

SCH_MGMT-663 Supply Chain Analysis

Amazon Prime Air Project Report

Team 2

Dimension 1:

Online Business:

Amazon's **domestic and global online sales** growth reflects the company's capacity to scale its vast retail operations while diversifying revenue streams. This has been possible through strategic investments, technological innovations, and global expansion.

Domestic Growth in Online Sales (U.S.)

1. Core Online Stores:

- Amazon's core online retail business, including product sales and digital content, showed steady growth, reaching **\$231.9 billion** in 2023, compared to **\$222.1 billion** in 2021. While the growth slowed somewhat from 2021 to 2022, a rebound occurred in 2023, suggesting that consumer demand for e-commerce remained robust, particularly as pandemic-related disruptions continued to normalize.
- Amazon's dominance in online retail comes not just from its extensive catalog but also from its logistical infrastructure, including fulfillment centers, robotics, and delivery capabilities. These systems allow Amazon to offer fast shipping, even on items not stocked directly by the company (e.g., third-party seller products).

2. Third-Party Seller Services:

- The **third-party seller services** segment grew rapidly from **\$103.4 billion** in 2021 to **\$140.1 billion** in 2023. This growth reflects Amazon's marketplace model, where third-party sellers contribute to the platform's inventory. It highlights the company's role as a marketplace rather than just a retailer. The increase also suggests that more businesses are leveraging Amazon's infrastructure, including its fulfillment services (Fulfillment by Amazon, or FBA) to reach a global customer base.
- Amazon's expanding logistics infrastructure has been critical in supporting this growth. The company continues to refine its fulfillment processes, which in turn supports the growth of third-party sellers, making it easier for them to reach customers globally.

3. Advertising Services:

- Amazon's **advertising services** have emerged as one of the company's most lucrative segments. From **\$31.2 billion** in 2021, it grew to **\$46.9 billion** in 2023. This growth has made Amazon a serious contender in the digital advertising space, competing with giants like Google and Meta (Facebook). With Amazon's vast customer data, advertisers can target specific demographics with greater precision.
- This segment includes a variety of advertising products such as **sponsored products**, **display ads**, and **video ads**, many of which are integrated directly into Amazon's shopping experience. The growth of advertising is tied to increasing reliance on digital platforms for consumer purchasing decisions, and Amazon's vast ecosystem provides advertisers with direct access to consumers at the point of purchase.

4. Amazon Web Services (AWS):

- **AWS**, Amazon's cloud computing division, continues to be a major growth driver, with sales increasing from **\$62.2 billion** in 2021 to **\$90.8 billion** in 2023. As businesses increasingly move to cloud-based solutions, Amazon has solidified its position as a leader in the cloud computing space.
- AWS's growth is underpinned by its extensive global infrastructure. In 2023, Amazon invested significantly in AWS data centers and other IT infrastructure, which contributed to a net increase in property and equipment under AWS's segment, from **\$43.2 billion** in 2021 to **\$72.7 billion** in 2023. AWS has become an essential part of Amazon's diversified business model, reducing its reliance on traditional retail and increasing profitability through high-margin cloud services.

Global Growth in Online Sales

In addition to growth in the U.S., Amazon's international presence continues to expand, driven by key markets in Europe, Japan, and emerging regions:

1. Rest of World:

- The "Rest of World" segment, which includes markets outside the U.S., saw significant growth, with sales increasing from **\$63.5 billion** in 2021 to **\$82 billion** in 2023. This growth is reflective of Amazon's continued global expansion and its investments in logistics and infrastructure in international markets. Localized Amazon platforms and fulfillment centers have bolstered international sales, making it easier for consumers worldwide to purchase products with faster delivery options.
- As global e-commerce adoption continues to rise, Amazon's tailored approach to local markets, including regional pricing strategies and localized content, has helped the company capture a larger share of international sales.

2. Key Regional Markets:

- **Germany:** One of Amazon's largest European markets, Germany saw modest growth, reaching **\$37.6 billion** in 2023 from **\$33.6 billion** in 2022. This highlights Amazon's ability to maintain its position in competitive markets by continuously adapting its offerings.
- **United Kingdom:** Amazon's sales in the UK grew from **\$30.1 billion** in 2022 to **\$33.6 billion** in 2023, indicating stable growth. Despite economic uncertainty in Europe, Amazon's consistent focus on its diverse product and service offerings (e.g., online retail, Prime subscriptions, and cloud services) has allowed it to maintain a strong position in the market.
- **Japan:** Sales in Japan grew steadily, from **\$24.4 billion** in 2022 to **\$26 billion** in 2023, reflecting a growing acceptance of e-commerce and Amazon's expanding logistics footprint in Asia.

Amazon's **domestic and global online sales** growth highlights the company's continued expansion and adaptation to market demands. While its **core online stores** have seen steady growth, its **third-party seller services** and **advertising services** have surged, positioning Amazon as a key player not only in retail but also in digital advertising and cloud computing. Additionally, AWS continues to be a critical pillar of Amazon's profitability, and its international expansion, particularly in emerging markets, provides a strong foundation for future growth.

Amazon's ability to scale its operations globally, maintain a vast product catalog, offer fast delivery, and diversify revenue sources across its marketplace, cloud services, and advertising segments underscores its ongoing dominance in the global digital economy.

Profile of Amazon's Top Sellers:

Amazon is a vast e-commerce platform with a dynamic marketplace consisting of millions of products. Some categories of products consistently drive high sales volumes:

1. **Electronics:** This remains one of Amazon's most successful categories. **Smartphones, laptops, headphones, and tablets** are among the top sellers. Leading brands like **Apple, Samsung, and Sony** dominate, contributing to Amazon's continued growth in this space. Additionally, Amazon's own electronics like the **Echo smart speakers** and **Fire TV** devices also rank high.
2. **Home and Kitchen Goods:** From **furniture** to **small appliances** like **air fryers** and **coffee machines**, home and kitchen products are top sellers, especially during holiday seasons. The growth in home-based cooking and tech-driven home devices (like **robot vacuums**) has further boosted Amazon's sales.
3. **Books and Digital Media:** As Amazon's original business model, books still hold a significant portion of Amazon's sales. **E-books** (via the **Kindle platform**) and physical books make up a substantial portion of the market. Alongside books, **Prime Video** subscriptions and digital audio books (**Audible**) are also major revenue contributors.
4. **Health and Personal Care:** This category is growing rapidly as more people shift to online shopping for products like **vitamins, fitness trackers, personal hygiene products, and health equipment**. Products in this category are typically lightweight, often falling within the weight limits for drone delivery.

5. **Toys and Games:** Categories like **LEGO**, **Barbie**, and **action figures** are perennial best-sellers. During the holiday season, toy sales spike, with Amazon capturing a major share of the global toy market.

Percentage of Items That Could Be Droned (based on weight and bulk)

Amazon's drone delivery service, **Prime Air**, is designed to deliver packages weighing **5 pounds (2.27 kg)** or less. This weight range covers a significant portion of the items sold on Amazon. The following categories are prime candidates for drone delivery:

1. **Electronics:**

- **Smartphones:** Typically weigh less than 1 lb (0.45 kg).
- **Headphones:** Weight is around 0.5 to 1 lb (0.23 to 0.45 kg).
- **Tablets:** Weigh less than 2 lbs (0.91 kg).

These products are small, lightweight, and commonly fall within the allowable range for drone delivery.

2. **Books:**

- **Paperback** books usually weigh between **0.5 to 2 lbs** (0.23 to 0.91 kg), making them ideal for drone delivery.

