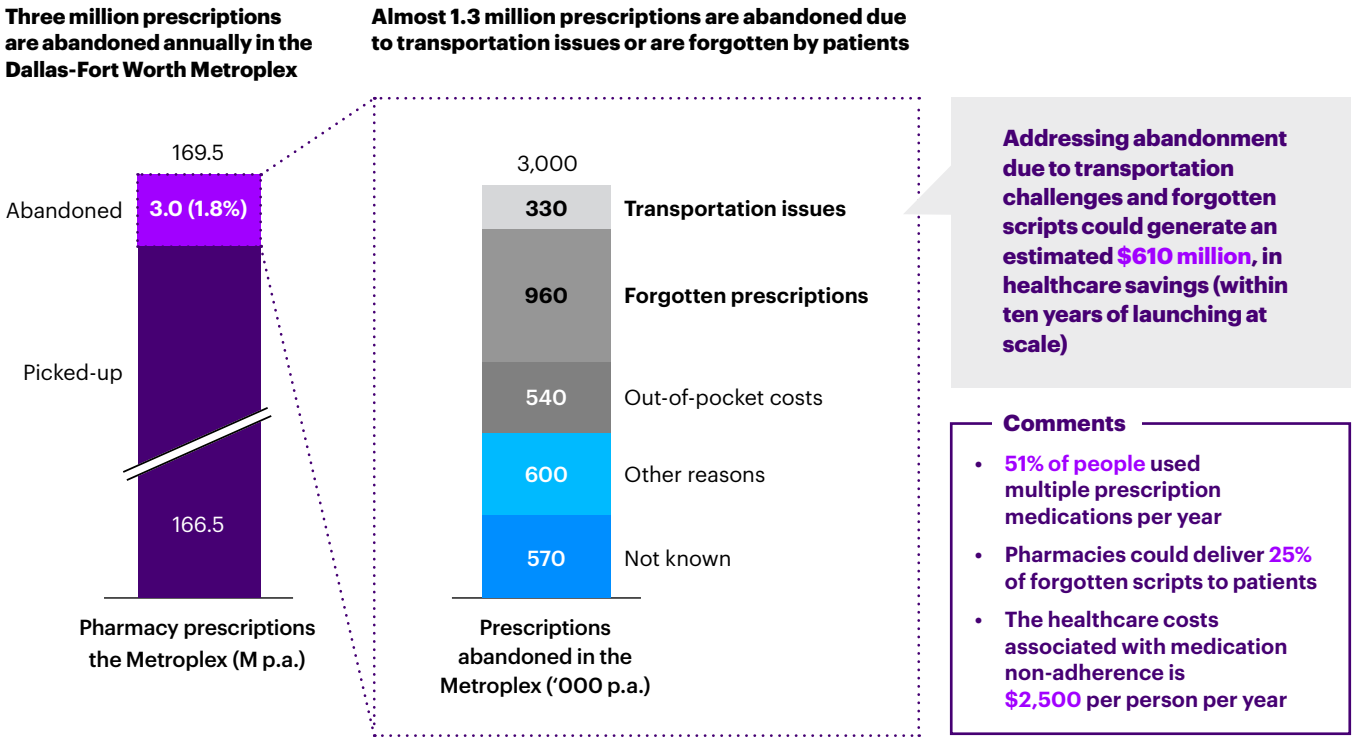
The potential impact of drone delivery for society in the Dallas-Fort Worth Metroplex

	Time horizon (years after drone delivery is launched at scale)	
Benefits for society	**Five years**	**Ten years**
Reduction in healthcare costs ($million p.a.)	330	610
Number of patients who benefit from healthcare savings ('000 patients)	275	458
Avoided vehicle miles traveled (deliveries and pick-ups in million miles p.a.)	120	470
Equivalent no. of cars removed ('000 cars p.a.)	11	41
Total time saved from congestion reduction per resident (million hours p.a.)	0.8	3.1
Total value of time saved from congestion reduction ($million p.a.)	16	60
Total carbon emissions avoided ('000 tons p.a.)	49	189
Equivalent carbon storage avoided (million trees p.a.)	1.7	6.7
Total avoided accidents (accidents p.a.)	190	725

Source: Accenture analysis.

EXHIBIT 15

Estimated healthcare cost savings in the Dallas-Fort Worth Metroplex



Note:
Abandonment rate of prescriptions were obtained from Shrank et al. (2010) 'The epidemiology of prescriptions abandoned at the pharmacy'. Persons that use multiple drugs are more likely to experience treatment failure after nonadherence of prescription medication. Annual healthcare cost savings were obtained from Watanabe et al. (2018) 'Cost of Prescription Drug-Related Morbidity and Mortality.

4.1 Improving healthcare

Medication nonadherence is a major challenge to the US healthcare system, costing more than $100 billion annually.[56] As described in Box 2, consumers abandon up to 2% (3 million) of prescriptions each year, due in part to transportation issues.[57]

Drone delivery can help make it cheaper and easier for consumers to adhere to their medication prescriptions. In the Metroplex, drone delivery of prescription medication could avoid a total of 480,000 prescription abandonments each year, including 330,000 prescriptions that are abandoned due to transportation challenges and 150,000 that are abandoned by patients who forget to pick up their medication.[58]

The Dallas-Fort Worth Metroplex could save a total of $610 million in healthcare costs by improving patient adherence to these 480,000 prescriptions. We expect this to be achievable by drone delivery within ten years of launching at scale. In five years, we expect the growing drone network to be able to achieve 50-60% of the potential savings – around $330 million.

In addition, delivery of healthcare care products and over-the-counter medication by drones would not only complement the increasing use of telehealth – where patients communicate with their doctors through video or teleconferencing – but also increase the safety of customers during a pandemic as they would not need to leave their homes.[59]

Drones could also be used for delivery of urgent and time-sensitive goods including automated external defibrillators (AEDs) and laboratory samples.[60] Drone deliveries of such high-impact items have been trialed at various locations worldwide and have been shown to deliver AEDs quicker than ambulances.

56 Iuga & McGuire (2014) 'Adherence and health care costs'.
57 Shrank et al. (2010) 'The Epidemiology of Prescriptions Abandoned at the Pharmacy'.
58 Clancy et al. (2019) 'Implementation of a community pharmacy workflow process to identify and follow up with prescription abandonment'
59 Webster (2020) 'Virtual health care in the era of COVID-19'; Deloitte (2019) 'The role of distributors in the US health care industry'.
60 Sanfridsson et al. (2019) 'Drone delivery of an automated external defibrillator – a mixed method simulation study of bystander experience'.

BOX 2

In pharmacy deserts, drones could help reduce prescription abandonment and waste

Access to pharmacies is important in the Dallas-Fort Worth Metroplex, where almost three in four adults use prescription drugs.[1] However, more than 11% (818,000) of residents live in 'pharmacy deserts', where the closest pharmacy is more than a mile away.

Of these people, 60,000 have no access to a vehicle and would need to walk or rely on public transportation to access healthcare products and medication. In addition, there are 86,000 people with disability living in pharmacy deserts, including 40,000 with mobility issues.[2] While consumers can receive prescription drugs by mail, same-day delivery, or pharmacy service, these options are relatively expensive. Consumers pay about $8 for same-day delivery, equivalent to 20% of the item value for a $40 transaction.[3]

Drones have a significant potential to improve access to medication across the Metroplex by enabling reliable, fast and cost-effective delivery. This is expected to reduce the abandonment of prescriptions, particularly among low-income populations and improve health outcomes for consumers.[4] Up to 2% (~2.5 million) of all prescriptions are abandoned annually in the Metroplex, of which 43% (~1.0 million) are attributed to transportation issues or are forgotten scripts.[5] This issue is more pronounced in low-income areas where about 18.9% (7,400) of consumers without vehicles abandon at least one prescription annually, negatively impacting medication adherence.[6] Section 4.1 describes the healthcare impact of medication nonadherence in more detail.

Drones also have the potential to streamline pharmacy businesses by allowing prescriptions to be dispatched in a timely manner. This would not only increase sales, but also reduce the cost of restocking abandoned medication by $9 million annually.[7]

1 *66% of all adults in United States use prescription drugs. 74.1% of the population in Dallas-Fort Worth-Arlington age 18 and above. Source: Ihara E (n.d.) 'Prescription Drugs'; US Census Bureau (2018).*
2 *Accenture analysis, based on pharmacy distribution in; Pednekar & Peterson (2018) 'Mapping pharmacy deserts and determining accessibility to community pharmacy services for elderly enrolled in a State Pharmaceutical Assistance Program'*
3 *CVS charges delivery service charge of $7.99 and the packages will be delivered by Shipt. NimbleRx also charges $7.99 for deliveries.*
4 *Lyon-Hill et al. (2020) 'Measuring the Effects of Drone Delivery in the United States'.*
5 *Kennedy et al. Pharm (2008) 'Unfilled prescriptions of medicare beneficiaries: prevalence, reasons, and types of medicines prescribed'.*
6 *Shrank et al. (2010) 'The Epidemiology of Prescriptions Abandoned at the Pharmacy'.*
7 *The costs of re-stocking abandoned medication are almost $9 per prescription. Source: obtained from Bekker et al. (2019) 'What does it cost to redispense unused medications in the pharmacy? A micro-costing study'; Pharmacy and drug store gross margin as a percentage of sales have decreased from 26.7% in 2014 to 24.8% in 2018. Source: US Census (2020) 'Annual Retail Trade Survey: 2018'.*

Source: US Census (2020) 'Annual Retail Trade Survey: 2018'.

4.2 Reducing congestion

Today, vehicle undertaking last-mile delivery and pick-ups in the Metroplex travel about 2.5 billion miles every year. Delivery vehicles are large, heavy, and can disproportionately disrupt other road users. Parking and access to loading areas can delay and inconvenience other commuters and pedestrians.

Within the next five years, pick-up and delivery transportation vehicle miles traveled (VMT) are expected to reach 2.8 billion miles per year, amid strong growth in e-commerce and food delivery. By that time, it is estimated that pick-ups and deliveries could be responsible for around 3% of the miles traveled on roads in the Metroplex, generating further emissions and parking issues, and worsening traffic congestion.

