UTILITY ANALYSIS OF FOOD ORDERING APPS USING GIS

A DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTSFOR

THE AWARD OF THE DEGREE

OF

MASTER OF TECHNOLOGY

IN

GEOINFORMATICS

By

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August 2022

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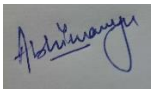
CANDIDATE'S DECLARATION

I, Abhimanyu Kumar, Roll No. - 2K20/GEO/01, Student of M.Tech (Geoinformatics Engineering), hereby declare that the project Dissertation titled "*Utility Analysis of Food Ordering Apps Using GIS*" which is submitted by me to the Multidisciplinary Centre for Geoinformatics, Department of Civil Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title or recognition.



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Date: 30th May 2022

ACKNOWLEDGEMENTS

Foremost, I would like to express my sincere gratitude to my supervisor Prof. Rajan Yadav for guiding me throughout this research work, and for his patience, motivation, enthusiasm, and immense knowledge. His guidance helped me a lot during this research and writing of this thesis. I feel motivated and encouraged every time I attended his meeting. Without his encouragement and guidance this project would not have materialized.

It gives me great pleasure in acknowledging the support and help of all the members of Multidisciplinary Centre of Geoinformatics Lab at Delhi Technological University who were always there to advice and guide me throughout my M. Tech journey. I am thankful to all the staffs and members of Department of Civil Engineering, our HOD, Department of Civil Engineering and the entire fraternity of Delhi Technological University for giving me the opportunity to study at this institute.

I am thankful to all my classmates and friends who made my stay in this institute, an unforgettable and rewarding experience. Finally, I feel great reverence for all my family members and the Almighty, for their blessings and for being a constant source of encouragement.

ABSTRACT

According to various business reports, this has been found that India is still lagging in terms of using food ordering apps. In terms of revenue obtained from these apps, it is in 7th position with 1.3 billion dollars. This leads to the need of understanding the behavior of users towards these food ordering apps as well as the utility analysis of the app itself to deliver food faster with the assurance of the good quality of food and to increase the domain of the app. In this study, we have created a clustering model which gives us the best cluster to be displayed in the app by consuming the data of the user's input.

We have used the coordinates of the restaurants and the responses of the users for those coordinates whether the restaurant's delivery is having any delay problem. All these things have been written in Python code which takes the input of the CSV file and does the clustering by sorting the probability of the delay in each cluster. On one hand, a model has been created. On the other hand, we have tried to use GIS software for spatial analysis of the proximity and road network density for better understanding of the locations. This analysis used the predefined algorithms available in the software.

Results show that successful clustering was done and the probability of the clusters are coming out be in order. The future for this study is to Integrate various factors like delay causes, ratings and demand during peak hours to refine the results more accurately and simplistically. In addition, this can be further combined with any existing app and can be helpful to increase their utility.

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CHAPTER 1

1. INTRODUCTION

1.1 Background

Over the last five years, the meal delivery sector has grown significantly. Food delivery has evolved from takeout to anything and everything, thanks to platform-to-consumer services like Zomato, Swiggy and UberEats, which have added billions of dollars in potential revenue capture [1]. COVID-19 has catapulted the sector forward a few years, as millions of people in lockdown for the first time ordered meals online [2]. Instacart, a grocery delivery startup, says it met its 2022 goals in the third week of the lockdown.

Food delivery is a global sector, fueled by the gig economy that has swept across North America, Europe, and Asia over the last decade. Globally, an expansion in smartphone users has encouraged online meal delivery businesses. Smartphone users are the principal online shoppers for the food and beverage business and an increase in smartphone users indicates [3], an increase in online food and beverage shopping illustrated using Figure.1.F&B e-commerce customers worldwide reached 1.5 billion in 2019 and are predicted to increase by 800 million by 2024, with an average annual growth rate of 25% [4].

Figure1. The Online Penetration of Food Services in India is Set to Double by 2024, Clocking a GMV of Nearly $13 Billion

Food delivery apps in China have the highest userbase and market penetration, with over 650 million users; the United States is the second largest market and the most well-funded [4]. China leads the world in overall food delivery revenue, with $27.3 billion in 2021. Meituan, the world's largest meal delivery app by revenue and usage, added $15 billion to the total. Zomato, an Indian meal [3], delivery company, has 80 million monthly active users and plans to grow to 20 million in the next few years as in Figure.2. As a result, the expansion of online food delivery services is being driven by an increase in smartphone users and internet penetration.

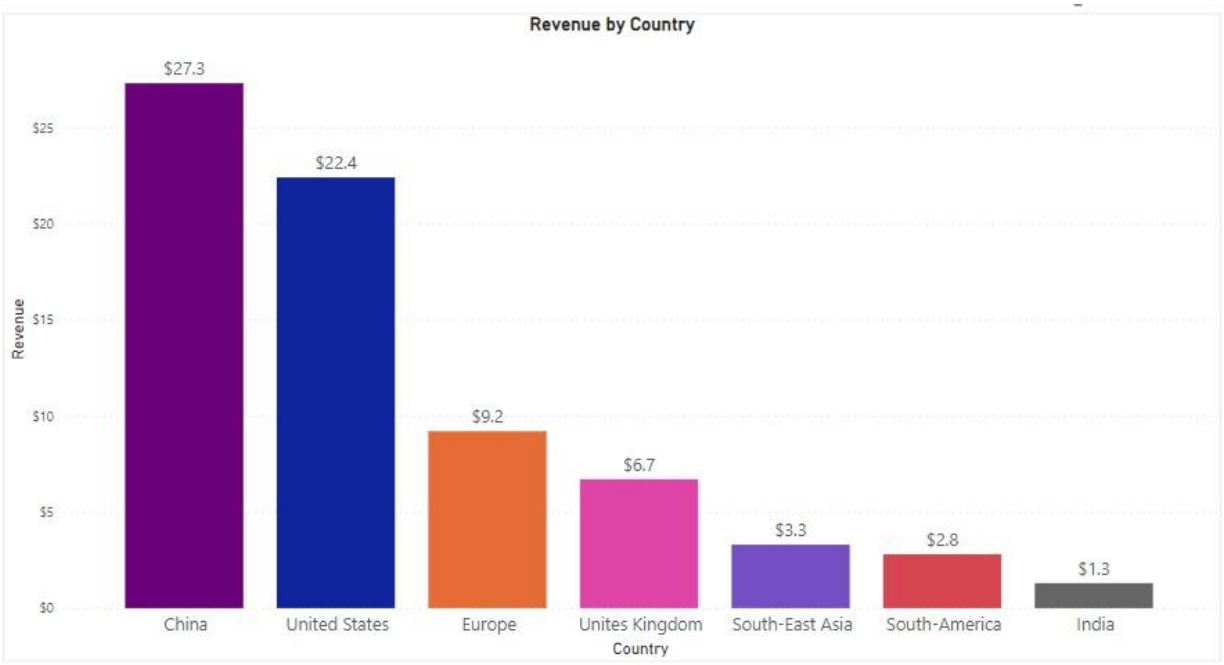


Figure.2. Revenue Generated through Online Food Ordering Apps in Various Countries

1.2 Indian Online Food Delivery Market

Online food delivery is basically a service in which a store or restaurant delivers food to a customer through the restaurant's website or with a common web portal. The improvement in internet services and allied technologies has allowed an easy access to customers [5], for availing all the information that is required to select, evaluate and purchase the product.

The online food delivery market in India is growing significantly with evolving lifestyle patterns and changing eating habits of Indians. The revolution in the online retail market has also made a strong impact on the Indian food industry [5], [6]. Longer working hours, longer travel time, and an increase in the number of working women and working couples are the primary causes of increased demand for efficient meal delivery to the doorstep in urban India. The rate at which India's online food delivery market is growing (double-digit CAGR- compound annual growth rate), the food supply market in India is expected to reach $8 billion by 2022 [3].

The Indian online food delivery market is undergoing a transformation. This market has showed potential in recent years, attracting significant investment. Zomato was valued at US$ 5.4 billion with the fresh investment of US$ 250 million, up from US$ 3.9 billion in December last year. Swiggy, its main competitor, is in advanced talks with SoftBank to invest up to US$ 450 million in the food delivery business, valuing it at US$ 5 billion [1], [2]. This is one of the few with a double-digit compound annual growth rate.

Market players in India are primarily located in urban areas such as Mumbai, Delhi, Bangalore, Delhi, and Mumbai. Smaller cities, on the other hand, are now being targeted by sellers due to their high growth potential. Aggregator and Cloud Kitchen are the two types of online meal delivery services. Consumers can use Food Aggregators to compare and order meals from multiple restaurants using a single app. Cloud kitchen, which are commercial facilities purpose-built to manufacture meals exclusively for delivery, are less common in India [2].