3. **Small Kitchen Appliances:**

- Items like **blenders**, **coffee makers**, and **toasters** typically weigh under 5 lbs (2.27 kg), making them suitable for delivery by drones.

4. **Health and Personal Care:**

- Many products in this category, such as **vitamins**, **personal care devices** (like razors), and **fitness trackers**, weigh less than 5 lbs and could be easily delivered by drone.

5. **Toys and Games:**

- **Action figures**, **board games**, and **LEGO sets** often weigh well under 5 lbs, making them viable candidates for Amazon's drone fleet.

However, not all products on Amazon fit this profile. Heavier or bulkier items, such as large **furniture**, **appliances**, and **electronics** (e.g., large televisions or desktops), exceed the weight limit for drones. These items would likely require alternative shipping methods.

Items for Storage/Replenishment at a Drone Hub

For Amazon Prime Air, the items that would be candidates for storage and replenishment at a **drone hub** need to meet specific criteria related to size, weight, and demand. The key considerations include products that are **lightweight**, **compact**, and have **high turnover rates** to justify the operational and logistical costs of using drones.

Here are some categories of products that would be strong candidates for drone delivery hubs:

1. **Small Electronics**

- **Smartphones:** Weighing between **0.5 to 1 lb (0.23 to 0.45 kg)**, smartphones are high-demand, lightweight, and high-value items. They are compact and ideal for drone storage.
- **Headphones and Earbuds:** These products are typically under **1 lb** and have frequent sales cycles, making them ideal for drones.
- **Fitness Trackers:** Lightweight, high-demand electronics such as fitness trackers (**Fitbit**, **Apple Watch**) also meet the weight and size criteria for drones.

Why Suitable: These items are high-turnover products with high customer demand. Electronics are also relatively compact, fitting the limited storage capabilities of drones. They also often come with a short lead time for replenishment, making them suitable for drone replenishment hubs.

2. **Health and Personal Care Products**

- **Vitamins and Supplements:** These often come in small packages and are generally lightweight (typically under **1 lb**).
- **Personal Care Items: Razors, toothbrushes,** and other small personal care products often meet the weight requirements and are popular with Amazon shoppers, contributing to consistent demand.
- **First Aid Kits:** Compact and frequently purchased in emergencies, small medical kits are another potential candidate.

Why Suitable: Health products are essential, light, and frequently purchased, making them ideal for drone hubs. Their small size and ease of storage also make them excellent for drone replenishment.

3. Books

- **Paperback and E-books: Books** (especially paperbacks) are lightweight and come in varied sizes, but the majority can fit within the **5 lb** weight limit for drones.
- **E-readers: Kindles** and other digital reading devices are also lightweight and fit easily into drone compartments.

Why Suitable: Books, especially paperbacks, are relatively small and lightweight, with high demand throughout the year. The consistent, high-volume nature of book sales also justifies replenishing stock at drone hubs.

4. Small Kitchen Appliances

- **Blenders, Toasters, and Coffee Makers:** Many of these products weigh between **1 to 5 lbs**, making them eligible for drone delivery. Their compact size and frequent sales make them viable candidates.

Why Suitable: Kitchen appliances are frequently bought and easily fit into the size and weight requirements for drone delivery.

5. Toys and Games

- **Action Figures:** These are typically lightweight and come in compact packaging, making them ideal candidates for drone hubs.
- **Board Games:** Smaller-sized games (like **card games** or **travel games**) are generally lightweight and suitable for drone transport.
- **LEGO Sets:** Smaller sets, especially those under 5 lbs, could be ideal for drone storage.

Why Suitable: Toys and games, particularly those with higher turnover rates (e.g., during holidays), are light and compact. They are commonly sold in small to medium quantities, making them a good fit for drone replenishment hubs.

6. Fashion and Accessories

- **Sunglasses, Jewellery, and Handbags:** These items are often small, lightweight, and have significant demand, especially during peak seasons like holidays.
- **Apparel:** Smaller items like **t-shirts, caps, and socks** (especially lightweight items) could be suitable.

Why Suitable: Fashion and accessories often experience high seasonal demand. Their small and light nature makes them well-suited for drone delivery.

Logistical Considerations

- **High turnover rate:** Products that sell quickly and consistently should be prioritized. Drone hubs are designed to serve immediate, fast-paced demand.
- **Compact and lightweight:** Items must be small enough to fit in the drone's limited storage space and light enough to stay within the 5 lb (2.27 kg) weight limit.
- **High demand/Popular products:** Seasonal or trending products that are ordered frequently, such as **gadgets** or **personal care** items, should be considered.

Challenges for Drone Replenishment

- **Product Packaging:** Bulkier items, or those with large packaging, are difficult to transport via drone. This could restrict certain categories, especially **furniture** or **large home appliances**.
- **Fragility:** While smaller electronics and books are ideal, some fragile products like **glassware** or **ceramics** may not be suitable for drone transport due to the risk of damage.

The ideal products for storage/replenishment at a drone hub should be lightweight, compact, and fast-selling. Categories such as **electronics**, **books**, **health and personal care products**, **toys**, and **fashion accessories** are prime candidates for drone delivery. Drone hubs can optimize the replenishment process for these high-demand, high-turnover items, improving the efficiency of Amazon's logistics network.

Dimension 2:

Drone Technology

Key Features of Amazon Prime Air's Drone Delivery

1. Technology: MK30 Drone

- **Capabilities:**

Payload Capacity: The MK30 drone can carry packages up to 5 pounds around speed of 50mph, which covers a significant percentage of Amazon's daily package volume.

Range: It boasts an improved operational radius, doubling the range of earlier drone models, enabling service to a broader customer base.

Delivery Speed: The drone is designed to deliver packages in less than an hour, aligning with Amazon's goal of near-instant customer gratification.

Weather Adaptability:

- The MK30 is equipped to handle moderate weather conditions, such as light rain, making it more reliable in unpredictable climates.
- Enhanced resistance to environmental challenges expands operational days and regions.

Noise Reduction:

- Specially designed propellers ensure the drone is 50% quieter than previous versions, addressing community concerns about noise pollution.
- Noise minimization techniques focus on reducing the acoustic footprint during all phases of flight: ascent, cruise, and descent.

Safety Features:

- The "detect-and-avoid" system ensures the drone can autonomously navigate around obstacles, including:
- Aircraft, such as planes or helicopters.
- Fixed structures like power lines and towers.
- Dynamic elements like trees and people.
- Equipped with advanced AI and sensors, the MK30 adapts to high-density and suburban environments, ensuring secure operation even in confined spaces.

Design Enhancements:

- The MK30 combines vertical take-off and landing (VTOL) capabilities with efficient wing-borne flight, providing stability and energy efficiency.
- Its compact design allows it to land and deliver in smaller, suburban yards, optimizing usability for densely populated areas.

2. Operational Framework:

Delivery Sites:

- Hybrid delivery stations integrate drone operations with Amazon's existing logistics network. These stations are strategically located near metropolitan areas for faster deliveries.
- Drone-specific sites co-located with Amazon's Same-Day Delivery centers and Fulfillment Centers ensure seamless workflow and inventory access.
- The infrastructure supports broader product availability (10x increase in selection) and rapid fulfillment of customer orders.

FAA-Approved Operations:

- Amazon received FAA certification for BVLOS (Beyond Visual Line of Sight) operations, a major milestone in enabling commercial drone deliveries in residential areas.
- The certification validates Amazon's safety protocols, allowing autonomous operations in diverse environments.