By supporting around 2% of last-mile transactions within five years of launching at scale, drones can reduce delivery VMT by 120 million miles per year, equivalent to removing 11,000 cars from the road.[62] In ten years, as growing demand for e-commerce fuels the growth of delivery VMT to 3.3 billion miles per year, the reduction in VMT from drones could be equivalent to removing 41,000 cars from the road. This can materially reduce congestion, greenhouse gas emissions and road accidents.

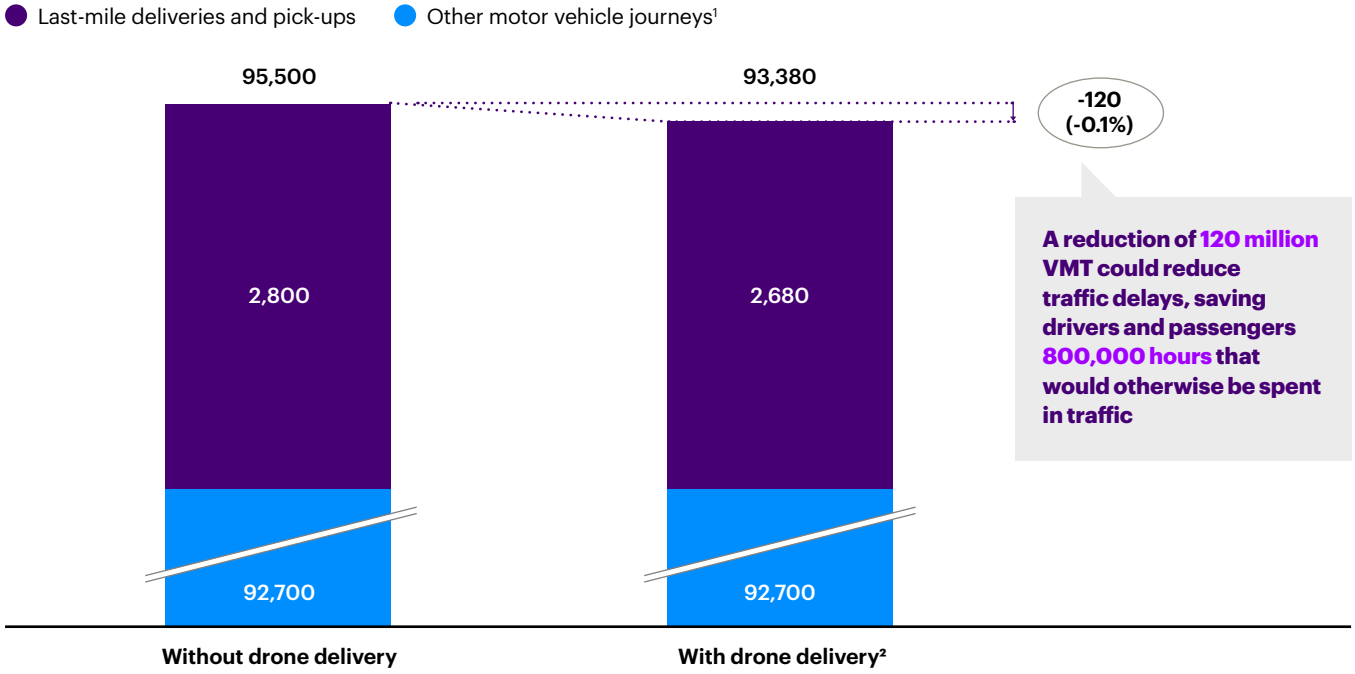
The Dallas-Fort Worth Metroplex is the 10th most traffic-congested area in the country and drivers spend the equivalent of three days (67 hours) a year stuck in traffic.[61] By reducing road traffic in the area, drones will alleviate congestion, which is expressed in terms of total person hours of delay. We expect a 120 million VMT reduction to reduce traffic delays by 800,000 driver and passenger hours.[62] This time saving has an estimated value of $16 million based on current time and vehicle costs.

EXHIBIT 16

Dallas-Fort Worth Metroplex road traffic could fall 120 million miles as flying drones replace delivery vehicles

Projected motor vehicle usage on Dallas-Fort Worth Metroplex roads in five years' time

Annual vehicle miles traveled (millions), drone delivery assumed to be at scale



Notes:
1. *Five-year projection for 'other vehicle journeys' is based on a 1.6% CAGR calculated from historical VMT data (2015-2018) in the US.*
2. *Does not include drone deliveries that replace bike deliveries.*

Source: Bureau of Transportation Statistics (BTS), Accenture analysis.

61 Texas A&M Transportation Institute (2019) 'Urban Mobility Report'.
62 The reduction in 110 million VMT is estimated to represent a 0.1% reduction in total distance traveled in the Metroplex in 2025. Based on analysis of the relationship between traffic congestion (in terms to total person hours of delay) and VMT from 2007 to 2017, we estimated that a 1% reduction in VMT would result in 1.9% reduction in total delay hours. Based on the 0.1% reduction in VMT, we estimated that total delay would reduce by 0.24% which is estimated to be around 800,000 passenger hours.

4.3 Reducing emissions

There is an urgent need for countries to lower their greenhouse gas emissions, which, if left at current levels, could have devastating global effects. Residents in the Metroplex have experienced extreme weather from flooding and storms to heatwaves and drought. By 2050, the Metroplex is likely to experience a 5°F increase in average temperature during summer months if global greenhouse gas emissions continue to increase.[63]

Research by Texas A&M shows that based on current trends, the consequences of climate change for Texas will be significant, including having twice as many 100-degree days each year, extended wildfire seasons and a greater frequency of other extreme weather events.[64]

The City of Dallas is committed to meeting the international emission reduction targets set by the Paris Agreement in 2016 and the goal to keep warming globally at or below 3.6°F. In 2017, Dallas Mayor Rawlings signed on to the Mayors National Climate Agreement in support of the Paris Agreement. In 2019, Dallas Mayor Johnson reaffirmed the City's ongoing commitment to protecting the community from the impacts of climate change and taking measures to reduce greenhouse gas emissions.

The Metroplex emits close to 10 tons of greenhouse gas per capita from transportation each year, 5% more than the US average.[65] Road transportation accounts for 33% of emissions in the Metroplex.[66] Drones can play a significant role in reducing emissions in the Metroplex by replacing on-road journeys.

Drones are more environmentally friendly than existing transportation methods, which in the Metroplex consist primarily of motor vehicle trips. A 2018 study (results shown in Exhibit 17) found that small drones generate 259 grams of greenhouse gas per last-mile delivery, in comparison to 296-728 grams for delivery trucks or vans after accounting for the economies of scale that a truck can achieve by delivering multiple packages along their route. Personal pick-ups via car are the worst polluters, emitting an average of 4,600 grams of greenhouse gas per trip.[67]

By using drones to fulfil around 2% of its deliveries, the Metroplex could lower its greenhouse gas emissions by about 49,000 tons or the equivalent of carbon storage of more than 1.7 million trees across 44,000 football fields in 2025.[68]

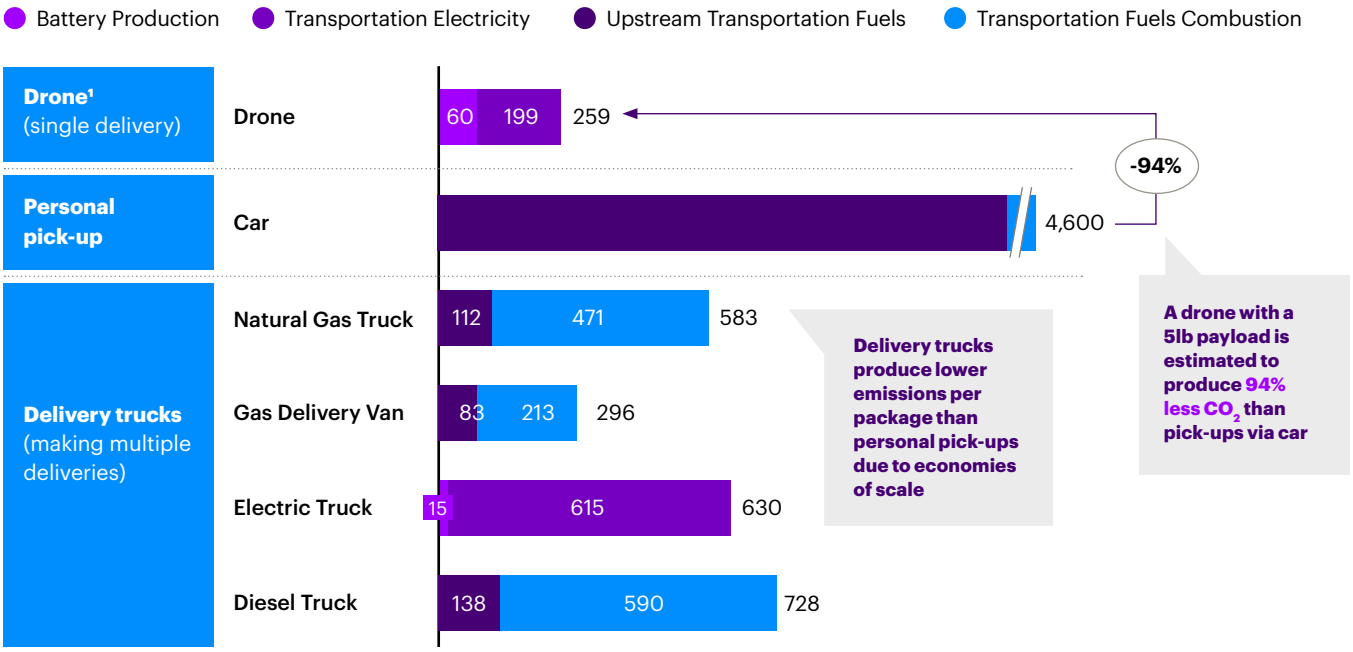
63 City of Dallas - Office of Environmental Quality & Sustainability, and AECOM (2020), Comprehensive Environmental & Climate Action Plan (CECAP) Draft Plan.
64 Texas A&M University, Office of the Texas State Climatologist (2020) "Assessment of historic and future trends of extreme weather in Texas".
65 City of Dallas Greenhouse Gas Emission Inventory (2015) '2015 Greenhouse Gas Emissions Inventory'.
66 Community on-road transportation generated about 6.8 million MT of CO_2 and total emissions from the community was 20.3 million tons.
67 While a shift to renewable energy would reduce these costs, it would also reduce emissions from drones. Modeling of carbon emissions per delivery obtained from Stolaroff et al. (2018), 'Energy use and life cycle greenhouse gas emissions of drones for commercial package delivery'. The estimates used in this paper exclude the fixed warehousing component (we consider the marginal emissions per vehicle trip only). Stolaroff et al. (2018) argue that a drone network requires more warehousing than other delivery modes.
68 Greenhouse gas to carbon storage using EPA equivalency calculator (2018). Assumes that trees absorb about 50 pounds of carbon per annum.