1.3 Demand in Online Food Ordering Market

These Online food ordering apps operate as a conduit between the restaurant and the customer. In India, we can observe a lot of people are inclined towards online food ordering services. The changing lifestyles of people, the demographics of population, jam-packed metro cities and stretched travel times are drivers for the convenient, ready-to eat and cheaper options of having food and groceries delivered at the doorstep [7]. Dynamic work schedules, escalation in disposable incomes and increase in overall spending capacity have promoted online food delivery, especially in the urban areas.

Many big and acclaimed restaurants and food retail chains have started registering and associating themselves on web-based ordering sites and apps like Zomato, Swiggy, Eat Sure etc thereby attracting more and more crowd and gaining higher profits percentage. Customers can now, more easily and effectively access and order food from various restaurants at a time and location that is convenient for users. Through such platforms, customers access information about the restaurants and their offerings, including menus meal pictures and description, and delivery time estimations [8], [9]. Customers can pay for their meals on said platforms, track their orders in real-time, and access food reviews and customer service. The typical online food ordering application even consists of various innovative characteristics, helping customers and restaurants overcome problems such as long waiting times, traffic, miscommunication, late delivery, or handling customer complaints.

Furthermore, prominent industry participants such as Swiggy, Zomato etc., continue to announce tempting deals for existing and new clients in order to maintain the fierce rivalry in the online food ordering business [8]. As a result, individuals are increasingly preferring to order food online and enjoy their favourite cuisine at home at a reasonable price, boosting the value and user base of India's online food ordering sector.

1.4 Governing Constraints in Online Food Delivery Market

The sector of online food delivery industry is growing rapidly in extent, which means it is influenced by a variety of factors. A small disturbance is enough to make a plummet in profit of the market. As a result, it becomes crucial to keep these variables at their optimal levels [10]. This section explains some of the constraints:

1.4.1 Supply chain and Logistics in Online Food Delivery

The cost of supply chain and logistics is a major impediment to the market for online meal delivery services. Order fulfilment, shipping, changing business resources to dynamic market demand, and last-mile connection are all included in this cost [10]. In addition, there are charges for packaging cardboard boxes, gas, mileage, and hiring a driver. To avoid rotting of items with a short shelf life, the supply chain and logistics must be in place.

According to a Capgemini analysis, retailers could lose up to 26% of their profit in 2019 if they do not modernise their logistics system to assure on-time delivery despite the rising use of online grocery stores. As a result, the costs borne by suppliers may limit the expansion of the online food delivery services market.

In the food delivery services sector, upgrading the distribution network to a more decentralised distribution system is popular. Suppliers will work with numerous players for the best market coverage between urban and rural markets, focusing their efforts on marketing, branding, and in-store merchandising to deliver a best-in-class shopper experience through the New Distribution System [2], [11]. To expand coverage, they are likely to work with aggregators, e-commerce delivery companies, rural distribution companies, and modern trade distribution arms. Amazon, the e-commerce aggregator, has announced intentions to collaborate with a number of small enterprises, retail shops, and rural supermarkets to improve last-mile connectivity.

1.4.2. Customer Behavioural Towards Online Food Ordering Services

Understanding customer perceptions of food and services, on the other hand, is vital for the food and service industry since it provides insight into customers' needs and preferences. Many incidents of shuttered restaurants have recently surfaced due to which consumers placing orders on those food platforms were only told either store does not deliver to the location or the restaurant has ceased operations [5], [12]. A small proportion of establishments registered on these meal delivery apps have also been reported to operate out of home joints with little concern for cleanliness or quality. This has outraged not only the clients, but also the food delivery employees.

Some of the most pressing issues confronting the meal delivery sector today are:

I. Shifting Customer Preferences:

Even as competition intensifies, food delivery market participants have upgraded the to the point that clients are spoiled for choice. This destabilises the client base and undermines brand loyalty [13].

II. Unstable Market Prices:

Several factors affect the prices in the food industry [5]. Businesses dealing in food delivery often cannot track or keep up with market prices and struggle to find the right pricing strategy.

III. Adhering to the Food Quality Standards:

Due to the high demand for online orders, delivery partners are finding to deliver meals from a restaurant far away the customer's location while keeping the highest level of quality [1], [11]. The contrast between food served on restaurant premises and food delivered to one's home creates a major gap that food delivery companies should work hard to close.

IV. Managing Customer Expectations:

Customers' pleasure is not solely the duty of delivery partners, but also of those working at the point of origin, the restaurant personnel. As a result, closing the gap between delivery partners and restaurant owners to collaborate and anticipate customer expectations is a difficulty [11].

V. Improper Food Handling:

Mishandling orders due to a lack of training is one of the most serious challenges that delivery drivers confront. Only a few food delivery firms have policies in place to ensure that their drivers are appropriately handling food [10]. Many consumers are concerned about sanitation, which is one of the main reasons why restaurants must assure sufficient training in order to improve the food delivery experience and maintain control over delivery times.

VI. The Logistics Conundrum:

Food delivery firm confront enormous logistical obstacles. The scope of receiving higher orders from a certain location, allocating the proper number of vehicles, maintaining food quality, and other essential logistics-related difficulties that food delivery companies encounter are some of the critical logistics-related issues that food delivery companies face [13], [14].

When choosing a last-mile logistics approach, restaurants and delivery services must consider all of these factors.

1.5 Influencing Factors for Customer Behavior and Perception

Customer Satisfaction and Behavioural Intention are two significant facets of the online food service industry that must not be overlooked. Improved service quality is the most effective strategy to influence consumer happiness [7], [14]. Service quality perceptions are an important strategic instrument for positioning and achieving high business performance.

This section explores into the most immediate aspects of customer behaviour and satisfaction:

I. Price:

The amount of money paid by customers in return for services or items can be characterised as price. It is also known as customer monetary costs, and it is a significant influencing factor in consumer behaviour intent. Generally, when the prices of online meal delivery apps are lower than the prices of dining out, users are more likely to use them. Customers engagement with the apps is boosted by price reductions and free offers. The price fairness of food articles contributes as a good predictor of purchasing decision and intention. As a result, customer satisfaction and behaviour are positively influenced [8].

II. Food Safety and Quality:

Customers' anxiety about the quality of processed food, as well as the safety measures employed in food processing and handling, is referred to as food safety concern. Customers are becoming more concerned about food safety, with an emphasis on the manufacturing process, food processing quality, and food additives. As a result, food delivery restaurants bolster their operations by guaranteeing consumers that their food is processed, handled, and delivered in a safe and sanitary manner [8], [10]. Considering consumers are concerned about food safety, online meal delivery apps should work with their restaurant partners to ensure that food is processed and

packaged safely. Customers may rest assured that online meal delivery apps are concerned about safety and hygiene, and that food preparation protocols are followed.

III. Loyalty and Trust:

Trust is defined as a trait of a service provider who is trustworthy in terms of honesty, adherence to agreements, and offering a dependable service in fulfilling claims. Whereas; the degree of customer allegiance to a particular brand is referred as brand loyalty [12]. It is often characterised as an expression of long-term buying behaviour based on brand trust, such as future repurchases, recommendations, word of mouth, and so on. Customers that have a high level of brand loyalty have a good response to the brand and are less likely to switch to another [12]. The behavioural side of loyalty is a customer's tendency to buy a particular retailer or brand repeatedly over time, and this measure is frequently quantified by the volume or frequency of purchase of a specific brand.

IV. Delivery Time:

The delivery of ordered food item on time is of huge concern. None of the customer feels satisfied if his/her order gets delayed. Delays in delivery leads in degradation of food quality therefore; impacting the customer satisfaction and perception for online food ordering apps. This further effects the online ratings and online reviews of the company [12], [15]. These delays can happen due various reasons such as traffic jams, less connectivity to major roads, large distance between customer and food restaurant or flawed road network. On the contrary, on time or before time delivery of food to the customer always creates a higher sense of satisfaction and importance. Thus, positively effecting the company’s growth in the market.

V. Social Influence:

Consumer awareness of online meal delivery services has been influenced by social media the most. The marketer could use social influence to communicate with current and potential customers in order to increase the number of customers. It aids in the promotion of online delivery applications and restaurant services by advertising to a larger and more diverse audience [14], [16].

Social influence impacts user perceptions of utility in the short and long term, as well as user intent and readiness to adopt new technologies.