Workflow:

- Orders are packed in drone-specific packages with enhanced cushioning.
- The drone launches from its station, navigating autonomously to its destination.
- Deliveries are conducted at altitudes of 40–400 feet, ensuring safety and efficiency while maintaining clear airspace.
- After delivery, the drone returns to its hub for recharging and readiness for subsequent missions.

3. Service Scope:

Items Delivered:

- Over 50,000 eligible items, including household supplies, beauty products, tech gadgets, and even prescription medications, can be delivered via drone.

Example use cases:

- Emergency deliveries of medications like asthma inhalers or flu treatments.
- Small electronics such as headphones or chargers.

Delivery Speed:

- Packages are delivered in under an hour, with many locations consistently achieving delivery times of 30 minutes.

Geographic Reach:

- Initial service hubs are operational in Tolleson, AZ, and College Station, TX.
- By the end of 2024, Amazon plans to expand to several new locations across the U.S., as well as internationally to Italy and the UK.

4. Environmental Impact

Sustainability:

- Fully electric operation aligns with Amazon's commitment to achieving net-zero carbon emissions by 2040.
- Reduces the dependency on gas-powered vehicles, thereby contributing to decreased greenhouse gas emissions.

Urban Benefits:

- Reduced traffic congestion by moving a portion of delivery logistics to airspace.
- Noise pollution mitigation through quieter drone technology enhances community acceptance.

Key Features of BVLOS Operations:**1. Enhanced Technology****Detect-and-Avoid System:**

- Drones utilize a sophisticated system to autonomously identify and avoid obstacles, ensuring safe navigation in busy airspaces.
- Real-world testing validated by FAA inspectors confirms the technology's reliability.

Flight Automation:

- AI-driven decision-making allows drones to manage their routes and respond to environmental challenges without human intervention.
- Remote pilots monitor operations to ensure compliance and safety.

Weather-Resilient Design:

- Advanced materials and engineering allow drones to operate in light rain, ensuring service continuity even during inclement weather.

2. Operational Benefits**Expanded Coverage:**

- BVLOS approval allows drones to operate in urban and suburban areas that were previously restricted to line-of-sight operations.

Delivery Speed:

- Autonomous routing ensures efficient paths, reducing travel time and meeting fast delivery expectations.

Amazon Pharmacy's Drone Delivery**1. Rapid Prescription Fulfilment****Service Features:**

- Over 500 medications, ranging from common flu treatments to chronic condition management, are eligible for delivery within 60 minutes.
- Medications are handled with care, verified by licensed pharmacists, and packed securely for drone transport.

Delivery Process:

- Drones operate at 40–120 meters altitude to avoid low-level hazards.
- A computer vision system ensures accurate placement at designated delivery points, such as customer-provided markers.

2. Consumer Benefits

Accessibility:

- Enhances access to critical medications for customers in underserved or rural areas.
- Reduces reliance on traditional pharmacy visits, saving time and effort.

Strategic Goals and Benefits:

1. Scaling Operations

Vision:

- Amazon aims to deliver 500 million packages annually using drones by the end of the decade.

Global Expansion:

- Plans to scale operations internationally as regulatory frameworks adapt to drone technology.

Integration with Logistics:

- Combines aerial delivery with ground robotics and automated systems for a comprehensive logistics network.

2. Consumer-Centric Approach

Convenience:

- Speedy delivery and broad product selection enhance customer satisfaction.

Affordability:

- Drone delivery incurs no additional fees for Amazon Prime members, making it a cost-effective solution.

3. Sustainability Goals

Green Logistics:

- Zero-emission drones reduce Amazon's carbon footprint and support its environmental objectives.

Challenges and Considerations:

1. Regulatory and Airspace Challenges

- Integrating drones into shared airspace alongside manned aircraft is a complex task.
- International expansion requires navigating different regulatory environments.

2. Technical Demands

- Further advancements in battery life and payload capacity are necessary for scaling.
- Extreme weather conditions, such as snow or high winds, remain limitations.

3. Community Engagement

- Concerns over privacy, data security, and noise pollution must be addressed through transparent policies.
- Building trust with local communities is essential for widespread adoption.

Cost of Implementation:

- The implementation of Amazon Prime Air's drone delivery system is costly, encompassing multiple areas:

- **Drone Development and Testing:** This involves extensive engineering and testing to ensure drones meet safety, efficiency, and regulatory standards, including the integration of advanced technologies like sense-and-avoid systems.
- **Infrastructure Investments:** Amazon must establish drone-specific fulfillment centers and charging stations, integrating these into its broader logistics network to ensure smooth operations.
- **Regulatory Compliance and Safety:** Compliance with FAA regulations and other safety measures require ongoing investments in certification, safety protocols, and drone technology advancements.
- **R&D for Continuous Innovation:** Amazon continues to invest in research to improve drone capabilities, including increasing payload capacity, reducing noise, and enhancing weather resistance.
- **Ongoing Maintenance:** Maintaining drones involves regular checks, repairs, and software updates to ensure drones operate at peak efficiency.

Patents:

Amazon holds numerous patents related to its drone technology, such as designs for the MK30 drone, autonomous flight systems, and weather-resistant technologies. These patents help Amazon protect its intellectual property and maintain a competitive edge in the drone delivery market.

- **Drone Design:** Patents for the MK30's structural design and its ability to efficiently handle vertical take-off and wing-borne flight.
- **Autonomous Navigation:** Patents for sense-and-avoid technology and algorithms for optimizing flight paths.
- **Delivery Mechanisms:** Patents on safe and efficient package delivery, including innovative cushioning materials.
- **Weather Resistance:** Patents related to the design elements that allow drones to operate in adverse weather conditions.
- **Logistics Integration:** Patents for integrating drones into Amazon's broader fulfillment network.

Regulations:

- Amazon's drone delivery system is subject to various regulatory hurdles, including:
- **FAA Approval:** Amazon's certification for BVLOS operations from the FAA is a critical achievement, allowing drones to operate safely in residential and urban airspaces.
- **Global Regulatory Challenges:** Different countries have different drone regulations, and as Amazon expands, it will need to navigate the regulatory environment in each region.
- **Safety and Privacy Regulations:** Ensuring the privacy of consumers and minimizing the noise impact of drones are crucial aspects of Amazon's expansion strategy.
- **Environmental Compliance:** Local regulations regarding noise pollution and air quality are also factors Amazon must address to scale its drone operations responsibly.

By continuing to innovate and scale its drone delivery capabilities, Amazon is positioning itself as a leader in the next frontier of logistics, offering faster, more sustainable, and more efficient delivery solutions.

Amazon Prime Air's drone delivery system represents a significant leap forward in logistics innovation, blending cutting-edge technology, sustainability, and customer-centric solutions. While challenges remain in scalability and regulation, the program's potential to revolutionize delivery systems is undeniable, offering faster, greener, and more efficient options for consumers worldwide.