EXHIBIT 17

For rapid deliveries, drones generate ~94% lower emissions than deliveries by car and are cleaner than other delivery options

Marginal environmental impact per package by mode of rapid delivery[1]

Grams of CO_2 equivalent per delivery ('last-mile' only)



Notes:

1. *Example is based on a drone with 2.5kg payload. The carbon emission is estimated based on a linear interpolation between the small and large drones modelled by Stolaroff et at. (2018), including battery production as the battery incurs wear with each delivery.*
2. *Excludes fixed emissions (such as those associated with warehousing) – it should be noted that a drone network may require more warehousing than a traditional delivery network (as argued by Stolaroff et al., 2018).*
3. *Stolaroff et al. assume trucks deliver 1.51 packages per mile traveled in the base case estimates. This sits between the 'same-day' and 'next-day' estimates used throughout this paper.*

4.4 Reducing accidents

Today, there are more than 128,000 motor vehicle crashes on roads in the Metroplex each year.[69]

Dallas and Fort Worth respectively have the fifth and sixth-highest rate of fatal traffic accidents among the 25 largest US cities.[70] Dallas drivers experience a collision every seven years on average compared to the average of once every 10.5 years in the US, meaning commuters in Dallas are about 46% more likely to get into a wreck than the average US driver. The risk of collision is almost as high in Fort Worth, at 30% above the US average.[71]

Replacing 120 million VMT of road-based deliveries and pick-ups could result in 190 fewer accidents each year.[72] This estimate is based on avoided road mileage from drone delivery and the average rate of crashes per mile traveled across the state of Texas. The injuries, time, inconvenience and economic cost caused by vehicle accidents are significant and should not be neglected.

69 Sum of total crashes for 13 north Texas counties using data from Texas Department of transportation(2019) 'Crashes and Injury by County'
70 National Highway Traffic Safety Administration using data from 2017.
71 Allstate America's Best Driver Report (2019).
72 Texas Department of Transportation(2019) 'Crashes and Injuries Cities and Towns'; Texas Department of Transport (2020) 'Comparison of motor vehicle traffic deaths, vehicle miles, death rates and economic loss 2003-2019'.

5.

Appendix

A.1 Constructing a scenario for the future role of drone delivery

The first step in estimating the benefits of drone delivery is understanding the number and types of deliveries that might be undertaken by drones in the future (see Appendix A.2). To accomplish this, the size of the current retail last-mile delivery market was estimated and grown over five- and ten-year horizons based on forecast economic growth in Texas (Exhibit 18).[73] Transactions were then characterized across several dimensions (retail category, weight, time sensitivity and distance from retailer) based on data inputs, expert consultation, and supporting assumptions. These transactions were further broken into those which are delivered today (versus picked up by customers) and how that might change. Assumptions were then made about the uptake of drone delivery for each transaction type (see Appendix A.3).

A.2 Sizing the last-mile delivery sector

To estimate the last-mile delivery market size, we divided retail sales into four relevant categories (as shown in Exhibit 18). We used Bureau of Labor Statistics (BLS) and Texas Comptroller data on consumer expenditure to find the total value of sales in in each category and divided it by the estimated average purchase sizes to find transaction volumes. This number of transactions was then grown to future period values in line with real economic forecasts from the Texas Comptroller.[74]

The transactions in each category were then split across three dimensions, in addition to their current mode (pickup/home delivery):

- Distance from the merchant to the end destination (i.e. customer's residence)
- Time sensitivity of the purchase — how quickly the item is required/wanted (instant, same day, or standard)
- Size/weight (in pounds) of the transactions

The assumptions used to disaggregate transactions into these components are shown below in Exhibit 19.

EXHIBIT 18

Estimating the number of transactions in 2030

	2019 retail sales,[1] $Million	**Average transaction size**[2] $	**Source**	**Number of transactions in 2019,** Million		**Number of transactions in 2030,** Million
Takeout food & beverages	**5,358**	**35.5**	Edison Trends (2020), food delivery sales	**151**	**Grown to 2030 at real GSP forecast of ~3.0% p.a.**[3]	**208**
Grocery	**16,486**	**36**	Food Marketing Institute (2018), Supermarket facts	**458**		**633**
Pharmacy & medical	**2,731**	**33**	BLS Consumer Expenditure Survey (2019) Public Use Microdata	**83**		**115**
Household items & other	**54,746**	**70.7**	Vend (2018) Retail Data 2018: 30 Retailer Statistics You Need to Know; average transaction size for relevant items	**775**		**1,069**
						Total of ~2.0 billion transactions in 2030

1 From Bureau of Labor Statistics (2019) Consumer Expenditure Survey Public Use Microdata and Texas State Comptroller data.
2 *Figures have been grown by CPI to 2020 levels where needed.*
3 *Estimated based on forecast Texas GSP growth in retail and leisure & hospitality categories; data from Texas State Comptroller GSP forecasts (Summer 2020).*

73 Texas GSP growth forecast in retail and leisure & hospitality categories; data from Texas State Comptroller GSP forecasts (Summer 2020).
74 Texas State Comptroller GSP forecasts (Summer 2020).

EXHIBIT 19

Distance, time sensitivity and size assumptions for transactions

Distance assumptions

Distance from outlet, %	% of households
<0.6 mi	10%
0.6-3 mi	60%
3-6 mi	25%
6+ mi	5%

Time sensitivity assumptions

Time sensitivity by category, %	Instant (<1 hr)	Same day	Standard (>1 day)
Takeout food & beverages	100%	N/A	N/A
Grocery	20%	60%	20%
Pharmacy and medical	45%	37%	18%
Household items[1]	2%	40%	58%

Size distribution of transactions

				Notes
	**Takeout food & beverages**	Small (<5lbs) Medium (5-13lbs) Large (>13lbs) **Total**	85% 10% 5% **100%**	• 5 lbs. payload assumed to capture 80-90% of today's food delivery
	**Grocery**	Small (<5lbs) (*Top-up*) Medium (5-13lbs) (*Top-up*) Large (>13lbs) **Total**	40% 30% 30% **100%**	• 2.5 supermarket visits per week (from FMI, 2019) – assume one is weekly shop and other 1.5 are top-ups (distributed evenly between small and medium) • Convenience stores included in this category, and have smaller purchase sizes, so share of small transactions increased slightly to 40%
	**Pharmacy & medical**	Small (<5lbs) Medium (5-13lbs) Large (>13lbs) **Total**	89% 10% 1% **100%**	• Based on an estimated distribution of baskets in the BLS Consumer Expenditure Survey (see below) • Granular estimates are sourced from this distribution
	**Household items & other**	Small (<5lbs) Medium (5-13lbs) Large (>13lbs) **Total**	49% 43% 8% **100%**	• Based on distribution of transactions between different subcategories within household items (e.g. furniture, electrical, hardware, etc.), and the share of each that is likely to be heavy, medium or light • Granular estimates are the result of a weighted average calculation

Note:
1 Based on McKinsey (2016) 'Parcel delivery – The future of last mile' with adjustments from expert interviews.
Source: Bureau of Labor Statistics (2019) Consumer Expenditure Survey, FMI (2019) US Grocery Shopper Trends, interviews with Wing, Google Maps analysis, consultation with logistics experts, Accenture Analysis.

Calculating weight distribution for pharmacy and personal care transactions

The pharmaceutical and personal care sector is broad and the steps taken to arrive at the weight distribution shown in Exhibit 19 are given in Exhibits 20 and 21.

From the dataset of transaction weights resulting from the process in Exhibit 20, a density function was estimated and used to calculate the proportion of transactions within relevant bands (Exhibit 21).

EXHIBIT 20

Constructing basket weights from consumer expenditure data

Illustrative pharmacy and personal care basket from Consumer Expenditure Survey data

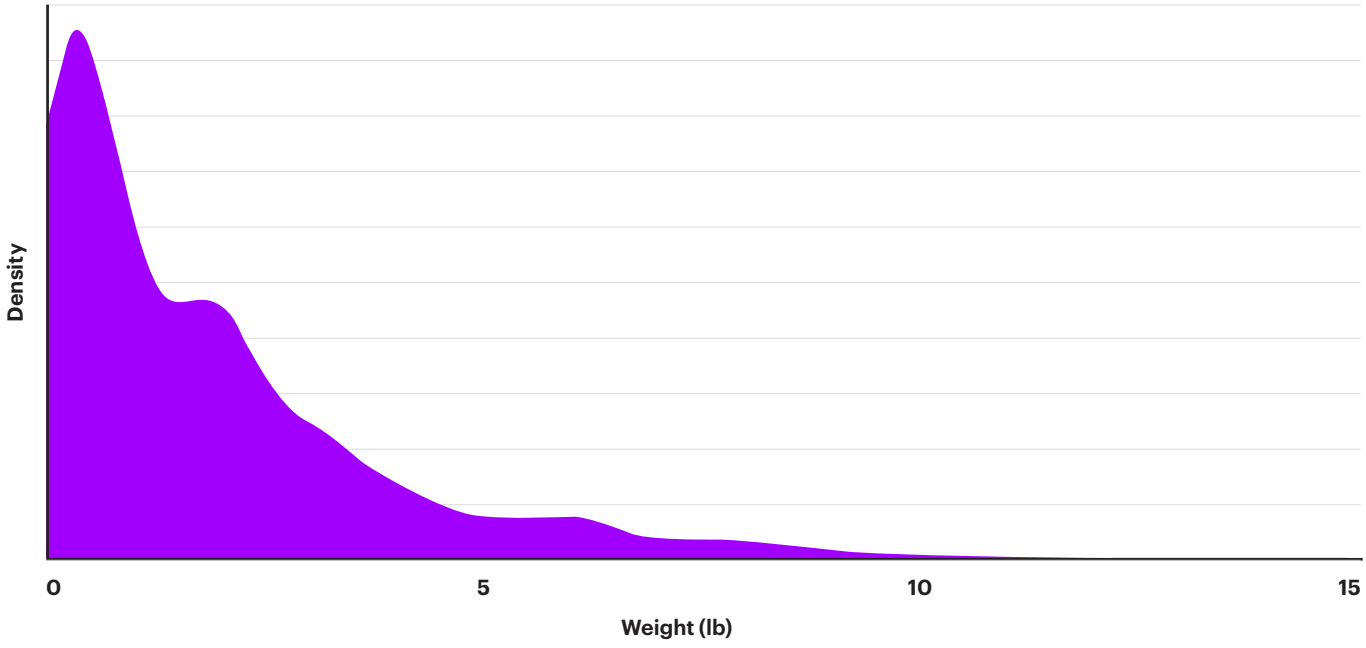
Expenditure category	Cost ($)	Weight
Prescription drugs	4.0	
Prescription drugs	14.3	
Non-prescription drugs	7.8	?
Topicals and dressings	7.2	
All four expenditure items	**33.3**	