VI. Convenience:

Convenience is defined as the degree of ease with which users can use a particular technology. It has a beneficial impact on consumers' intention to utilise mobile apps in the future. The ability to share your present location with the delivery app aids and leads to more personalised information. The programme uses information about the user from the mobile communication network platform to recommend services such as the best restaurants in the area [7], [14]. Physical mobility has been overcome due to advancements in transit networks and development in communication technology.

1.6 GIS – Geographic Information Systems in Online Food Delivery

A GIS-class system is a digital programme or framework that captures, analyses, and presents interactive geographic data to the user. GIS integrates location data (where things are) with all forms of descriptive information to create a map (what things are like there). This lays the groundwork for mapping and analysis in research and nearly every industry. Users can utilise GIS to understand trends, relationships, and the context of their location [17]. Improved communication and efficiency, as well as better management and decision-making, are all advantages.

The main purpose is to give the user a tool to make a system query, change map-based data, and output the results. These processes don't have to be totally visual; there are a variety of situations when a text-based response is sufficient, such as all statistical processing using geospatial data, such as migrations or employment [17]. When it comes to online meal ordering, geographical localization is critical - the customer must both specify his or her location or address and choose a restaurant that can deliver food to that place [18].

Food delivery is a difficult challenge to address since it necessitates striking a balance between providing a positive customer experience and delivering orders quickly. Even in

unavoidable conditions, they accomplish so by maximising time, cost, and routes (like rain, traffic issues, and fall in available delivery executive). They achieve this goal by reducing the amount of time a delivery executive spends waiting for the next order to be assigned to him or her, either by reducing the time spent waiting at restaurants (while the food is being prepared) or by reducing the time spent waiting for the next order to be assigned to him or her. Yes, GIS has made these challenges small [17], [18].

Burger King uses real-time geofencing and location intelligence to locate customers within 600 feet of any of their locations in order to give digital coupons for orders placed at any of their locations. Food-tech businesses are taking advantage of this by leveraging real-time location to target the right customer at the right moment as consumers become more relaxed about their data. Location-based advertising has various advantages, including better and real-time data and a high level of traction for businesses. For example, in areas where they typically receive lunch orders (such as campuses or business spaces), they could advertise breakfast specials from multiple restaurants [18]. Companies are also employing location information to determine zone-by-zone cancellation rates, determine the demand and supply of food and delivery executives in a given area, and provide a snapshot of delivery and restaurant footfall volumes and variances. Again, all these things are possible due to GIS which binds us to earth reality.

1.7 Objectives

The purpose of this study is to understand customers perceptions, intentions, and behavioural patterns. Moreover, it also focuses on the geographical aspects of customer and food restaurants locations.

The delay aspect from the food restaurant is considered while creating clusters. The objectives of the study are emphasised in the section.

- To analyse the user behaviour and perception towards online food ordering apps using Excel.
- To make use of the spatial analysis tools for creating maps and analysing them for density analysis for the road network.
- To find the reachability and suitability of restaurants which are engaged in online food delivery, a Proximity analysis has been done.

- To create a model for clustering the food restaurants in order of their spatial locations.
- To compare the probability of the clusters in a code and sort it down in decreasing order according to the delay, the minimum delay will top the list, implemented by using a python module.

CHAPTER 2

2. LITERATURE REVIEW

The online meal ordering company is a massive market that is still growing and striving to expand its reach in order to attract footfalls. People may now enjoy their favorite meals from any cuisine with just one click thanks to these applications. People can eat whenever and wherever they choose at significantly lower prices. A lot of studies have recently been conducted to better understand people's perceptions and behavioral patterns around online meal ordering apps. It is critical for a business to understand the thinking of its customers in order to keep them or entice them to use its services.

On the one hand, this helps the organization avoid client turnover while also allowing them to keep ahead of their market competition. It's critical to understand what your buyer wants and what he or she expects from your services. A model to investigate the primary factors that influence client adoption of online meal delivery apps can be augmented [13]. Customers' decisions to utilize these online purchasing systems are influenced by content, usability, and functionality, according to the research.

Another theme that researchers looked into was the key factors of user acceptance of online meal ordering apps. In this regard, [19] proposed a number of factors (namely, perceived enjoyment, perceived usefulness, social norms, self-efficacy, and perceived ease of use) as key predictors of a customer's willingness to use online food ordering apps [19], based on the Technology Acceptance Model (TAM).

For determining the primary predictors of customer desire to use online food ordering systems [20], developed a model based on the Contingency Framework and IT Continuation Model. Customers considered it beneficial and easier in this study, and as a result, they were more likely to establish good opinions and be inclined to use the programme again. The authors also highlighted how customers' opinions of usability and simplicity of use are influenced by online food systems' capacity to save them time and money [20].

Customers' perceptions of online meal ordering apps have been a hot topic among academics, with several studies looking into it. A study found that perceived value and customers' attitudes toward food delivery apps are largely [21], shaped by levels of trust, design, and product verity, and that there are significant differences in customers' perceptions of such apps between single-person families and multi-person families [21].

Customers' perceptions toward online meal ordering apps were impacted by aspects such as utility, innovation, and trust, according to research [22]. Several studies [9], [23], have looked at the consequences of using online meal ordering apps, namely satisfactio, customer experience, and conversion. A mobile app is a sophisticated interactive tool that allows people to interact with a brand through its features [23], [24]

In the food and beverage service industry, researchers discovered that reliability had a positive correlation with consumer happiness [25]. Furthermore, according to [26], [27], customers' habitual behaviour, whether in terms of using smartphones and associated apps or ordering food from restaurants, could be a very important factor in shaping customer intention and behaviour toward online food ordering apps [28].

Client turnover and geographic location are also major variables in customer retention. Several studies on customer churn forecasting have been conducted in various locations. Different data mining methods were utilised, resulting in various outcomes. Retailers would benefit from knowing the spatial, demographic, and attitude impacts that play into consumption behaviour, according to [29], such effects can be better understood when analysing choice at the category and regional level. Customers' actual location makes it simple to detect geographic elements (strategic geographic spots) that may influence turnover [29]. The proximity to a specific supermarket is most likely an important element in determining churn [30].

For customer churn prediction [31], used Improved Balanced Random Forest (IBRF). It appears to greatly improve predicted accuracy when compared to methods such as decision trees, Class-Weighted Core Support Vector Machines (CWC-SVM), and artificial neural networks. Different classification methods such as Random Forests [32], Logistic Regression, and SVM to compare churn prediction in telecom.

SVM was shown to be the most accurate classifier [32], with an accuracy of 82 percent, compared to Random Forests (80.88 percent) and Logistic Regression (80.88 percent) (80.75 percent).

Food distribution systems are one type of geographical information system (GIS) that can be digitized and used. The main case in the food delivery system is determining the shortest path and tracking the movement of food delivery vehicles. As a result, a shortest path determination facility and food delivery vehicle tracking are required to ensure that the digitization process of the food delivery system can be applied efficiently [32], [33]. For moving food delivery vehicle object tracking, this research employs the A Star (A*) algorithm and location-based system (LBS) programming. According to this study, an integrated system was developed that can be used by food delivery drivers, customers, and administrators to streamline the meal delivery process [33]. The use of food delivery system in the scope of geographical information system (GIS) can be carried out by using the shortest path and tracking of moving vehicles.

CHAPTER 3

3. STUDY AREA

Delhi covers an approximate area of 1484 sq km with a huge population of 1.9 crores as per Census, 2011. Delhi is India's capital, and it is located at 76.96^{o} E, 28.44^{o} N, intersected by 77.40^{o}E, 28.76^{o} N. Aside from Delhi, there are a few large outlying cities that make up the National Capital Region (NCR) [34]. NCT of Delhi houses the country's Union Government as well as state government agencies. The various parameters of Delhi have been illustrated using Table I, which are as per census 2011.

Table I

Parameters of NCT of Delhi

Parameters	Delhi
Geographical area (sq km)	1,483
Administrative districts (No)	9
Population density (persons per sq km)*	11,297
Total population (million)*	16.7
Male population (million)*	8.9
Female population (million)*	7.8
Sex ratio (females per 1,000 males)*	866
Literacy rate (%)*	86.3

Delhi is India's international hub for politics, trade, culture, and literature. Delhi has a global culture and speaks a variety of languages. For regular transactions, English and Hindi are often used. Other languages spoken include Punjabi, Bihari, and Haryanvi, among others. Gurgaon, Noida, Faridabad, and Ghaziabad are some of the major satellite cities [34]. Consider Figure.3, which shows Delhi's location in relation to the Himalayas in the north and the Aravalli Mountains and the Yamuna in the south and east, respectively. The city's elevation varies between 213 and 290 metres. Summers are hot and dry, and winters are rather cool, with summertime high

temperatures reaching 45°C. The monsoonal weather pattern dominates rainfall, with the wettest months being June to September [35].