Dimension 3:

Key Demographic Data Points

Age Distribution: This includes breakdowns by age groups

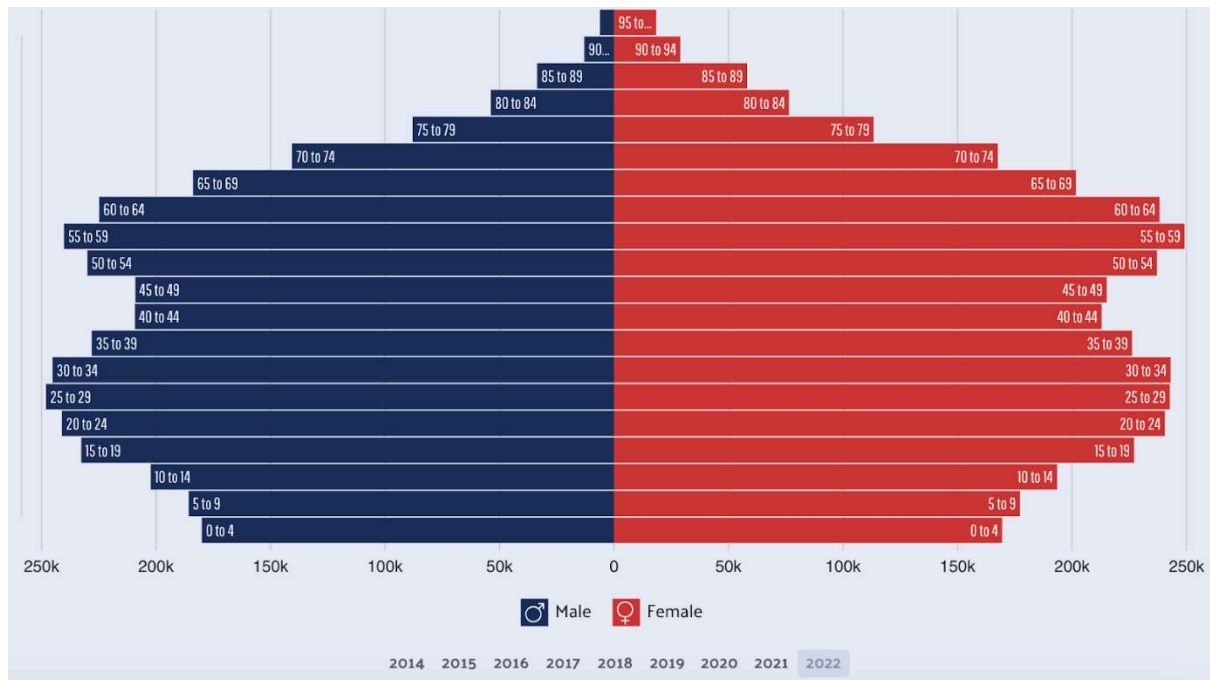


Figure 1

Median Income: Median household income, often broken down by race/ethnicity, occupation, and household type. The diagram below shows median household income by type of families. Median Household Income in Massachusetts = **\$99,858** \pm \$1,355

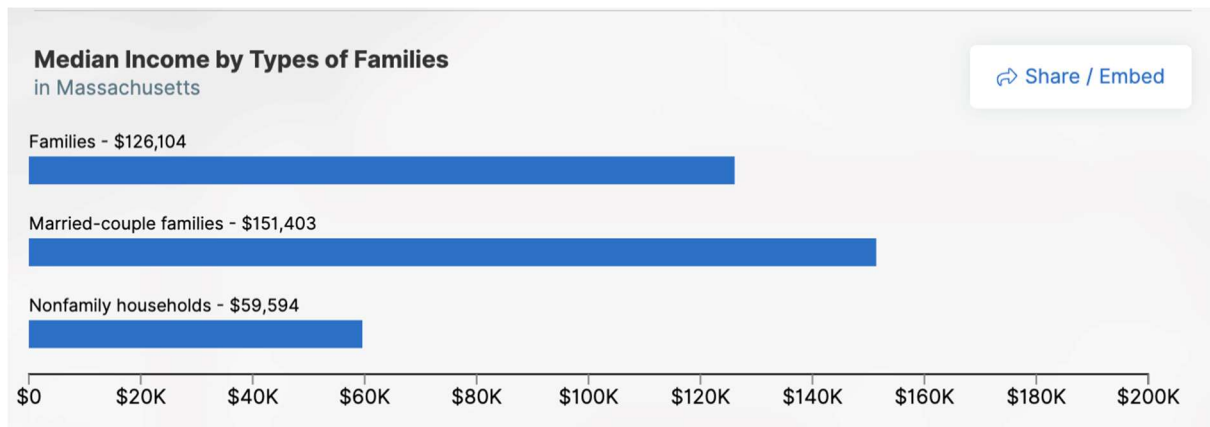


Figure 2

Income Distribution: Data showing income brackets and what percentage of households fall into each category. The workforce of Massachusetts in 2020 was 3,420,898 people with 49.4% women and 50.6% men. The Visualization below shows workforce distribution by gender and age.

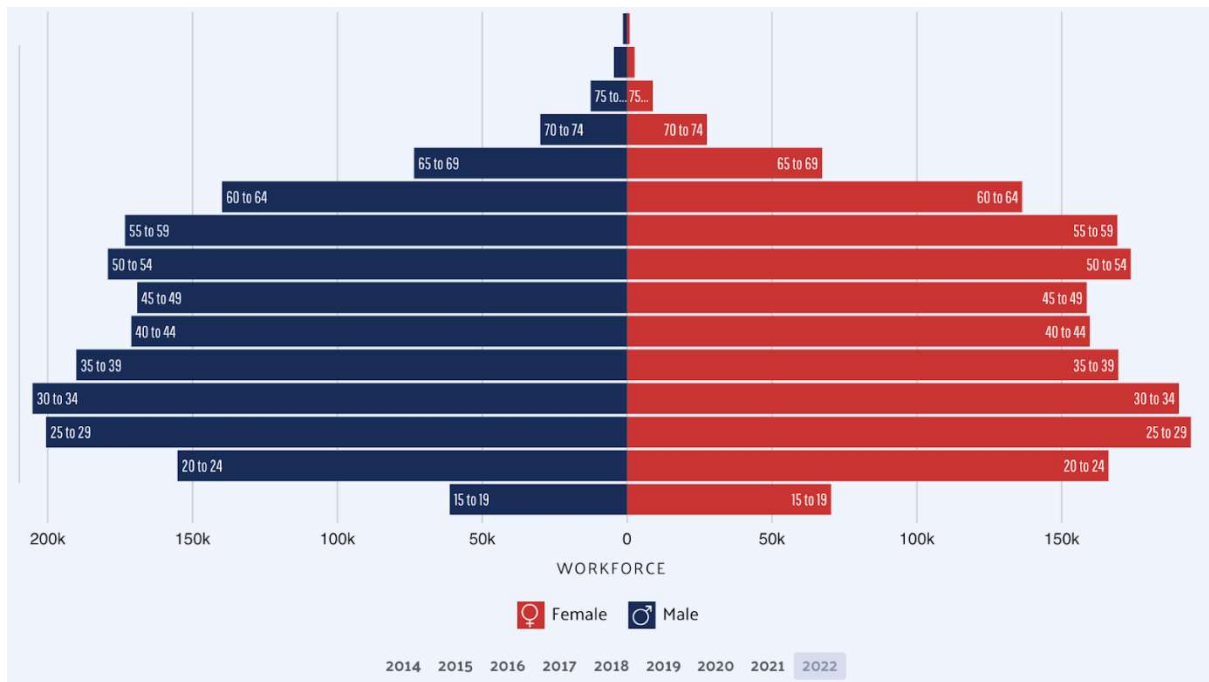


Figure 3

Poverty Rate: The percentage of people or households below the poverty line.