Representative item weights were joined to expenditures reported by consumers in 2018 to estimate the weight of transactions

Note:
Weights were taken from existing online store listing of items considered representative of each expenditure category.
Source: Bureau of Labor Statistics (2019) Consumer Expenditure survey, desktop research.

EXHIBIT 21

Estimated density of pharmacy and personal care transactions



Note: Distribution estimated as a kernel density using a Gaussian kernel.

Following the breakdown across these three dimensions, we estimated the share of transactions delivered and picked up. This was informed by a variety of external data sources relating to both current shares and projections for the future, shown in Exhibit 22.

EXHIBIT 22

Estimating the share of transactions that are delivered

	Current based on 2019 data		In ten years	
			Five-year estimates assume constant CAGR	
Takeout food & beverages	16%	Average US online takeout delivery market shares from Colliers and Morgan Stanley, expressed as share of total takeout food sales	40-50%	Existing growth and market estimates of online takeout and delivery (Morgan Stanley 2018)
Grocery	5%	Share of transactions that are delivered (consultancy research from Bain & Company 2019 and Brick Meets Click 2019)	25-35%	Engagement with industry sector experts. Delivery market estimate using predicted growth (Nielsen & FMI 2018)
Pharmacy & medical	4%	Ratio of mail order to total prescription drug sales in Texas (IQVIA 2019)	50-60%	Projected e-pharmacy share and growth rates (IQVIA 2019, Fortune Business Insights 2019)
Household items & other	11%	E-Commerce as a share of total retail in the US, obtained from Census Bureau Quarterly E-Commerce Report (average across 2019)	25-35%	Current market and forecast based on historic growth (Census Bureau Quarterly E-Commerce Report)

Source: Colliers (2019) Future of Food (Winter 2019 Retail Spotlight Report); Bain & Company (2019) Omnichannel Grocery Is Open for Business—and Ready to Grow; Brick Meets Click (2019) Grocery Shopping Survey; Census Bureau (2020) Quarterly E-Commerce Report (2nd Quarter); Morgan Stanley (2020) Can Food Delivery Apps Deliver Profits for Investors; IQVIA (2019) Custom data request, quoted in KFF (2019) is Number of Mail Order Prescription Drugs Per Capita; Fortune Business Insights (2019) Global ePharmacy Market to Touch USD 177,794.9 Million by 2026.

The net result of these steps is a cross-tabulated dataset across each time horizon — today, in five years and in ten years — with estimated transactions by retail category and current delivery mode for each combination of weight, distance, and time-sensitivity. This is stylistically shown in Exhibit 23 below.

EXHIBIT 23

A dataset was constructed that provides a detailed breakdown of current and future retail transactions

Weight (lbs)	**Distance** (miles)	**Required delivery timeframe**		
		Instant delivery (<1 hour)	**Same day**	**Standard** (>1 day)
<5	<0.6			
	0.6-3			
	3-6			
	6+			
>5	<0.6			
	0.6-3			
	3-6			
	6+			

For each cell, the dataset contains the number of transactions, split by:

- **Retail product category**
- **Whether the transactions are delivered or picked up by the customer**

These figures are estimated for the present and future periods based on a range of data sources and assumptions.

A.3 Establishing a reasonable scenario for drone uptake

For each cell in Exhibit 23 above, assumptions were made about the share of transactions that are expected to be serviced by drone delivery. These are assumptions only and represent an example scenario rather than a prediction of future uptake.

Each transaction was assigned a probability of replacement based on its characteristics (Exhibit 24). Considerations included distance, weight, time sensitivity, current delivery method and retail category.

Assumptions were developed first for the ten-year scenario. For the five-year estimates, we retained similar demand-side assumptions but constrained these figures based on expected drone delivery supply limitations including gradual roll-outs and regulatory constraints.

To arrive at an overall estimate of the share of transactions that are delivered by drone, the individual replacement rates were combined with the transaction data estimated in Section A.2. On a weighted-average basis, this suggests that 6.5% of transactions could be delivered by drone in the long run (ten-year estimate), and 2% of transactions when supply constraints are applied (five-year estimate).

EXHIBIT 24

Assumptions were made about the potential uptake of drone delivery for the relevant transaction types

% of transactions in the Metroplex that are expected to be delivered by drone

Transactions in scope for drone delivery

Within five years of launching at scale

Weight (lbs)	Distance (miles)	Required delivery timeframe		
		Instant delivery	Same day	Standard
<5	<0.6	3-10%	1-6%	
	0.6-3	6-12%	3-6%	
	3-6	6-10%	3-6%	
	6+			
>5	<0.6			
	0.6-3			
	3-6			
	6+			

Within ten years of launching at scale

Weight (lbs)	Distance (miles)	Required delivery timeframe		
		Instant delivery	Same day	Standard
<5	<0.6	10-33%	5-20%	
	0.6-3	20-40%	10-20%	
	3-6	20-33%	10-20%	
	6+			
>5	<0.6			
	0.6-3			
	3-6			
	6+			

Factors influencing the share of transactions undertaken by drone include:

1. **Distance: A maximum distance of 6 miles was assumed and very close transactions are less likely to be delivered by drone due to competition with foot and bicycle.**
2. **Weight: A maximum item weight of 5lbs was imposed.**
3. **Time sensitivity: Drone uptake is higher for instant transactions due to the higher speed and lower cost of drones versus other methods of instant delivery.**
4. **Current delivery method: Delivered transactions are generally more likely to be replaced by drone than pick-ups as the latter represents a bigger behavioural change**
5. **Retail category: Other item characteristics that make it more susceptible to delivery changes.[1]**

Dimensions 4 & 5 are aggregated in this exhibit for presentation purposes.

Note:
1. *For example, takeout food uptake is assumed to be higher as it has formed the primary use for previous drone delivery trials as well as other app-based delivery approaches today, while pharmacy uptake is high due to the nature of the category making it suitable for industry-wide delivery changes.*

Source: Accenture analysis.

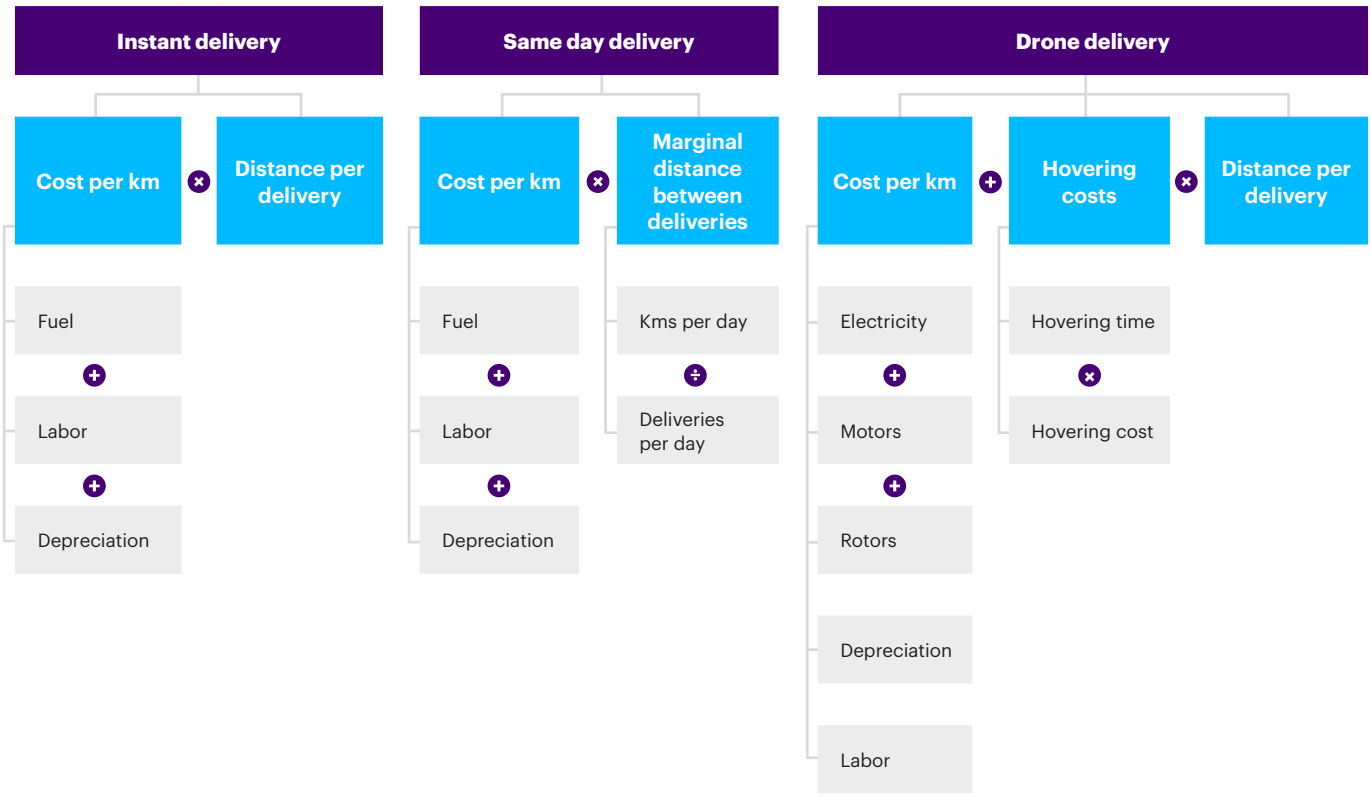
A.4 Estimating the change in delivery costs

A.4.1 Estimating the cost of current and future delivery modes

This report considered the marginal cost associated with a delivery when completed by bikes, cars, vans, and drones. The components of these costs include labour, fuel, and depreciation for current modes (bikes, cars, and vans). For drone delivery costs, we aggregated the cost of inputs including motors, rotors, batteries, labour and electricity (Exhibit 25). The marginal costs were calculated for each mode across distance and urgency categories. The cost savings from drone delivery estimated in this report (in the range of 80-90%) are consistent with external estimates (see Exhibit 26).