The status of Delhi as a union territory was maintained until 1991, when the National Capital Territory (Delhi) Act was passed, making Delhi the National Capital Territory of Delhi with effect from January 1, 1992. Delhi had only one district and one tehsil at the, time of the 1961 census. Between the censuses of 1971 and 1991, the Delhi revenue district was divided into two tehsils: Delhi tehsil and Mehrauli tehsil. Delhi was divided into 9 districts and 27 sub-divisions in 1996, all of which were coterminous with tehsils. According to census 2011, the National Capital Territory of Delhi consists of 1 division, 11 districts, 33 subdivisions, 59 census towns, and 300 villages [34].

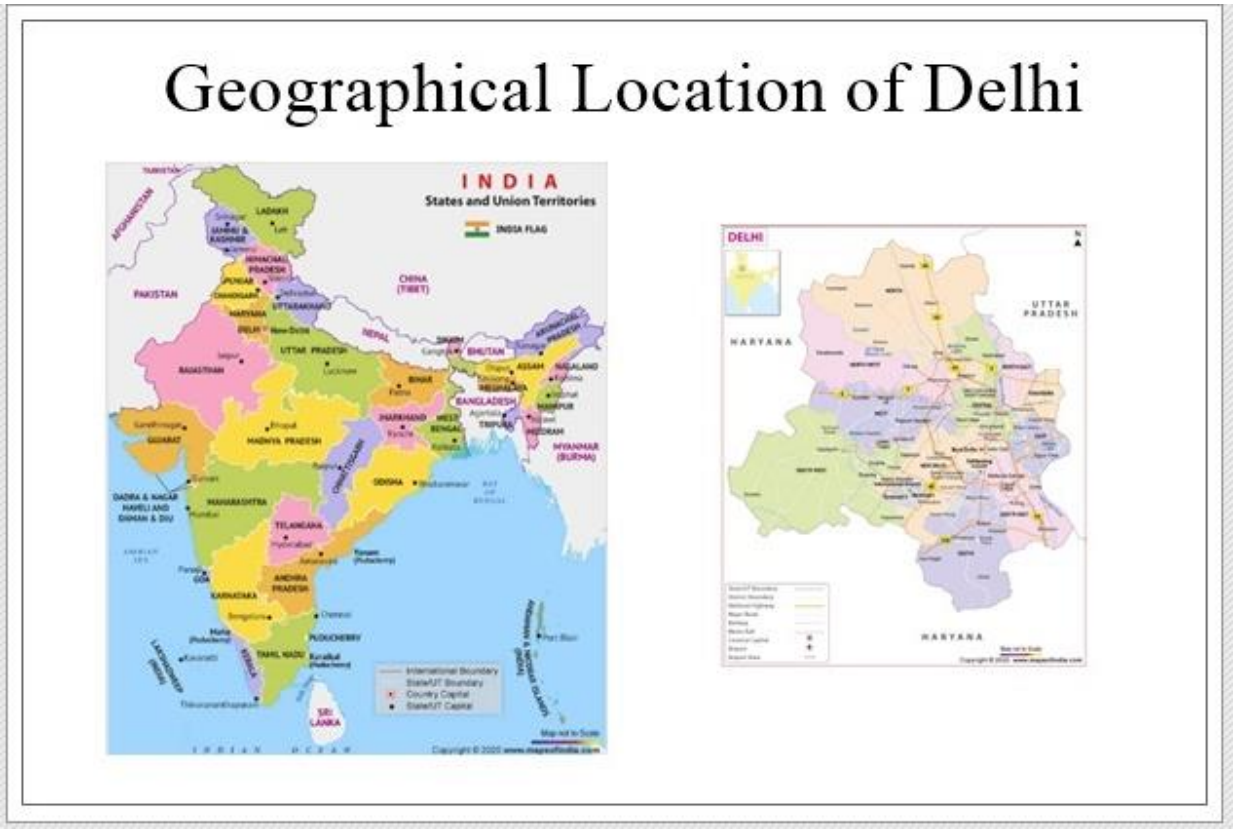


Figure. 3. Location of Delhi in Map of India

Delhi has been one of the fastest growing global cities, with a population of over 18 million people this year, up from 400,000 in 1901. Its population expanded by 215,000 due to

natural growth and 285,000 due to migration in 2001 alone [36]. After Tokyo and Mumbai, Delhi is anticipated to be the third largest conurbation by 2020. Although, Delhi struggles to keep up with its rapid growth and is under a lot of pressure to upgrade its commercial and residential facilities.

In terms of road network, Delhi has a total road network length of approximately 31,432 kilometres. The state has about 80 kilometres of National Highways that are managed by the National Highways Authority of India (NHAI). The transportation sector has attracted much attention in recent Finance Bills. Moreover, this industry has even received a significant budgetary allocation [36], in light of the need for facility improvement.

Delhi's economy is highly contributed by commerce and trade rather than manufacturing and agriculture. At current prices, the tertiary sector generated 81.8 percent of Delhi's GSDP in 2011-12, totaling US$ 53.5 billion, followed by the secondary sector, which contributed US$ 11.3 billion (17.3 per cent). Over 2004-05 and 2011-12, the tertiary sector grew at the quickest rate of the three, with a CAGR of 17.9%. Trade, hotels, real estate, banking, insurance, transportation, communications, and other services have all contributed to the expansion. The knowledge-based service industry, including information technology and consulting [34], [35], dominates Delhi's economy. In addition, the state boasts a number of small-scale companies that are mainly pollution-free.

Almost all MNC's in India have headquarters in Delhi thereby making it a massive workplace. In context of food, Delhi has essentially all the flavors and taste which represents the essence of India. Thus, helping it to form a great Indian food market. This big kitchen has benefited the online food ordering business. Many restaurants and café chains of Delhi have started registering themselves with food online ordering apps. This lets people to enjoy their delicacies at their homes. Currently, in Delhi, there are about 95,000 restaurants, with 20,000 of them offering online meal delivery [37]. As the demand for online food delivery is increasing, this number is rapidly climbing. As a result, this business has grown tremendously.

Broadly, Delhi region has expeditiously progressed and has witnessed substantial economic growth in recent years that has significantly contributed [35], towards the overall growth and development of the Country of India.

CHAPTER 4

4. METHODOLOGY

Data collected from google form have to be analyzed to understand the characteristics of customers. The analysis is divided into two parts. The first part includes the technique of data analytics while the other include spatial analysis. These two analyses are necessary for getting the outcomes. Consider Figure.4, which show the methodology adopted in the study.