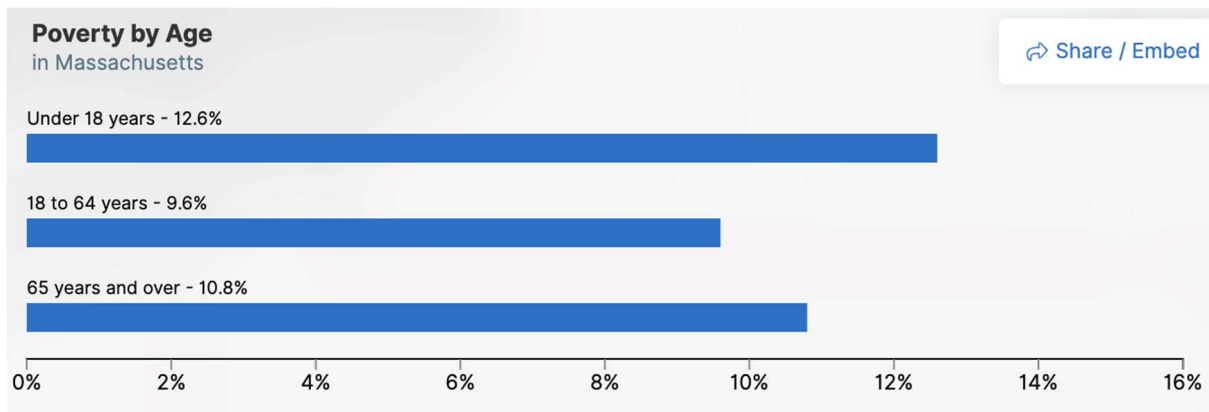


Figure 4

Education Level: The highest level of education attained by residents. The education level of Massachusetts residents could significantly impact Amazon's approach to launching Amazon Prime Air, its drone-based delivery service. High levels of education in the population generally correlate with tech-savviness, adaptability to new technology, and certain consumer expectations, which Amazon would likely consider in its strategy.

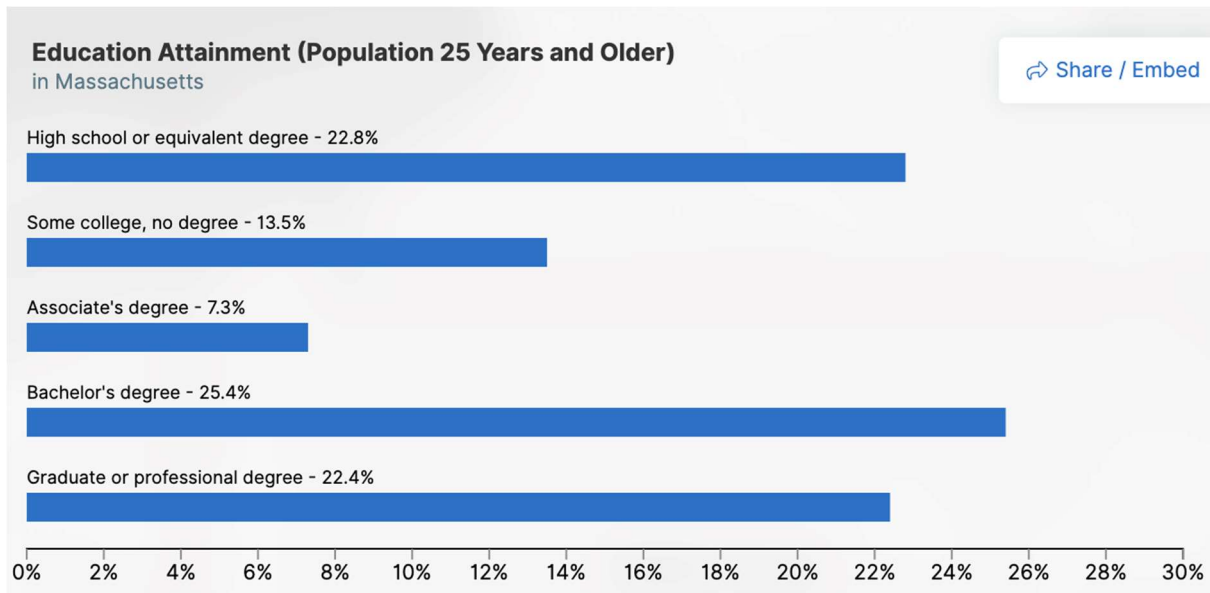


Figure 5

Ethnic/Racial Composition: Breakdown of the population by race and ethnicity in one decade shows that Massachusetts is largely white(non-hispanic).To effectively communicate the benefits of Prime Air to a racially and ethnically diverse state like Massachusetts, Amazon should consider culturally sensitive marketing that resonates with each community. This might include multilingual campaigns, community events, or partnerships with local organizations.

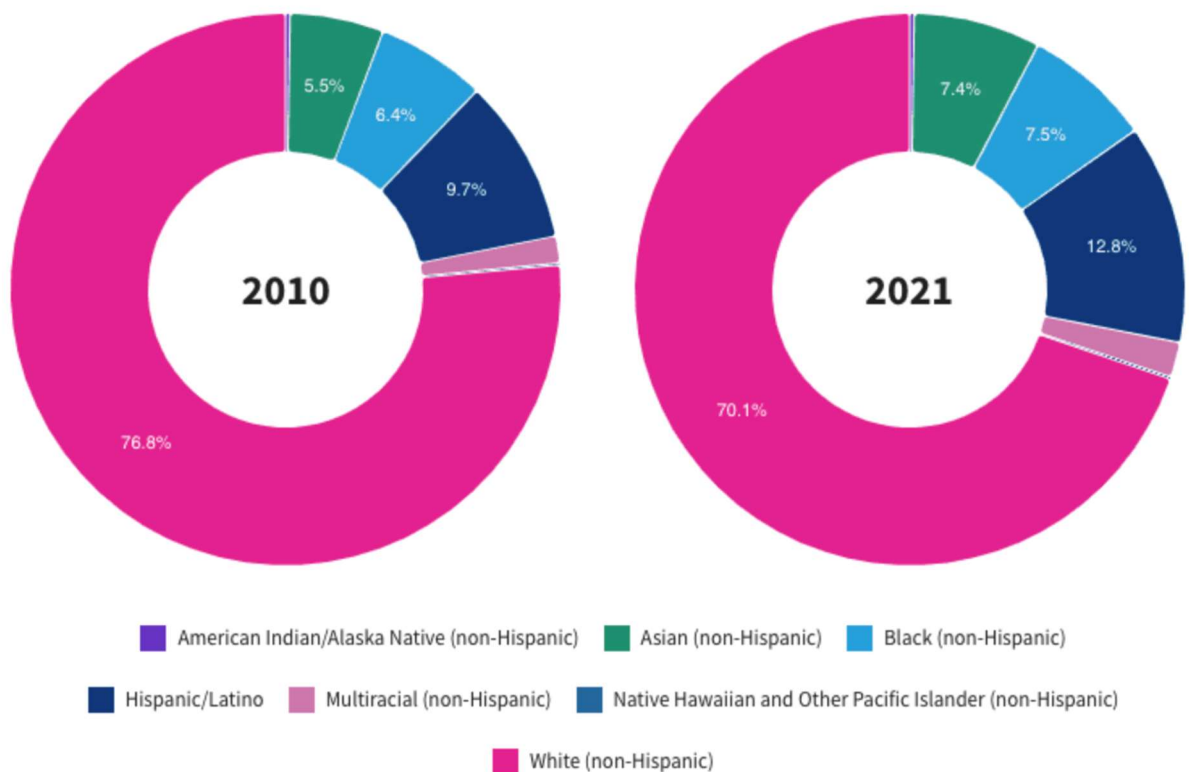


Figure 6

FAA Classes :

Class A: Generally, that airspace from 18,000 feet MSL up to and including FL 600, including the airspace overlying the waters within 12 nautical miles off the coast of the 48 contiguous States and Alaska; and designated international airspace beyond 12 nautical miles off the coast of the 48 contiguous States and Alaska within areas of domestic radio navigational signal or ATC radar coverage, and within which domestic procedures are applied.