EXHIBIT 25

Estimating the cost of instant, same day, and drone delivery[1]



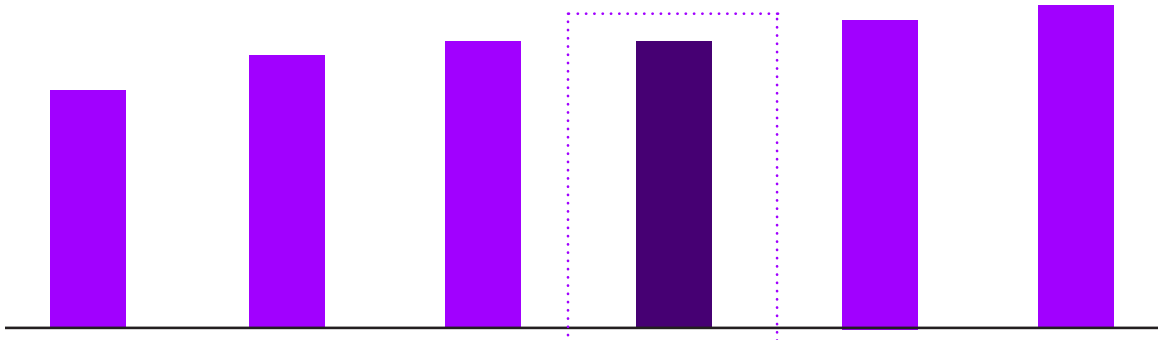
Note:
1. *Distances were calculated for each distance category: <0.6mi, 0.6-3mi, 3-6mi; estimated delivery distances are equal to the average return trip for each distance category.*

EXHIBIT 26

80-90% drone cost savings are consistent with existing views

Estimated cost per delivery by source

% estimated cost saving



% decrease from drone delivery	70%	80%	85%	80-90%	91%	95%
Source	Interview with **JD.Com**	**Deutsche Bank**[1] cost saving for Amazon	**ARK Invest**[2] drone cost scenario for Amazon	**Accenture Analysis** drone delivery in the Dallas-Fort Worth Metroplex	**Prashab Menon** cost saving from Amazon drone delivery	Interview with **Amazon robotics**
Type of delivery in example	Total cost of all retail delivery	*Assumptions unclear*	2.3kg package transported 16km Compared to express	Instant delivery for deliveries under 5lbs over short-medium distances	*Assumptions unclear*	2kg package transported 10km

Note:

1 Cost saving from a combination of delivery automation, drones and robots.
2 Labor costs are a high share of potential drone delivery costs, at 60%.
Source: Desktop research, ARK Invest, Business Insider, University of California Berkeley, Ivey Business Review.

A.4.2 Estimating the cost of instant delivery

To estimate the cost of instant delivery, we assume that food delivery and instant-service private couriers deliver only one parcel per trip. These deliveries essentially operate point-to-point and so the marginal cost is the cost associated with a trip between the origin and destination points.

Under this scenario, the distance traveled per delivery is similar between current modes and drone delivery, simplifying the process of estimating cost savings. Assumptions, tested with industry experts, were made on average delivery speeds and distances for current modes accounting for road design, traffic, and route activities.

Instant delivery is more expensive than same-day or standard delivery because economies of scale are harder to achieve (as the item must be transported directly from the retailer to the customer). This stratification of costs is consistent with market prices from FedEx, Uber Eats, and delivery startups such as Lalamove and TaskRabbit.

EXHIBIT 327

Inputs and sources for calculating current delivery costs

Area	Metric	Source
Marginal cost of delivery	Fuel costs	• Texas gasoline and diesel prices (US EIA 2019) • US Department of Energy/EPA Fuel Economy Checker: parcel van and passenger sedan
	Labor costs	• Indeed, Bureau of Labor Statistics (2019) Occupational Employment Statistics
	Labor (pick-up) costs	• US Census Bureau (2019) American Community Survey
	Depreciation costs	• CarGurus, USNews: Mercedes Sprinter and Toyota Corolla Depreciation over 5-8 years
	Trip speed	• Industry expert interviews
Distance of marginal trip	Distance traveled per trip by vehicle	• US Bureau of Transportation Statistics • Industry expert interviews
	Parcels delivered per day	• Accenture analysis • Industry expert interviews

A.4.3 Estimating the cost of same-day and standard delivery

For valid cost comparisons with existing delivery modes, economies of scale were considered for same-day and standard delivery. These scale benefits come from parcels being delivered on combined, optimised routes and hugely improve the unit economics of parcel delivery. Compared to point-to-point delivery, these options are significantly cheaper.

Conservative assumptions were made with respect to the scale of benefits from parcels being delivered together. The marginal distance per parcel was determined to increase with the distance between its destination and point of origin (i.e. logistics center or shop) and reduced by the capability of providers to combine parcels on their routes.

A.4.4 Estimating the cost of drone delivery

A bottom-up approximation of drone costs was undertaken for this report. This included the physical components of a drone and the costs associated with operations, such as pilot labor and electricity. To ensure realistic estimates, conservative assumptions were taken with respect to weight capabilities, range, speed, and cost.

EXHIBIT 28

Inputs and sources for calculating drone delivery costs

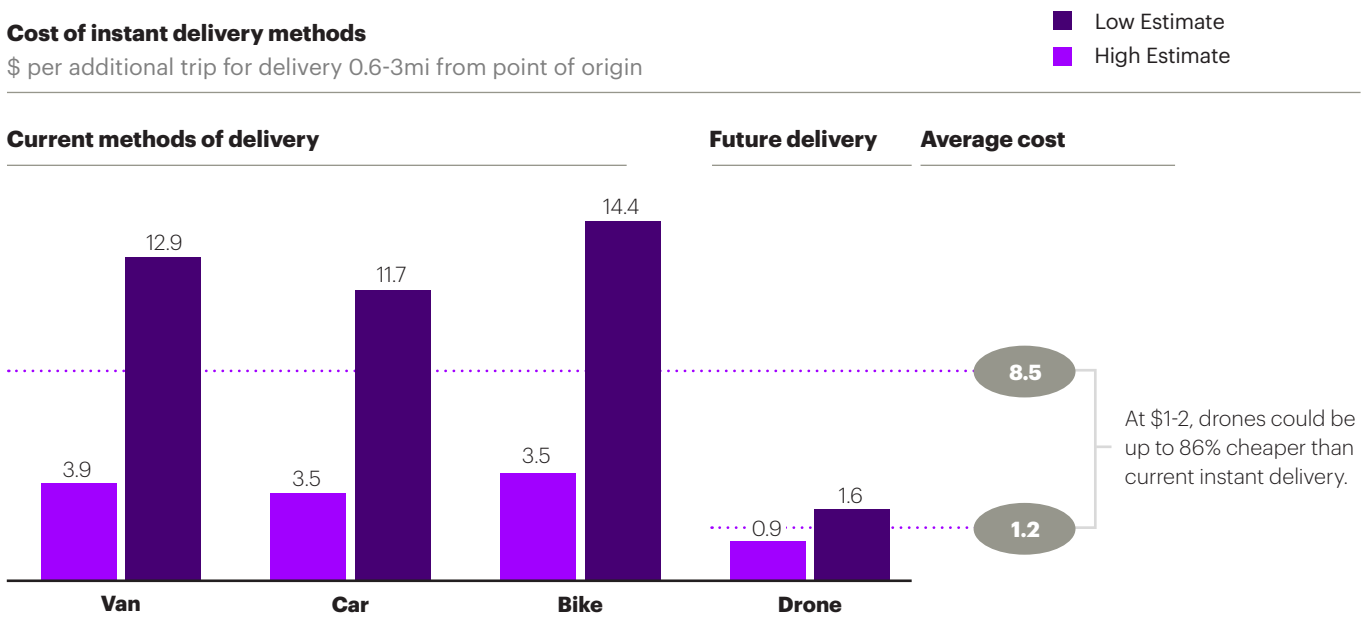
Area	Metric	Source
Marginal cost of delivery	Electricity and battery costs	• Jenkins et al. (2017) Forecast of commercial UAS package delivery market • Industry expert interviews • Accenture analysis
	Depreciation costs (including motors and rotors)	
	Labor costs	• Indeed, Bureau of Labor Statistics (2019) Based on commercial pilot salary
Operating trip assumptions	Hovering time	• Jenkins et al. (2017) Forecast of commercial UAS package delivery market • Industry expert interviews • Accenture analysis
	Speed	
	Flight time	
	Trips per day	

EXHIBIT 29

At $1-2 per trip, drones could be 86% cheaper than current instant delivery[1]