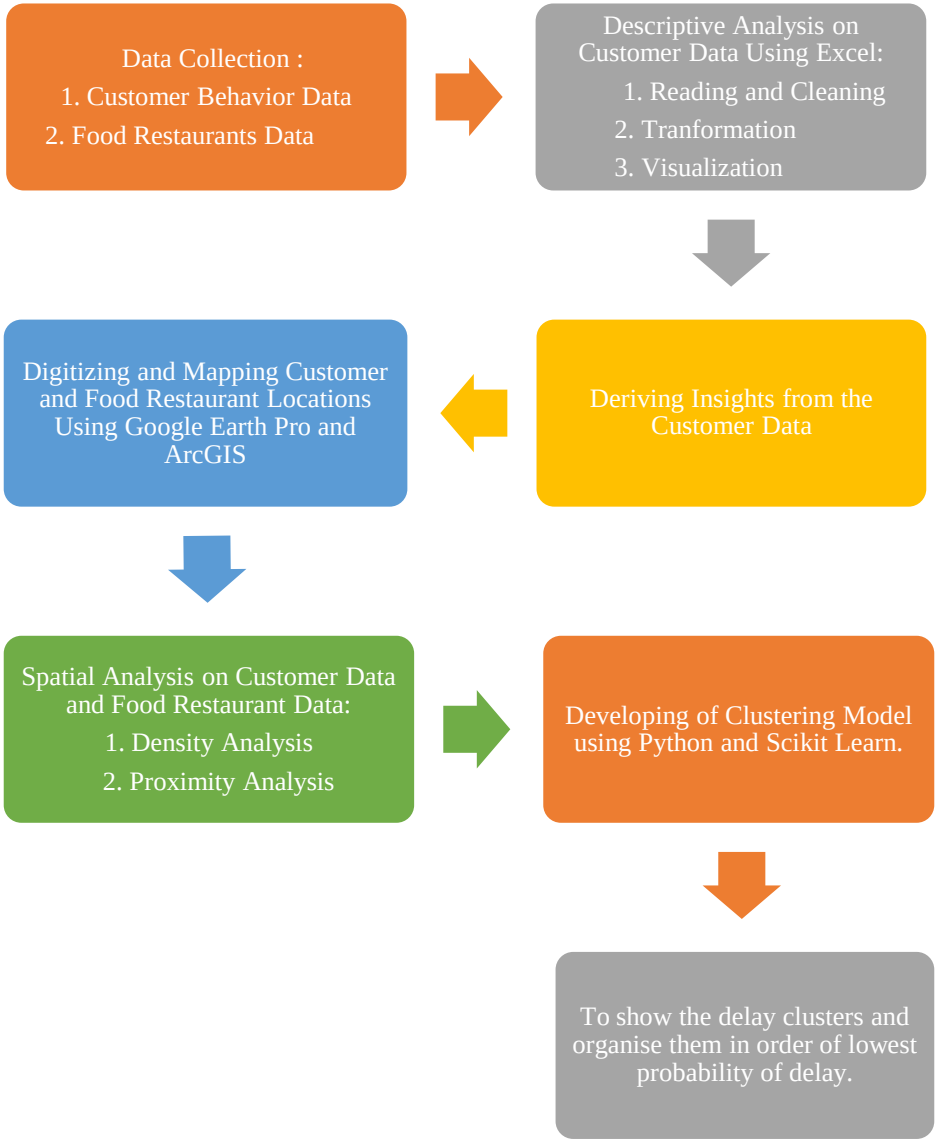


Figure. 4. Diagramatic View of the Steps Involved in the Study

4.1 Data Collection

The primary data that will be the basis for this study is collected through a google form by preparing a questionnaire. Respondents were allowed to fill out the questionnaire/form online using Google Forms, making data collection simple and straightforward. Google Forms offers a variety of templates for creating forms based on a variety of topics. The Google form used in this study was created from the initial concept [38].

The data collecting questionnaire was created with the respondent's privacy in mind, thus no questions were included that could potentially compromise the respondent's privacy and discourage them from filling out the form. The questionnaire is prepared on Likert Scale which makes them easy to understand [39]. It will further help in drawing conclusions, reports, results and graphs from the responses in a realistic way. In a customer satisfaction survey, an ordinal scale is important since it allows customers to rate their opinions. A 5-point Likert scale, for example, invites customers to rate their agreement with a statement on a scale of high to low, with one neutral option in the middle [40]. Responses from a Likert scale for customer service can be used to gauge a wide range of emotions, including agreement, satisfaction, frequency, and desirability.

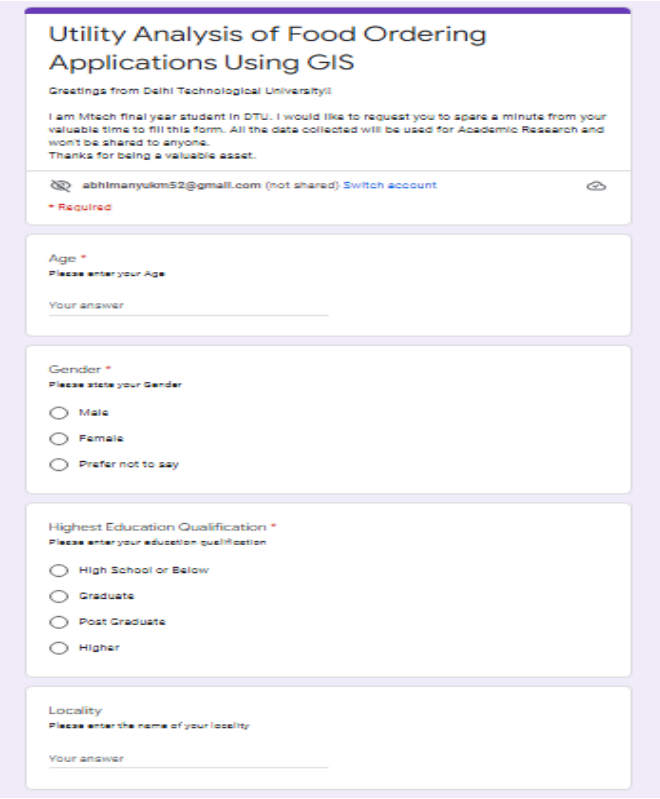
The respondent was given the option of answering or skipping the question based on their preference, so only a small number of questions were made mandatory. This allows the respondent to fill out the form quickly and without reluctance.

The google form have been divided into multiple set of questions, the first set contains the information about the user demographics such as age, locality, education etc. the next set contains questions related to users perception and behaviour towards online food ordering apps [41]. The questions are framed in such a way that they help to understand the frequency of use of online delivery apps, the name of the app that the user uses on a regular basis, the level of satisfaction received after using the app, the issue of reachability, the perception of price set by online food ordering apps, the quality of food received, the food options available for ordering, and so on. The google form also asks on the app's user interface, the number of restaurants linked to it, the time it takes for meals to be delivered, and suggestions for improving the service.

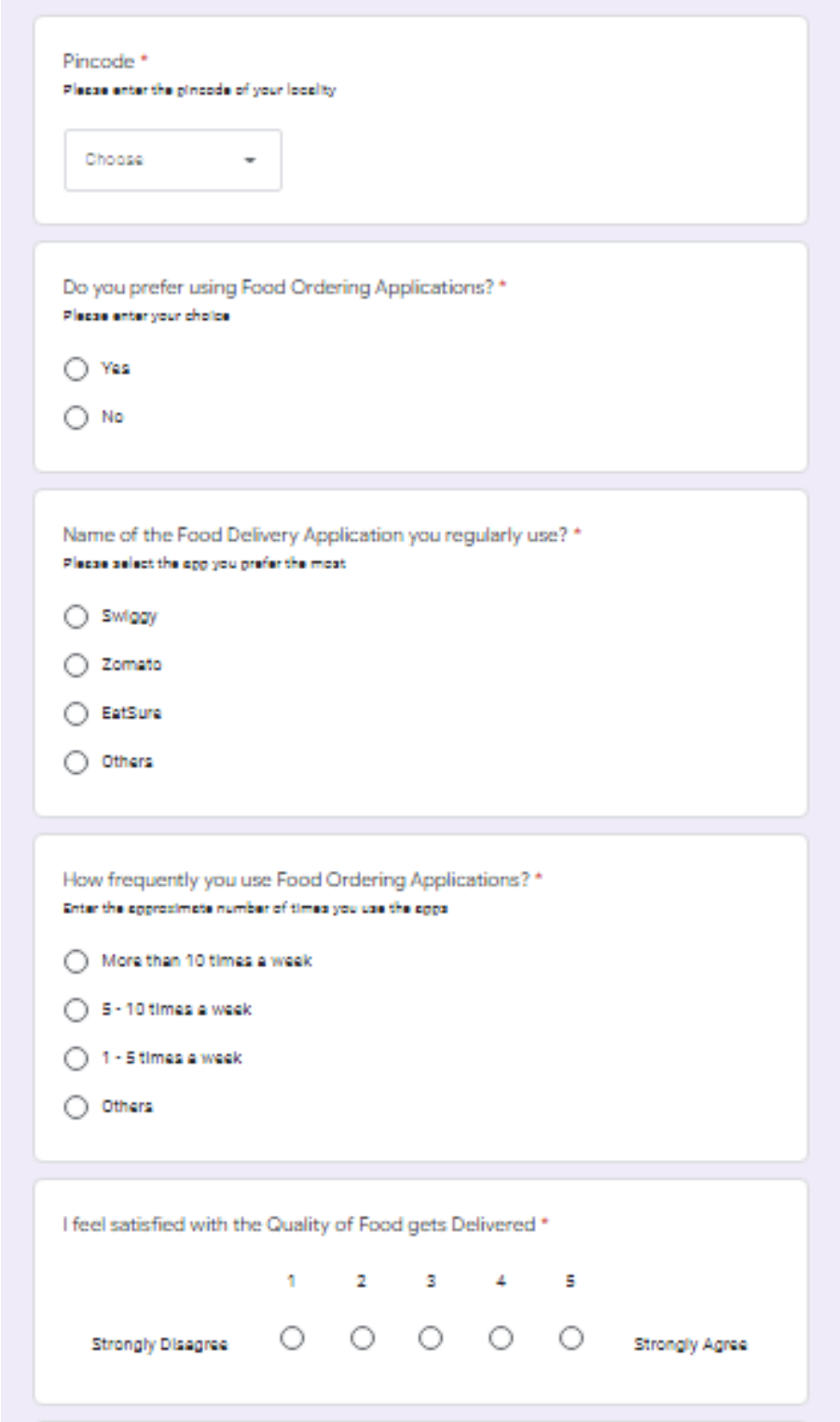
The purpose of data gathering is to determine the user's location based on their pin code and their activity when using Online food ordering app, therefore it includes both qualitative and

quantitative information [38], [41]. The goal of collecting quantitative data is to do behavioral analytics, whereas the goal of collecting qualitative data is to categorize users into distinct regions based on their location and data gathering features. The data related to restaurants and food joints of Delhi was collected from the websites of Zomato, Swiggy and Eatsure. Their locations were also recorded which will be analyzed for determining the results. The study's target area is the National Capital Territory of Delhi, thereby only Delhi's pin codes are provided, while the rest of the pin codes are preserved in the others category. The users are then asked to fill out a Google form, which is subsequently disseminated among them to collect responses.