Class B: Generally, that airspace from the surface to 10,000 feet MSL surrounding the nation's busiest airports in terms of IFR operations or passenger enplanements. The configuration of each Class B airspace area is individually tailored and consists of a surface area and two or more layers (some Class B airspace areas resemble upside-down wedding cakes) and is designed to contain all published instrument procedures once an aircraft enters the airspace. An ATC clearance is required for all aircraft to operate in the area, and all aircraft that are so cleared receive separation services within the airspace. The cloud clearance requirement for VFR operations is "clear of clouds."

Class C: Generally, that airspace from the surface to 4,000 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower, are serviced by a radar approach control, and that have a certain number of IFR operations or passenger enplanements. Although the configuration of each Class C airspace area is individually tailored, the airspace usually consists of a 5 NM radius core surface area that extends from the surface up to 4,000 feet above the airport elevation, and a 10 NM radius shelf area that extends no lower than 1,200 feet up to 4,000 feet above the airport elevation.

Class D: Generally, Class D airspace extends upward from the surface to 2,500 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower. The configuration of each Class D airspace area is individually tailored and when instrument procedures are published, the airspace will normally be designed to contain the procedures.

Class E: Class E airspace is controlled airspace that is designated to serve a variety of terminal or en route purposes as described in this paragraph.

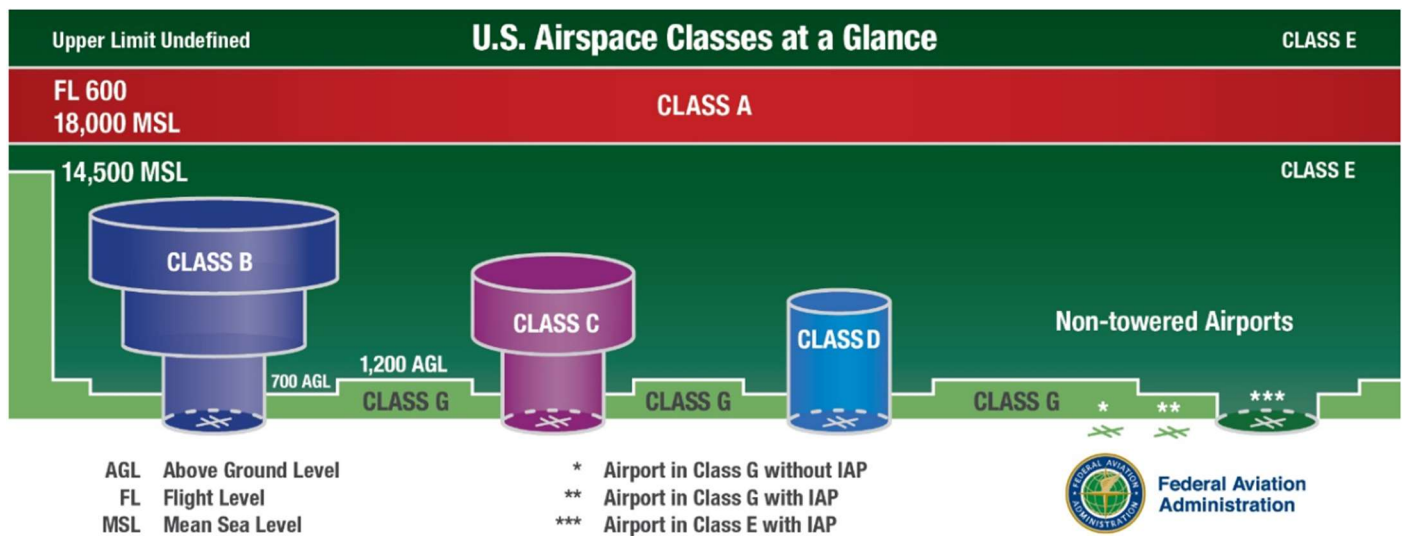


Figure 7

From the understanding of the FAA approvals, listed some urban and rural areas –

1. Cambridge
2. Somerville
3. Burlington
4. Winchester
5. Saugus
6. Worcester
7. Springfield

Age and Income Distribution

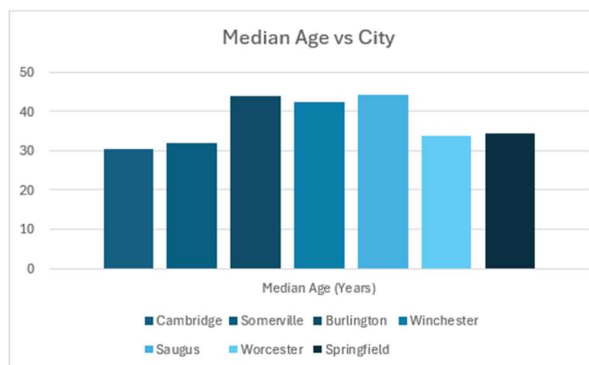


Figure 8

The results indicate that Cambridge has a predominantly young population, coupled with a higher-than-average income level.

Calculate the miles travelled by drone

Average speed of MK30 drone considered as 50mph.

1. For 5 minutes:

- Distance = 50 mph × (1/12) hours = 50 / 12 miles = **4.17 miles**

2. For 10 minutes:

- Distance = 50 mph × (1/6) hours = 50 / 6 miles = **8.33 miles**

3. For 15 minutes:

Distance = 50 mph × (1/4) hours = 50 / 4 miles = **12.5 miles**

Population distribution 5 min, 10 min, 15 min

City Considered	Prime Air Drone Delivery Possibility	City	Areas	Minutes	Miles	Population	Median Age (Years)	Average Income (\$)
BOSTON	Eastern Mass	Cambridge	Central Square	5 min	4.17	790,067	30.5	134307
				10 min	8.33	1,608,223		
				15 min	12.5	2,116,588		
			Kendall Square	5 min	4.17	816,271		
				10 min	8.33	1,588,019		
				15 min	12.5	2,119,210		
			Harvard Square	5 min	4.17	710,825		
				10 min	8.33	1,607,095		
				15 min	12.5	2,103,903		
		Somerville	Davis Square	5 min	4.17	639,844	32	126619
				10 min	8.33	1,564,936		
				15 min	12.5	2,107,050		
			Union Square	5 min	4.17	785,365		
				10 min	8.33	1,589,078		
				15 min	12.5	2,113,246		
			Ball Square	5 min	4.17	649,274		
				10 min	8.33	1,537,487		
				15 min	12.5	2,121,293		
		Burlington	-	5 min	4.17	119,643	43.9	133936
				10 min	8.33	535,304		
				15 min	12.5	1,634,790		
		Winchester	-	5 min	4.17	294,793	42.3	208531
				10 min	8.33	1,246,337		
				15 min	12.5	2,007,727		
		Saugus	-	5 min	4.17	284,137	44.4	96064
				10 min	8.33	979,619		
				15 min	12.5	1,801,796		
Worcester	Central Mass	Worcester	-	5 min	4.17	96118	33.9	69262
				10 min	8.33	324346		
				15 min	12.5	506639		
Springfield	Western Mass	Springfield	-	5 min	4.17	202546	34.3	47101
				10 min	8.33	431084		
				15 min	12.5	577332		

Figure 8

A strategic approach would be to focus on locations with higher population density within a 5-minute drone travel radius, as this would maximize delivery potential and minimize travel time. Based on the analysis, Cambridge emerges as the most suitable hub, given its favourable demographic profile, including a young population, optimal median age, and relatively high average income.