Cost of instant delivery methods

$ per additional trip for delivery 0.6-3mi from point of origin



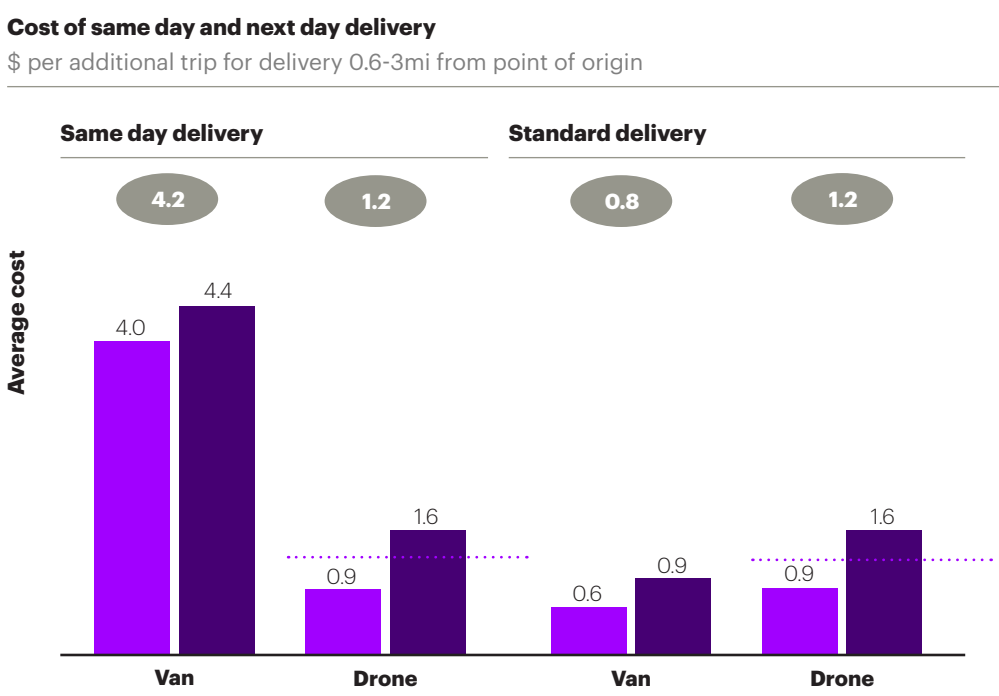
Note:
1. Assumes an instant delivery return trip of 1.2-6mi.
Source: Accenture analysis.

EXHIBIT 30

Drones become less cost-efficient when competing with large vehicles that gain economies of scale by delivering multiple parcels[1]

Cost of same day and next day delivery

$ per additional trip for delivery 0.6-3mi from point of origin



- At $1-2 per trip, drones can be competitive in same day delivery, up to 71% cheaper than a parcel van
- However, drones are more than 55% more expensive than parcel vans for next day delivery, where large vehicles achieve economies on scale.

Note:
1. Assumes initial delivery distance is 1.1-1.2 mi per delivery for same day delivery; 0.2-0.4 mi per delivery for next day delivery.

A.5 Estimating benefits for local businesses

A.5.1 Reducing delivery costs

With the estimates of costs for various delivery modes described above, the potential reductions as a result of shifting to drone delivery was estimated. The method for this estimate is shown below in Exhibit 31.

EXHIBIT 31

Calculating the reduction in last-mile delivery costs for businesses in the Dallas-Fort Worth Metroplex

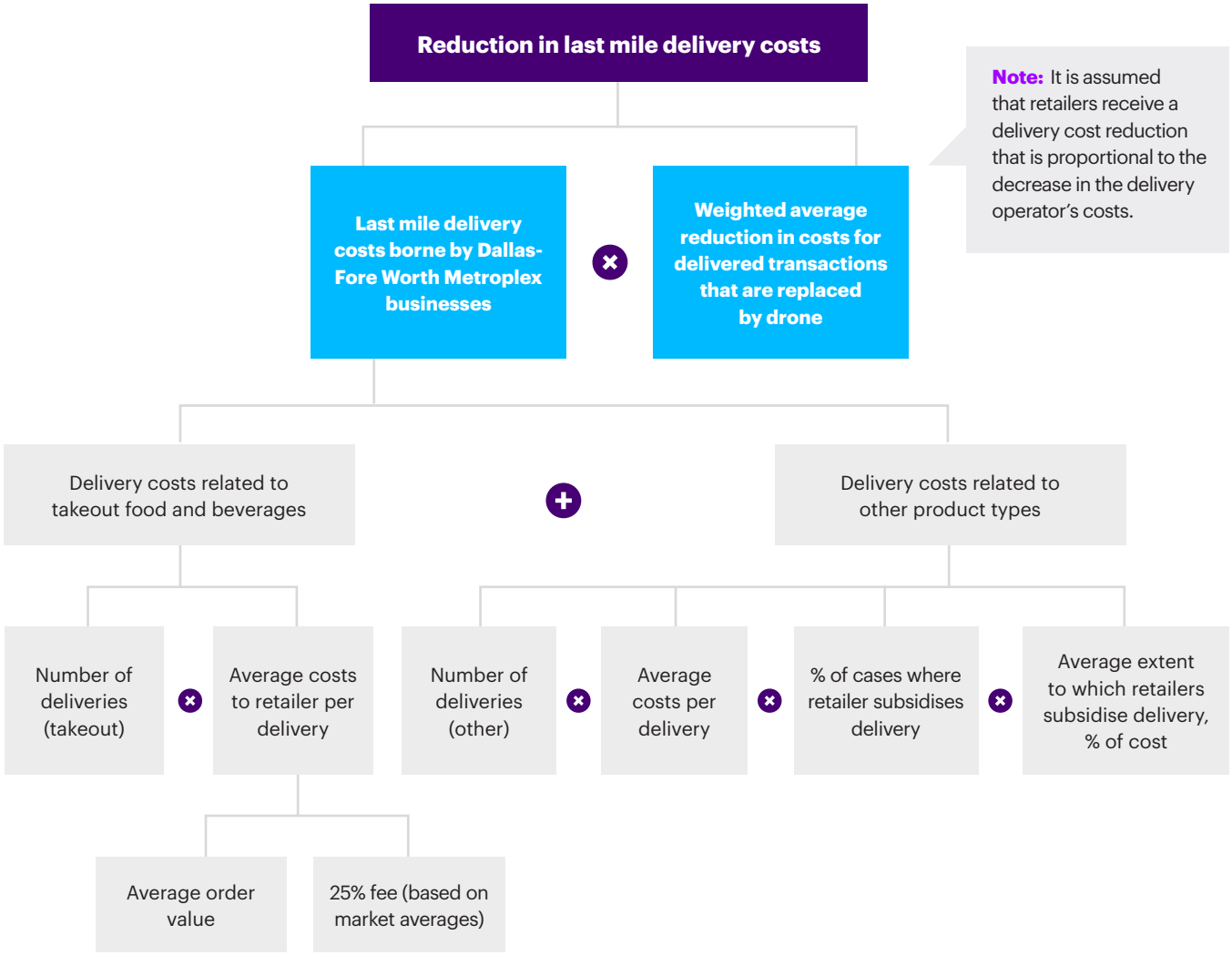


EXHIBIT 32

Inputs and sources for calculating reduction in delivery costs

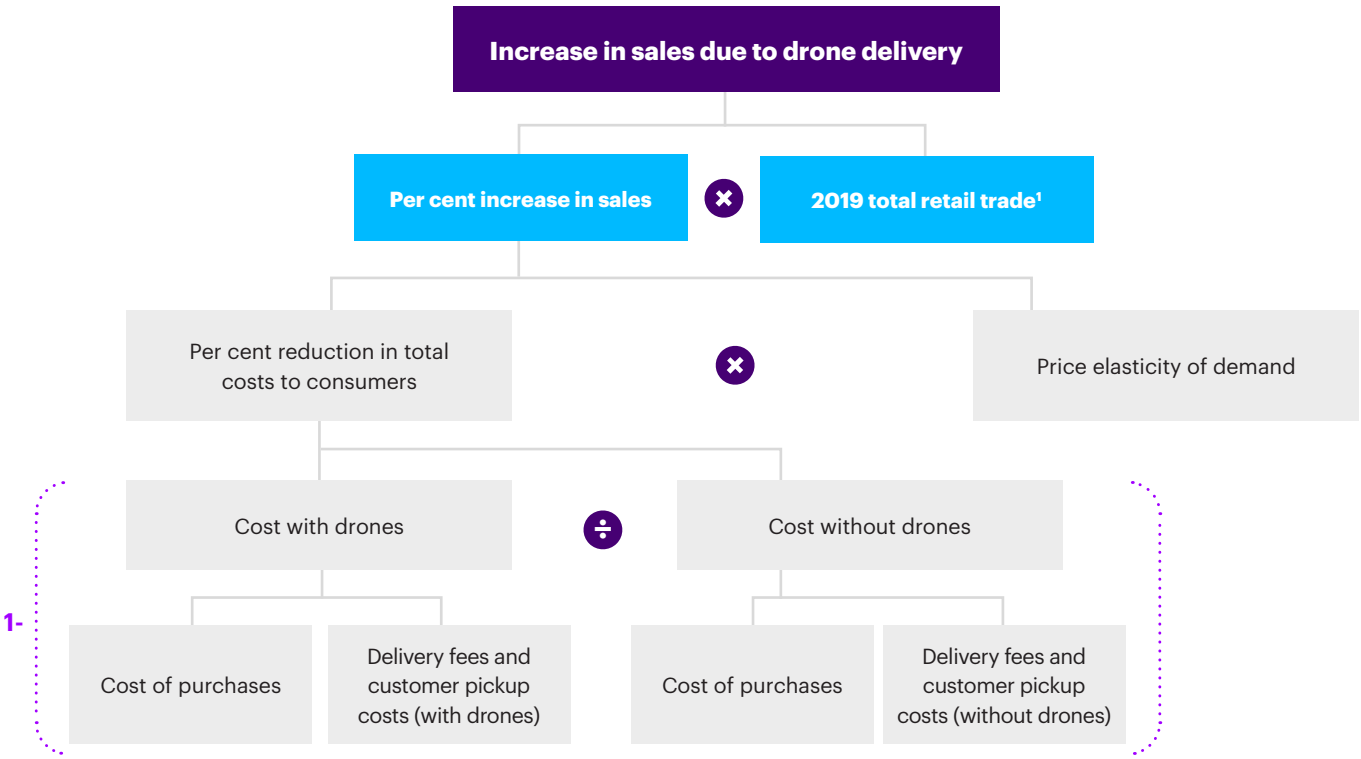
Area	Metric	Source
Weighted average reduction in costs for delivered transactions that are replaced by drones	Weighted average cost reduction (%)	• Estimated using the results obtained in earlier sections of this appendix (cost of drones and current delivery methods, current mix of transactions)
Last mile delivery costs borne by Dallas-Fort Worth Metroplex businesses	Number of deliveries (takeout)	• Obtained from earlier analysis (sizing the last-mile delivery sector)
	Number of deliveries (other)	• As above for non-takeaway transactions
	Average cost per delivery	• Obtained from earlier analysis of the cost of delivery for each mode, combined with the current transaction mix
	Prevalence and amount of retailer delivery subsidisation	• Analysis of mystery shopping data presented in Copenhagen Economics (2016), Principles of e-commerce delivery prices

A.5.2 Generating more sales

By reducing the costs of deliveries and pickups – both explicit in the form of delivery fees and implicit in the time and cost of pickup journeys – drone deliveries save consumers money. These savings can generate new transactions in the Metroplex which would not have happened without drone delivery options. The process for estimating the increased transactions is shown below in Exhibit 33, with the necessary input sources shown in Exhibit 34.