The form prepared is illustrated using Figure.5(a), Figure.5(b), Figure.5(c), Figure.5 (d) and Figure.5 (e), to better understand the perspective of data collection:



(a)


Pincode *
Please enter the pincode of your locality
Choose
Do you prefer using Food Ordering Applications? *
Please enter your choice
Yes
No
Name of the Food Delivery Application you regularly use? *
Please select the app you prefer the most
Swiggy
Zomato
EatSure
Others
How frequently you use Food Ordering Applications? *
Enter the approximate number of times you use the apps
More than 10 times a week
5 - 10 times a week
1 - 5 times a week
Others
I feel satisfied with the Quality of Food gets Delivered *
1
2
3
4
5
Strongly Disagree
Strongly Agree

(b)

I do not feel reachability issue in my order delivery *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I prefer to buy using Food Ordering Applications because it gives/ provides the best price/cost *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I do not feel any difficulty while using the application *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I feel satisfied with the choices/ menu of food items I get while ordering through the Application *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I prefer using Food Ordering Applications because these have associations with big restaurants *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I always prefer ordering Food using Applications over Dine out *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

(c)

I have experienced delayed delivery while ordering from Food Ordering Applications *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I have been using Food Ordering Applications and had have received delayed delivery of my food item *

- ○ 0%
- ○ 10%
- ○ 20%
- ○ 30%
- ○ 40%
- ○ 50%
- ○ 60%
- ○ 70%
- ○ 80%
- ○ 90%
- ○ 100%

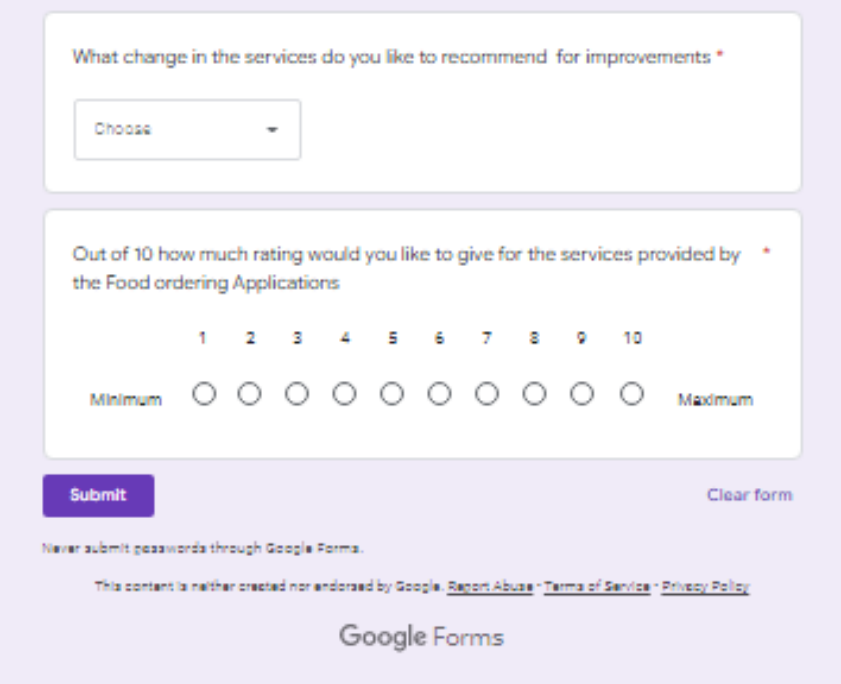
Compensatory benefits received from the company in case of delayed deliveries to make you happy *

- ○ By giving gift coupons
- ○ By making order free
- ○ By giving an apology note
- ○ None

I feel that busy schedule have forced me to use Food ordering Applications instead of delay and other disadvantages *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

(d)



(e)

Figure. 5. Data Collection Form Prepared (a)Demography Questions (b)Usage Frequency Questions (c) Behavioral Analysis Questions (d) Delay and Satisfaction Questions and (e) Recommendations and Ratings Questions

The data collected will undergo through various techniques of data enrichment to make it fit for the analysis. It will then be fed into various tools to extract insights and findings in order to better understand how users feel about online meal ordering apps.

4.2 Descriptive Analysis Using Microsoft Excel

Excel is a fantastic tool for extracting meaning from large amounts of data. It is also useful for performing calculations, mathematical modelling, statistical analysis and keeping track of nearly any kind of data. The data can take the form of numbers, dates, times, percentages, or words logically. The matrix of cells is the key for unlocking all of that potential. Numbers, text, and calculations can all be found in cells. This allows you to add up your data, organize and classify it, arrange it in tables, and create visually appealing charts. The Excel programme has a grid-like tabular format with adjacent cells [42]. Excel is a commonly used and readily accessible software application for graphical visualization. Excel supports a wide range of formulas which makes the analysis speedy and easier [43]. There is variety of formulas that enables user to clean and manipulate as per the requirements of the work. It also supports a great range of visualization tools starting from basics to advanced. A user can create line charts, bar graphs, pie charts, heat maps, correlation matrices, box plots, histograms, scatter plots, pairwise plots etc, simply using a set of codes and functions.

In actuality, making visualization in Excel can be more difficult than in other programmes, and users with less experience and comfort with Excel's advanced [43], features may have more difficulties. In this paper we have made the graphical charts with the help of excel which is used to get inference from the data and to summarize the data by finding various spread, mean, median and other such statistically available features [42].

4.2.1 Data Reading and Data Cleaning

The reading of primary and secondary data is the first step in any analysis. The datasets are first imported into the software allowing the user to read and comprehend them. The reading of data identifies the type of data and inferences that can be drawn from the dataset. The practice of dealing with numerous irregularities in data that will be used for further analysis is known as data cleaning. The necessity for data cleaning stems from the possibility that the data contains null values, errors, or outliers [44]. Until these values are addressed in the data collection, the data analysis cannot be true and supported. There are several methods for dealing with these values, including removing values with errors, removing noise, and replacing in incomplete data using the average, median, or any other value in the data [44].

4.2.2 Data Transformation

Data transformation is the method of changing data from one format to another,usually from an origin system's format to a target system's needed format which is extracting data from a source, converting it into a usable format, and delivering it to a destination [44]. Several data integration and data management tasks, such as data integration and data storage, need data transformation [44]. This technique makes the data fit for analysis by removing redundancies and undesirable variables.

4.2.3 Data Visualization

The method of putting information into a visual framework, such as a map or graph, to make data easier to interpret and extract insights from is known as data visualization. Data visualization's main purpose is to make it easier for the users to spot patterns, trends, and outliers in massive data sets [45].

4.2.4 Data Analysis for Customer Behavioral Patterns

Descriptive statistics are used to characterize the fundamental characteristics of a study's data. They provide concise brief summary of the samples and metrics. They, together with simple graphical analysis, are the basis of almost all statistical techniques [46]. This is used to offer explicit description in a format that is easy to understand. We have a lot of measures in this research study, and we want to test this on number responses [46]. Descriptive analytics assist us in making sense of enormous amounts of data. Each descriptive analysis condenses a large amount of data into a concise summary from which additional insight can be derived.

4.3 Spatial Analysis

Spatial analysis is a process in which the problems are modelled geographically, results are derived using computer processing and then explored for insights [47]. This type of analysis is said to be extremely useful for determining the spatial suitability of specific areas for strategic targets, calculating and predicting outcome, interpreting and understanding change, identifying crucial patterns disguised in the data, and even more. Spatial analysis is beneficial in providing new views to the decision-making process [48].

The majority of data and measurements could be linked to specific locations and hence can also be depicted on a map [47]. We may learn what is present and where it is by using spatial data. The real world can be represented as discrete data. If it is stored by its exact geographic location then it is be referred as Feature data. On the other hand, if it is stored as continuous data represented by regular grids then it is referred as Raster Data.

The representation of data depends on the nature of what we have to analyze. The natural environment such as elevation, temperature, precipitation is generally represented using raster grids, whereas the built environment like roads, buildings and administrative data like countries, census areas tend to be represented as vector data [47]. Moreover; the information that describes what is at each location are stored as Attributes which can be connected to both raster and vector data.