Dimension 4:

LOCATION ANALYSIS

Population Percentage within 15 min radius:

For our study, the center points will be the selected regions (above) that is FAA approved to fly a drone and a suitable place to build a warehouse. For example, Cambridge as seen, is an ideal location for having a warehouse. With this in mind, we can map out the radii coverage where the drone will potentially reach within 15-min threshold.

Defining the Coverage Radius

- **Drone Speed and Time Calculation:** By knowing the drone's maximum speed (e.g., 50 mph), you can calculate the maximum distance it can travel in 15 minutes (e.g., 15 minutes = 1/4 hour, so distance = 12.5 miles).
- Using the ruler tool in **"Circle" mode**, you can map a circle with a 12.5-mile radius (or equivalent based on speed and terrain) around a central delivery hub. This visualizes the potential delivery coverage area.

I have generated the photo showing the potential areas that could be covered.

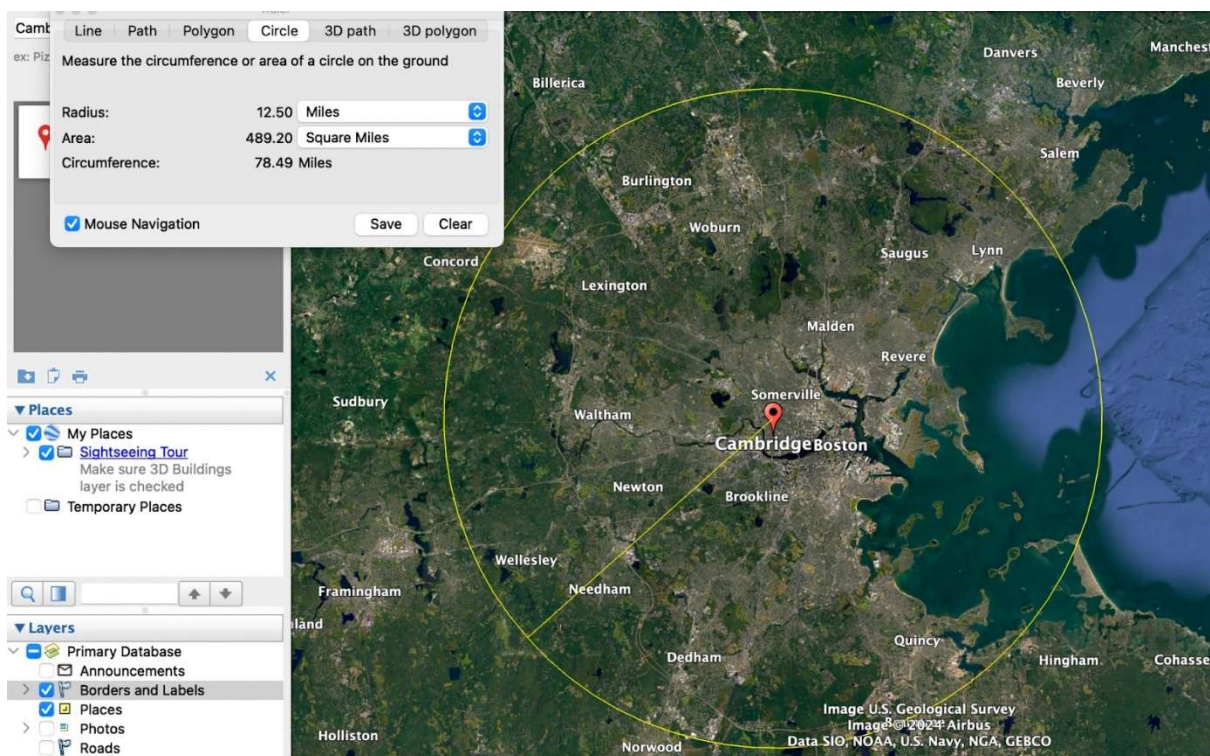


Figure 9

As seen above, A 12.5-mile radius from Cambridge encompasses several cities and towns, including:

Cities	Approx. Population (July 2023)
Cambridge	118,214
Boston	653,833
Somerville	80,407
Brookline	62,962
Revere	57,954

Lexington	33,882
Newton	88,415
Malden	65,133
Saugus	28,630
Burlington	26,527
Quincy	101,597
Lynn	101,241
Woburn	41,647
Waltham	64,477
Wellesley	30,733
Dedham	24,968
Total	1,580,620

The Strategic advantage for Cambridge includes **high population density** as seen above and diverse demographics indicating a strong potential customer base for drone delivery services.

Worcester:

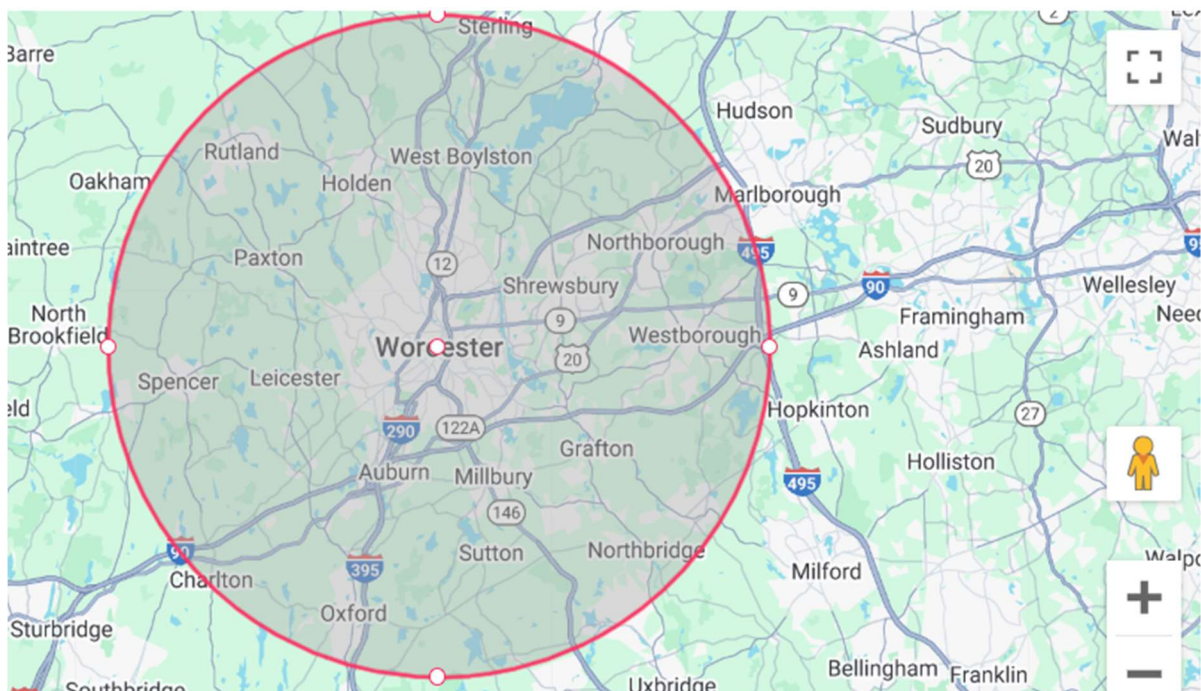


Figure 10

Town	Population (2020 Census)
Rutland	9,376
Holden	20,774
Paxton	5,256
West Boylston	8,300
Shrewsbury	39,746
Northborough	15,767
Westborough	19,000
Grafton	20,365
Millbury	14,390
Sutton	9,479
Auburn	16,188
Oxford	14,404
Leicester	11,972
Spencer	12,229