EXHIBIT 33

Calculating the increase in Dallas-Fort Worth Metroplex sales due to more convenient, cheaper delivery



1 *Includes takeaway but excludes meals consumed at restaurants.*

EXHIBIT 34

Inputs and sources for calculating the increase in sales

Area	Metric	Source
2019 total retail trade	Total retail trade in the Dallas-Fort Worth Metroplex in 2019	• BLS Consumer Expenditure Survey (2019) • Texas State Comptroller retail sales data (2019)
Per cent increase in sales	Cost of purchases	• BLS Consumer Expenditure Survey (2019) • Texas State Comptroller retail sales data (2019)
	Delivery fees and customer pickup costs with drones	• Obtained from earlier analysis (see "Estimating the change in delivery costs")
	Delivery fees and customer pickup costs without drones	• Obtained from earlier analysis (see "Estimating the change in delivery costs")
	Price elasticity of demand	Elasticity of 0.76, based on: • Supermarkets elasticity of 0.6, obtained from Andreyeva (2010) The Impact of Food Prices on Consumption: A Systematic Review of Research on the Price Elasticity of Demand for Food. American Journal of Public Health • Adjusted upwards reflecting the higher expected elasticities of other categories and their relative weight in the Dallas-Fort Worth market • This elasticity measure is conservative as it does not measure the additional intangible value of increased convenience (aside from pickup time saved) and greater choices, which would also be expected to increase retail sales.

A.5.3 Expanding market reach

Aside from their benefits in terms of cost, drones also present a significant evolution from today's delivery modes due to their expansion of delivery range. This increase in range was reviewed from both a consumer perspective (in terms of additional choice) and a business perspective (in the form of additional customers reached through delivery).

The market reach expansion for businesses was estimated by examining the number of households within a range of 3 miles from 6 central locations in the Metroplex. The number of households was calculated using geospatial demographic data from the North Central Texas Council of Governments (2020). This was then compared with the number of households within a radius of 6 miles of the outlet. The 6-mile estimate was then expressed as a multiple of the 3-mile estimate to show the range expansion (Exhibit 35).

EXHIBIT 35

Inputs and sources for calculating expansion of market reach

Area	Households available within range		Increased reach	Source
	3 miles	6 miles	(x fold)	
Fort Worth	31,246	127,639	4.1	DFW Maps (2020)
Dallas	71,305	199,637	2.8	As above
Frisco	22,387	81,018	3.6	As above
Plano	34,748	149,998	4.3	As above
Mesquite	32,015	125,028	3.9	As above
Arlington	56,119	152,083	2.7	As above
Average	41,303	139,232	3.4	As above

A.5.4 Estimating participating businesses

In order to prepare business metrics on a 'per participating business' basis, it was necessary to form a view as to how many businesses were likely to participate in drone delivery.

To accomplish this, assumptions were made as to the likely average share of a participating business' transactions that would be delivered by drone in each retail category. These assumptions were combined with model results relating to the total drone delivery share of each category and business count estimates to form an estimated number of participating firms.

EXHIBIT 36

Calculating the number of businesses participating in drone delivery

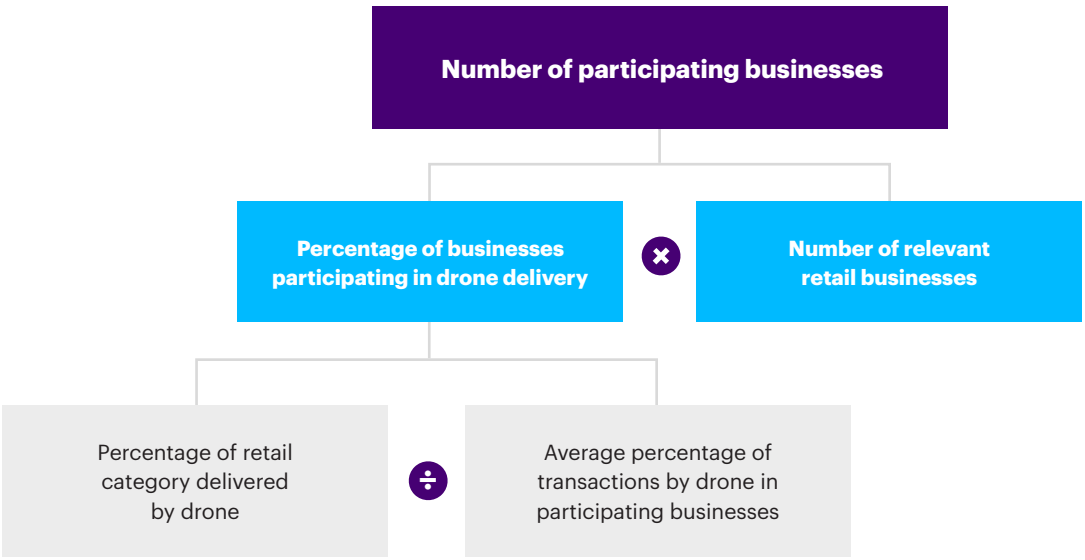


EXHIBIT 37

Inputs and sources for calculating the number of businesses participating in drone delivery

Area	Metric	Source
Relevant retail businesses	Number of relevant retail businesses	• US Census Bureau (2020) 2018 County Business Patterns
Percentage of businesses participating	Percentage of retail category delivered by drone	• Earlier analysis (see "Establishing a reasonable scenario for drone uptake")
	Average percentage of transactions by drone in participating businesses	• Accenture analysis

A.6 Estimating benefits for consumers

A.6.1 Reducing delivery fees

The reduction in last-mile delivery costs for consumers was estimated as shown in Exhibit 38.

EXHIBIT 38

Calculating the reduction in delivery fees for consumers

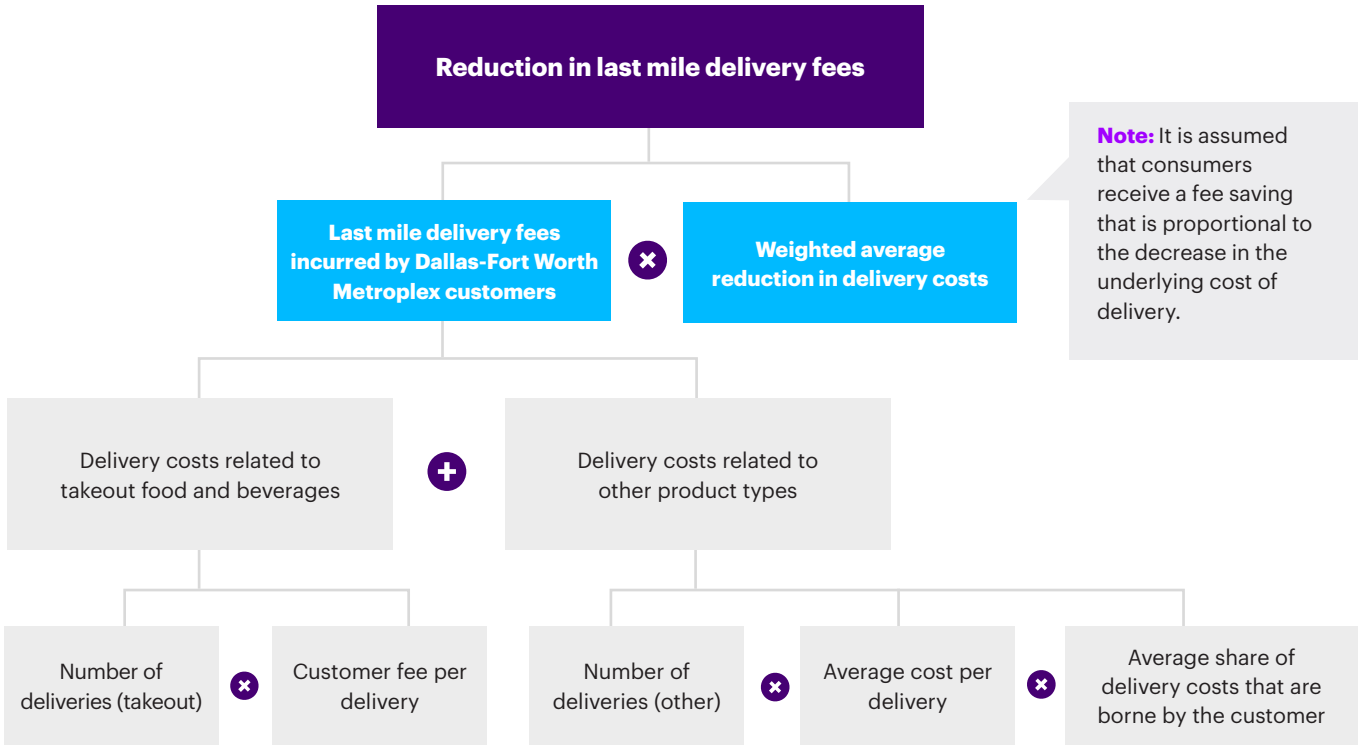


EXHIBIT 39

Inputs and sources for calculating consumer delivery fee savings

Area	Metric	Source
Weighted average reduction in costs for delivered transactions that are replaced by drones	Weighted average cost reduction (%)	• Estimated using the results obtained in earlier sections of this appendix (cost of drones and current delivery methods, current mix of transactions)
Last mile delivery costs borne by Dallas-Fort Worth Metroplex consumers	Number of deliveries (takeout)	• Obtained from earlier analysis (sizing the last-mile delivery sector)
	Average customer fee per delivery (takeout)	• Food delivery order sample from TechCrunch across several US cities
	Number of deliveries (other)	• As above for non-takeout transactions
	Average cost per delivery	• Obtained from earlier analysis of the cost of delivery for each mode, combined with the current transaction mix
	Average share of delivery costs borne by consumers	• Analysis of mystery shopping data presented in Copenhagen Economics (2016), Principles of e-commerce delivery prices

A.6.2 Estimating instant delivery times for each mode of transportation

This paper estimated and compared expected delivery times across delivery modes (van, car, bike, and drone) and timeframes (instant, same day and standard). Average delivery distances were estimated for each of the range categories used (less than 0.6 mi, between 0.6-3 mi, between 3-6 mi, and over 6 mi). The speed assumptions necessary to calculate time taken to deliver at these distances were then estimated for each delivery mode based on research and industry expert interviews.