The datasets in the GIS are managed as a specific layer, means one dataset corresponds to only one layer which can be graphically integrated using analytical operators [47]. This analysis is termed as overlay analysis. Geographic information system allows us to work with these layers to investigate and answer essential questions by blending layers through operators and displays [47].

The most fascinating and impressive component of GIS is spatial analysis. The use of spatial analysisvallows us to merge data from a variety of sources and to generate new sets of data using a complex set of spatial operators [48]. This extensive set of spatial analytic tools improves our ability to respond to complicated spatial problems.

Various layers can be studied to determine a location's suitability for a specific activity. Additionally, image analysis can be utilized to track changes over time. These tools allow us to answer crucial questions and make judgments that are beyond the reach of simple visual assessment [48].

4.3.1 Obtaining of Customer Locations and Restaurants / Food Joint Data

The information about customers location is compiled from a dedicated google form developed for collecting customer behavioral responses towards online food ordering apps in Delhi. The Latitude and Longitudes of these sites are obtained using Google Maps. The restaurant

data associated with online food ordering apps is collected through Zomato.com website [49], Swiggy.com website [50] and Eatsure.com website [51]. The customer locations data and list of restaurants and food joints of Delhi are explained using Table II and Table III, within the section respectively.

Table II

Customers Location in Delhi

S.No.	Customers Location	Latitude/Longitude
1.	Rani Bagh, Shakurpur, New Delhi, Delhi 110034, India	28.6879079N / 77.1341675E
2.	New Delhi, Delhi 110085, India	28.7153451N/ 28.7153451E
3.	Shahdara, New Delhi, Delhi 110053, India	28.6756862N/ 77.2596337E
4.	Sector 7, Rohini, Delhi, 110085, India	28.7080569N/ 77.1179541E
5.	Yamuna Vihar, Shahdara, Delhi, 110053, India	28.7009403N / 77.2721047E
6.	Pitam Pura, New Delhi, Delhi, India	28.6989703N/ 77.1387225E
7.	Pocket 5, Sector-24, Rohini, Delhi, 110085, India	28.7265416N/ 77.0827519E
8.	Sector 23, Rohini, Delhi, 110099, India	28.7205959N/ 77.0809093E
9.	Sector 5, Rohini, Delhi, 110085, India	28.7163042N/ 77.1032095E
10.	Sector 6 Rd, Rohini, Delhi, 110085, India	28.7104613N/ 77.1093179E
11.	Rohini Sector-22, Pocket 5, Rohini, Delhi, 110086, India	28.7176439N / 77.0642715E
12.	Kohat Enclave, Pitam Pura, Delhi, 110034, India	28.6964931N/ 77.1386014E
13.	Patel Nagar, New Delhi, Delhi, India	28.6554182N/ 77.1529569E
14.	Anand Parbat, New Delhi, Delhi, India	28.6649414N/ 77.267595N
15.	Lajpat Nagar, New Delhi, Delhi, India	28.5649034N/ 77.13841E
16.	Moti Nagar, Industrial Area, Kirti Nagar, Delhi, 110015, India	28.6582349N/ 77.2094473E

Table III

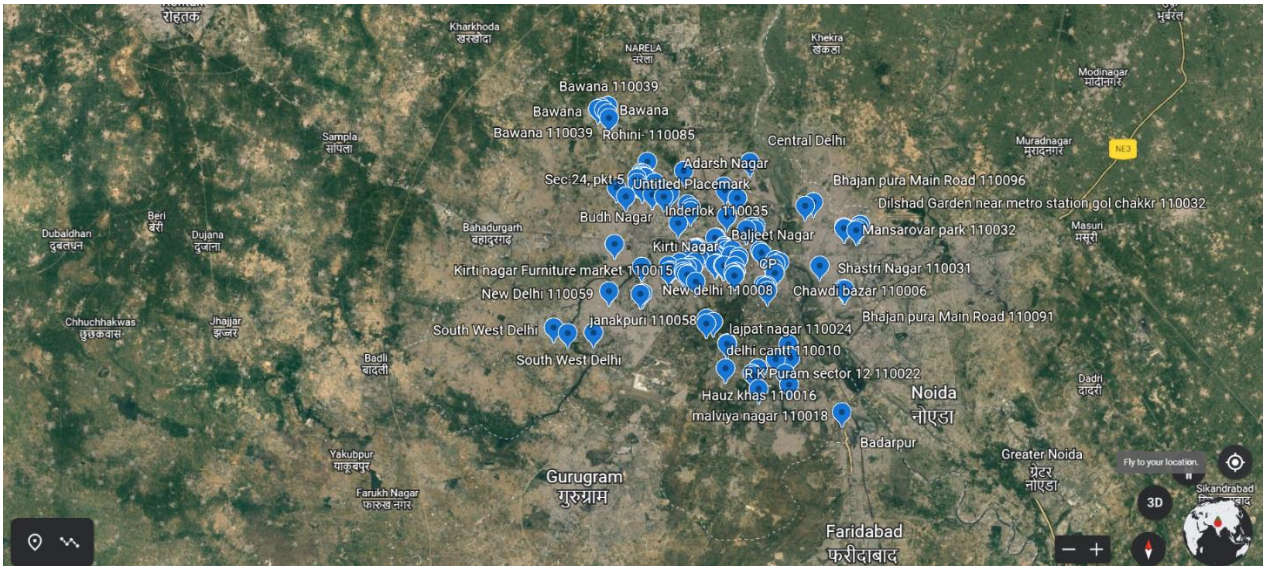
Restaurants and Food Joints of Delhi

S.No.	Restaurants/ Food Joints Location	Latitude/Longitude
1.	Cafe Coffee Day, Vasant Vihar	28.5334920N/ 77.1518947E
2.	Dominos Pizza, Patel Nagar	77.1722681N/ 28.6457998E
3.	Flavours Restaurant, Defence Colony	77.2340570N/ 28.5663465E
4.	Sagar Ratna, Hauz Khas	77.2117158N/ 77.2117158E
5.	Costa, Chanakya Puri	77.2222257N / 77.2222257E
6.	Dilli Darbar, Shahdara	77.2867997N/ 28.6892639E
7.	KFC- Kirti Nagar	28.6562618N/ 77.1460291E
8.	Haldiram- Lajpat Nagar	28.5633277N/ 77.2519539E
9.	Dunkin Donuts- Kamla Nagar	28.6782709N/ 77.2049331E
10.	Burger King- Karol Bagh	28.6487284N/ 77.1908881E

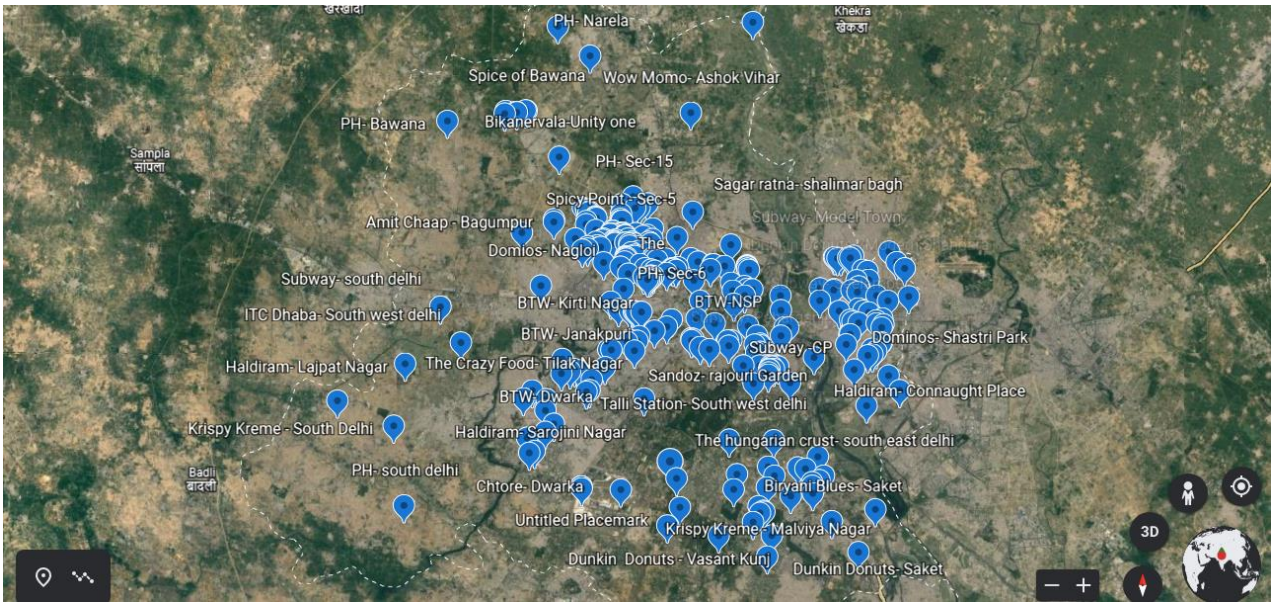
4.3.2 Perform Digitization in Google Earth Pro

The overall objective of digitization is to convert paper maps and satellite images into vector data i.e. in terms of points, lines and polygons [52], [53]. The desktop version of Google Earth Pro provides us an option to digitize the point, line and polygon features in Google Earth software itself but in .kml file format. These .kml files can be further converted into .shp files in ArcGIS or any other GIS software. We prefer to use shape files because their retrieval and editing are way simpler because their processing is faster. They require very less space on disk and are easy to read and write [52], [53].