Total Population: 197,970

Springfield:

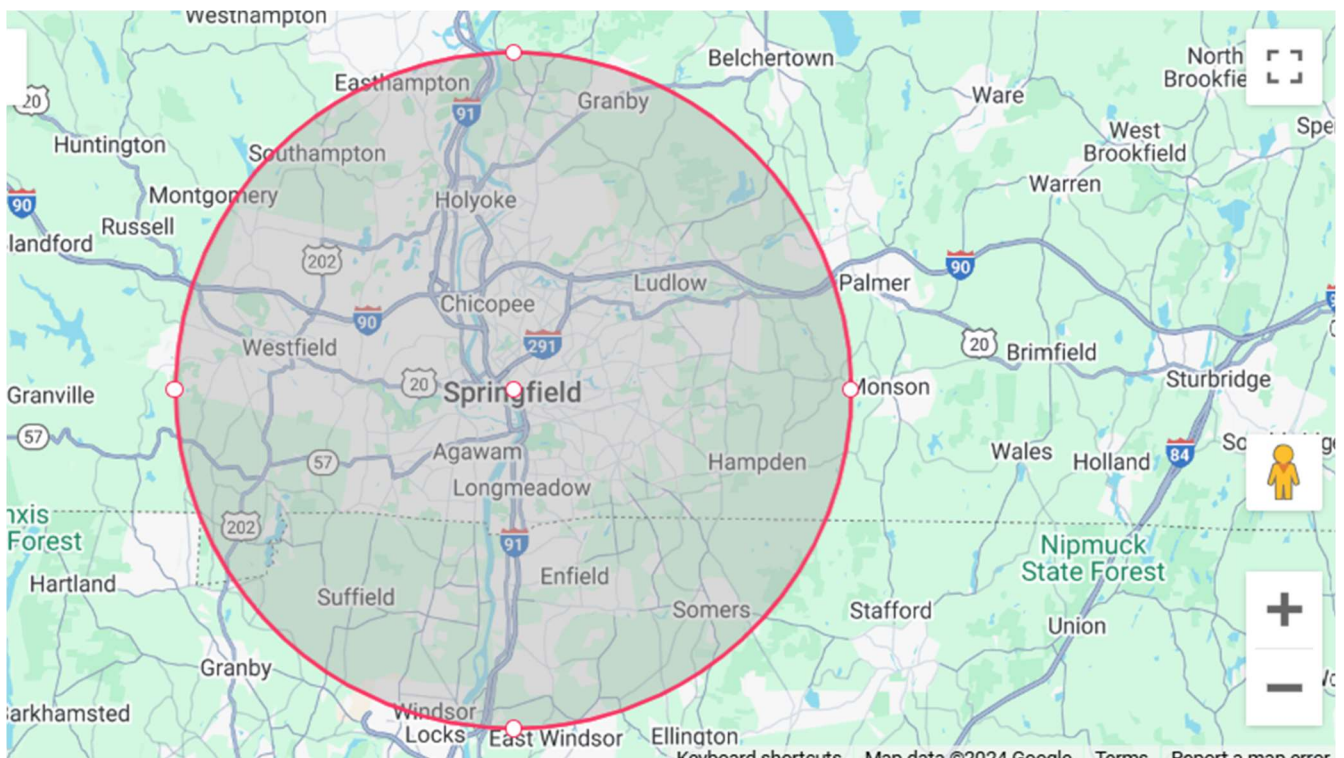


Figure 11

Town	Population (2020 Census)
Westfield	41,994
Suffield	15,736
Enfield	44,654
Agawam	29,605
Chicopee	55,700
Holyoke	41,442
Ludlow	21,292
Hampden	5,433
Somers	10,334

Total Population: 226,190

Percentage of Population Covered

Massachusetts has an estimated population of 7 million. The coverage by the three hubs is calculated as:

- **Cambridge Hub:** Covers 23% of the state population.
- **Worcester Hub:** Covers 2.8% of the state population.
- **Springfield Hub:** Covers 3.2% of the state population.
- **Total Coverage (15-min Threshold):** 28% of the total population.

To Determine the Volumes that Can be handled by such a facility:

We will need to analyse the following. I have put them in a table with description.

	A	B	C	D
1				
2				
3	Input	Value	Description	
4	Population (12.5mile radius)	1,580,620	Total population within a 12-mile radius.	
5	E-commerce Penetration (%)	15%	Percentage of the population shopping online	
6	Avg. Orders per Shopper/Year	24	Number of orders per year per shopper.	
7	Drone-Suitable Orders (%)	30%	Percentage of orders suitable for drones.(Assumption)	
8				

Figure 12

- **Step 1: Calculate the Online Shoppers**
E-commerce penetration means that **15%** of the 1.5 million population shops online:
Online Shoppers=1,580,620×0.15=237,093
So, **237,093** people are potential online shoppers.
- **Step 2: Calculate Total Annual Orders**

Each shopper places an average of 24 orders per year:
Total Annual Orders= $237,093 \times 24 = 5,690,232$
So, there are approximately **5.7 million** orders annually.

- **Step 3: Estimate Drone-Suitable Orders**

Assume 30% of these orders are suitable for drone delivery:
Drone-Suitable Orders= $5,690,232 \times 0.30 = 1,707,069.6$
This means **1.7 million** orders per year could potentially be delivered by drones.

- **Step 4: Convert Annual Orders to Daily Volume**

Daily Volume= $1,707,069 / 365$
= $4,676.903$
Approximately **4700** orders per day.

Assuming I want to reach customers in a 15-minute threshold in a warehouse in Cambridge, MA. I will need a warehouse with a daily capacity of 4700 orders.

Similarly targeting for **Springfield** and **Worcester** the outcome is **670** orders per day and **585** orders per day

This is a base study for any location one chooses to build a warehouse. Having the 12.5-mile radius population, we can determine the volume each facility can hold in any given location.

Note:

Drone-suitable orders of 30% is just an assumption. No study shows the actual percentage of drone suitable orders.

While Springfield (West Mass) and Worcester (Central Mass) may offer lower land costs, their challenges in customer density and delivery efficiency make them less ideal for a high-tech drone warehouse. In contrast, urban locations such as Cambridge (East Mass) present better opportunities to enhance operational efficiency and improve customer satisfaction.

Additional aspects:

- Weather and Terrain: Massachusetts' severe winters could pose challenges to drone operations. It is advisable to implement backup vehicle-based delivery systems to ensure reliability during adverse weather conditions.
- Customer Perception: Building customer trust in the safety and reliability of drone deliveries is essential for widespread adoption. Effective education and communication about the technology's benefits will be key.
- Integration with Existing Infrastructure: Integrating drone hubs with current warehouse and distribution networks can optimize operational efficiency, reduce costs, and enhance service delivery.

Conclusion

Based on the information above, it would be more effective to focus on deploying the model gradually over the course of a year, starting with Cambridge, which is currently the most suitable location. Springfield and Worcester could also be considered for future expansion, but their lower population density and delivery challenges make them less ideal for immediate deployment. Evaluating the performance in Cambridge will provide valuable insights for scaling the model to other areas.

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