EXHIBIT 40

Inputs and sources for calculating delivery times

Area	Metric	Source
Current vehicle speeds	Average speed of instant delivery	• Industry expert interview • Accenture analysis
	Average speed of same day delivery	• Roadie, Lalamove, FedEx • Industry expert interview
Drone delivery speeds	Average speed of trip by delivery distance	• Industry expert interview • Accenture analysis

Estimating the reduction in delivery times for consumers

The potential reduction in delivery times was calculated based on the difference in weighted average delivery time when performed by drone compared with the weighted average time by current modes. For instant deliveries (e.g. current delivery through Uber Eats), the weighted average delivery time reduction is approximately 60%.

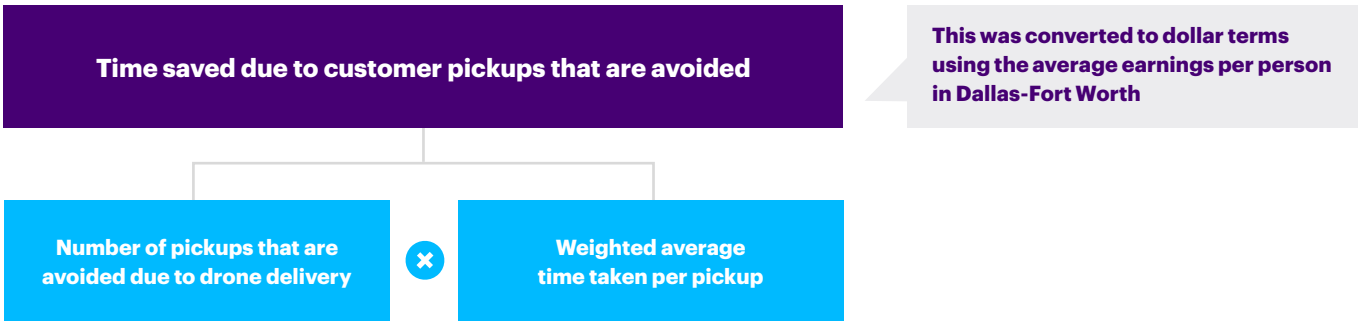
Estimating time savings due to replacement of customer pickups

The time saved due to replacement of customer pickup journeys with drone deliveries was estimated according to the approach shown in Exhibit 41. The time-cost used reflects the average per capita income[75] in the Dallas-Fort Worth Metroplex, adjusted down to account for instances where multiple pickups are made in one trip.

75 Based on Census Bureau (2020) American Community Survey 2019 estimate of $36,274 per annum, converted to an hourly basis.

EXHIBIT 41

Calculating the time saved due to pickups that are avoided due to drone delivery



A.6.3 Expanding product variety

A similar method to the one described earlier in "Expanding market reach" was applied to estimate the potential benefits in terms of retail delivery availability for consumers.

To understand the benefit for consumers, a sample of two residential addresses in the Metroplex were selected, and the number of food outlets that could deliver within 40 minutes was selected via a food delivery service. This was compared with the number of food outlets that could deliver in *more than* 40 minutes. By comparing these sets of restaurants, inferences could be made about the number and variety of restaurants available.

A.6.4 Estimating the number of users

Similar to the estimation of participating businesses, it was necessary to form a view as to the number of households likely to actively use drone delivery. To do this, educated assumptions were made as to the reach of drone delivery services in the Metroplex (50-60% of the region within five years of launching at scale, and 100% within ten years, as discussed earlier in this paper). Within this serviced reach, it was assumed that drone delivery would experience similar uptake to food delivery apps.[76]

76 eMarketer (2019) 'US Smartphone Food Delivery App Users'.

EXHIBIT 42

Inputs and sources for calculating expansion in available delivery options

Area	Metric	Source
Restaurants available for a consumer on Brandywine Ln, Little Elm, TX 75068	Current range of restaurant delivery	• Uber Eats (2020)
	Number of current and potential restaurants in range	• As above
Restaurants available for a consumer on Waterview Drive Little Elm 75068	Current range of restaurant delivery	• Uber Eats (2020)
	Number of current and potential restaurants in range	• As above

EXHIBIT 43

Inputs and sources for calculating the number of households actively using drone delivery

Area	Metric	Source
Number of households actively using drone delivery	Share of population with access to drone delivery	• Accenture analysis of the expected rollout of drone delivery services
	Likely active-user share of population with access	• eMarketer research on online food delivery app users

A.7 Estimating benefits for society

Societal factors encompass a broad range of impacts, including some indicators that are difficult to measure or attribute directly to drone delivery such as lives saved by emergency medical delivery and boosts in innovation. As such, this report estimates the healthcare, environmental and safety benefits from drone delivery that result from improving access to medication and having fewer motor vehicles on the road. While some other benefits are often not as easy to measure or quantify, they are important contributions to the Dallas Fort Worth Metroplex that can be observed and described.

A.7.1 Healthcare cost savings

The potential healthcare cost savings from drone delivery were analyzed by calculating the number of abandoned pharmacy prescriptions that could be delivered by drones each year. Improving medication adherence of patients and saving healthcare costs (Exhibit 15 in Section 4).

The number of abandoned prescriptions in the Metroplex was calculated based on an average abandonment rate of ~2% of all prescriptions.[77] Of these, 11% were abandoned due to transportation issues, and 32% were forgotten. Drones could deliver prescriptions to consumers facing transportation issues and to a fraction (assumed 25%) of consumers that forgot their medication.[78] The costs of treatment failure associated with abandonment are up to $2,500 per person annually,[79] representing a large healthcare burden, partly addressable by drones.

77 Shrank et al. (2010) 'The Epidemiology of Prescriptions Abandoned at the Pharmacy'.
78 Brown et al. (2011) 'Medication Adherence: WHO Cares?'.
79 Watanabe et al. (2018) 'Cost of Prescription Drug-Related Morbidity and Mortality'.

Drone delivery could increase medication adherence and therefore save $610 million annually in healthcare costs within ten years of launching at scale. Within five years, it is assumed that drone delivery has limited reach in the Metroplex (50-60% of the population). Therefore, the corresponding potential healthcare cost savings are also lower at $330 million. Consumers in low-income areas without access to a vehicle abandon up to 18.9% of their prescriptions.[80] This vulnerable group therefore has a large potential to benefit from drone delivery and improved medical outcomes due to better adherence.

A.7.2 Number of cars removed and reduction in city-wide congestion

The potential reduction in car removed from the road and congestion from drone delivery was calculated from the number of fewer miles on the road as a result of drone delivery. The replacement rate of drone delivery was calculated and converted in reduction in vehicle miles traveled. The number of cars removed was calculated based on the average VMT in the Metroplex of 11,400 miles per annum. Based on analysis of the relationship between traffic congestion (in terms to total person hours of delay) and VMT from 2007 to 2017, we estimated that a 1% reduction in VMT would result in 1.9% reduction in total delay hours. Based on the 0.13% reduction in VMT, we estimated that total delay would reduce by 0.24% which is estimated to be around 800,000 passenger hours.

A.7.3 Emissions reduction

The potential reduction in CO_2 emissions from drone delivery is the difference between the emissions avoiding by reducing motor vehicles on the road and additional emissions produced due to drone delivery. The emissions associated with motor vehicle reduction was estimated by calculation the total last-mile distance traveled by motor vehicles that would be replaced by drone delivery, multiplied by the emissions per km by vehicle type (specifically cars and light commercial vehicles). Additional emissions produced by drones was estimated in the same way, by using the rate of emissions per trip from drone delivery. The average emissions per trip for drone delivery versus other methods was based on modeling by Stolaroff et al. (2018), adjusted to better reflect the Texan energy production market and the characteristics of the type of drones under consideration.

A.7.4 Road accidents prevented

The potential number of accidents avoided by drone delivery as a result of fewer vehicles on roads is calculated by using the current rate of accidents per km multiplied by the reduction in distance traveled by road vehicles including bicycles. This estimate is likely to be conservative as road accidents and crashes can be underreported in official data.

80 Hensley et al. (2018) 'Poverty, Transportation Access, and Medication Nonadherence'.

EXHIBIT44

Inputs and sources for calculating societal benefits

Area	Metric	Source
Emissions reduction	Total emissions from motor vehicles by vehicle type	• Environmental Protection Agency (EPA)
	Total distance traveled by motor vehicles, by vehicle type	• US Department of Transportation Bureau of Transportation Statistics and Federal Highway Administration
	Emissions per trip for drone delivery and other methods	• Stolaroff et al. (2018) Energy use and life cycle greenhouse gas emissions of drones for commercial package delivery • US Energy Information Administration • Accenture analysis
Road accidents prevented	Total number of road crashes	• Texas Department of Transportation
	Total distance traveled by vehicle type	• US Department of Transportation Bureau of Transportation Statistics and Federal Highway Administration
Cars removed from road	Average distance traveled per vehicle	• Accenture analysis of motor vehicle travel (above) and US Census Bureau vehicle estimates
	Distance avoided by vehicle type	• Accenture analysis • Industry expert interviews
Congestion reduction	Congestion delay hours per vehicle mile traveled	• Texas A&M Transportation Institute • Accenture analysis
	Cost of traffic delay time	• Texas A&M Transportation Institute