In this study, we have marked the locations using Placemark Tool, illustrated using Figure.6(a) and Figure.6(b), which are then exported as layers in KML format. The layers are then opened in ArcGIS where they are converted to their corresponding Shapefiles.



(a)



(b)

Figure. 6. Placemark at Concerned Locations (a) Customers Locations and (b) Restaurants/ Food Joints Locations

4.3.3 Mapping of Customers Locations and Restaurants/Food Joints

A clear delineating map of the study has been prepared using ArcGIS. This ArcGIS software is a geographical information system that allows you to handle and analyse geographic data by showing geographical statistics such as temperature data or trade flows through layer building maps [54]. It's used by a variety of academic institutions and departments in the humanities and sciences to generate and present new research. It is also used by a number of governments and private/commercial organisations around the world make geographical data to everyone in a company institution both privately andvpublicly onvthevweb [54]. As a result, the software effectively serves as a platform for linking, sharing, and analyzing geographic data. Consider, Figure.7, which shows the various districts present in the study area.

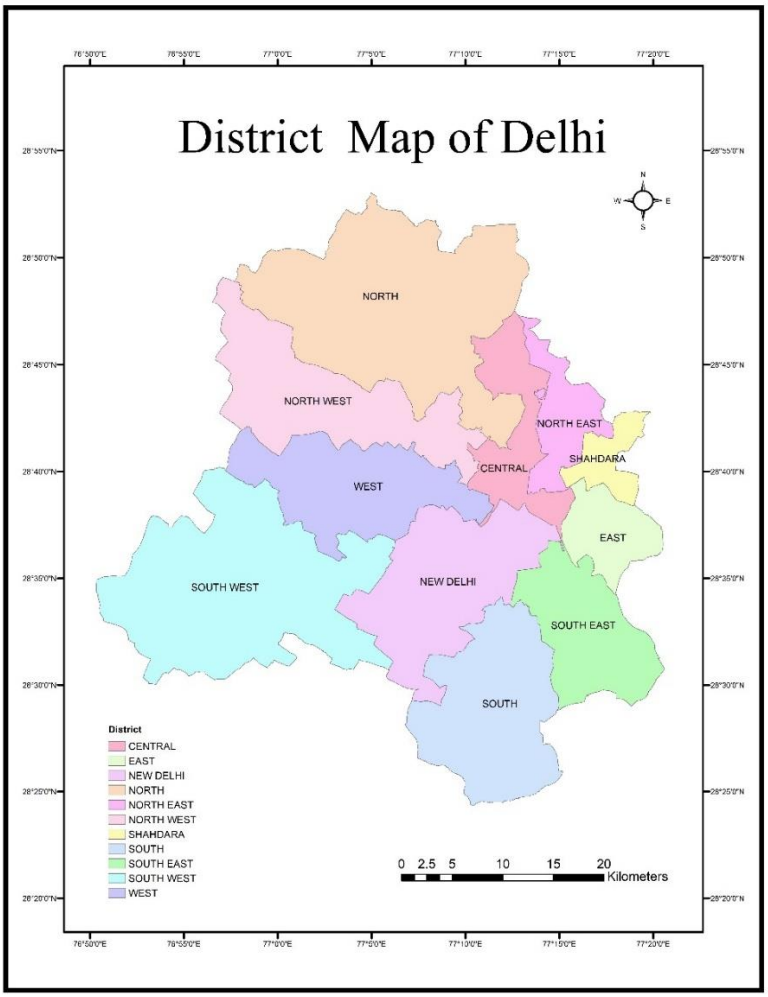


Figure. 7. The District Divisions of Delhi

The concerned locations after being converted into shapefiles are mapped on the study district to form a well-defined map that will show all the customers locations and restaurants/food joints distinctly. These customers locations and restaurants/food joints maps are illustrated using Figure.8 and Figure.9, respectively. These maps describe the variability in location and spread of customers through Delhi.

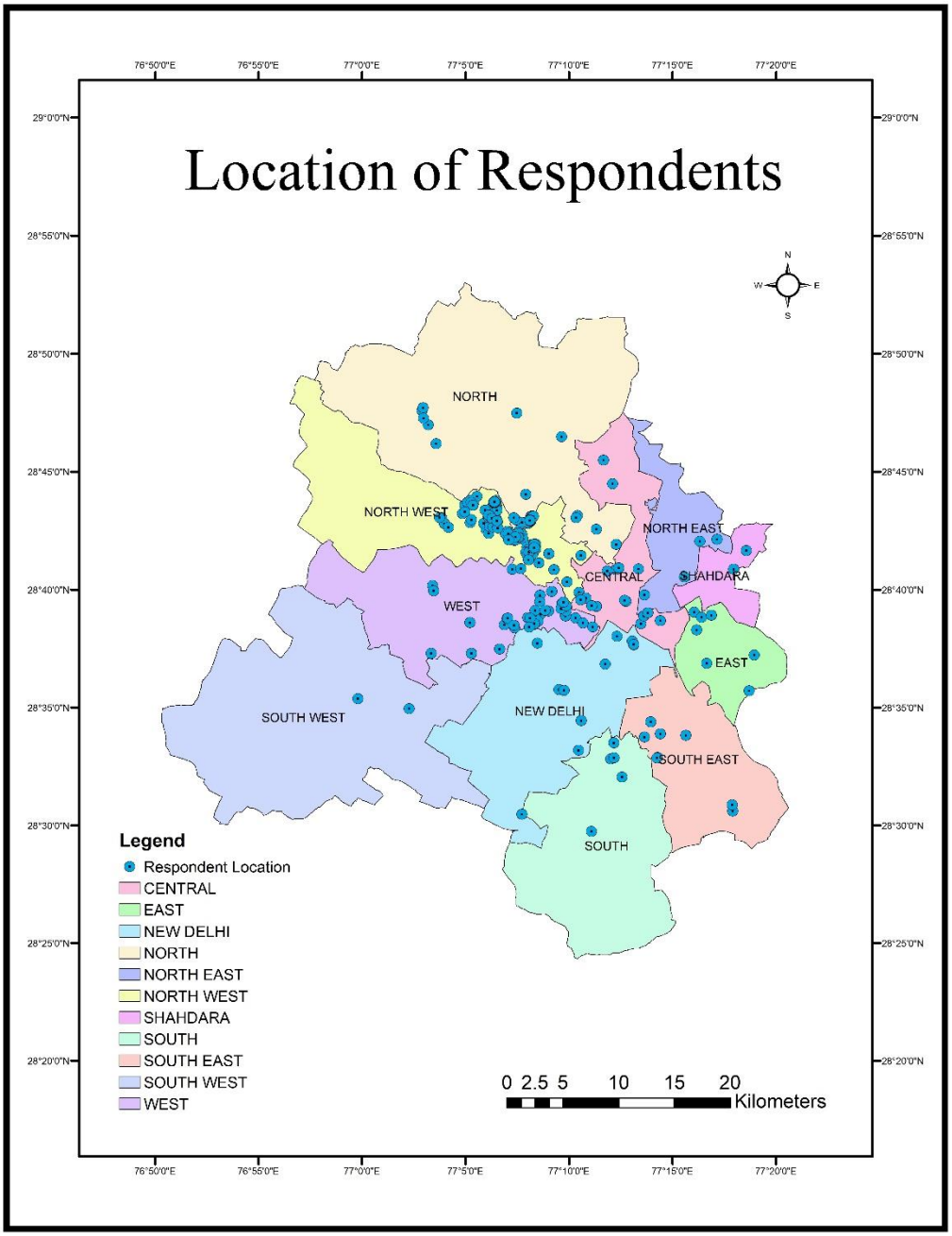


Figure. 8. Respondent Locations Spread over Delhi

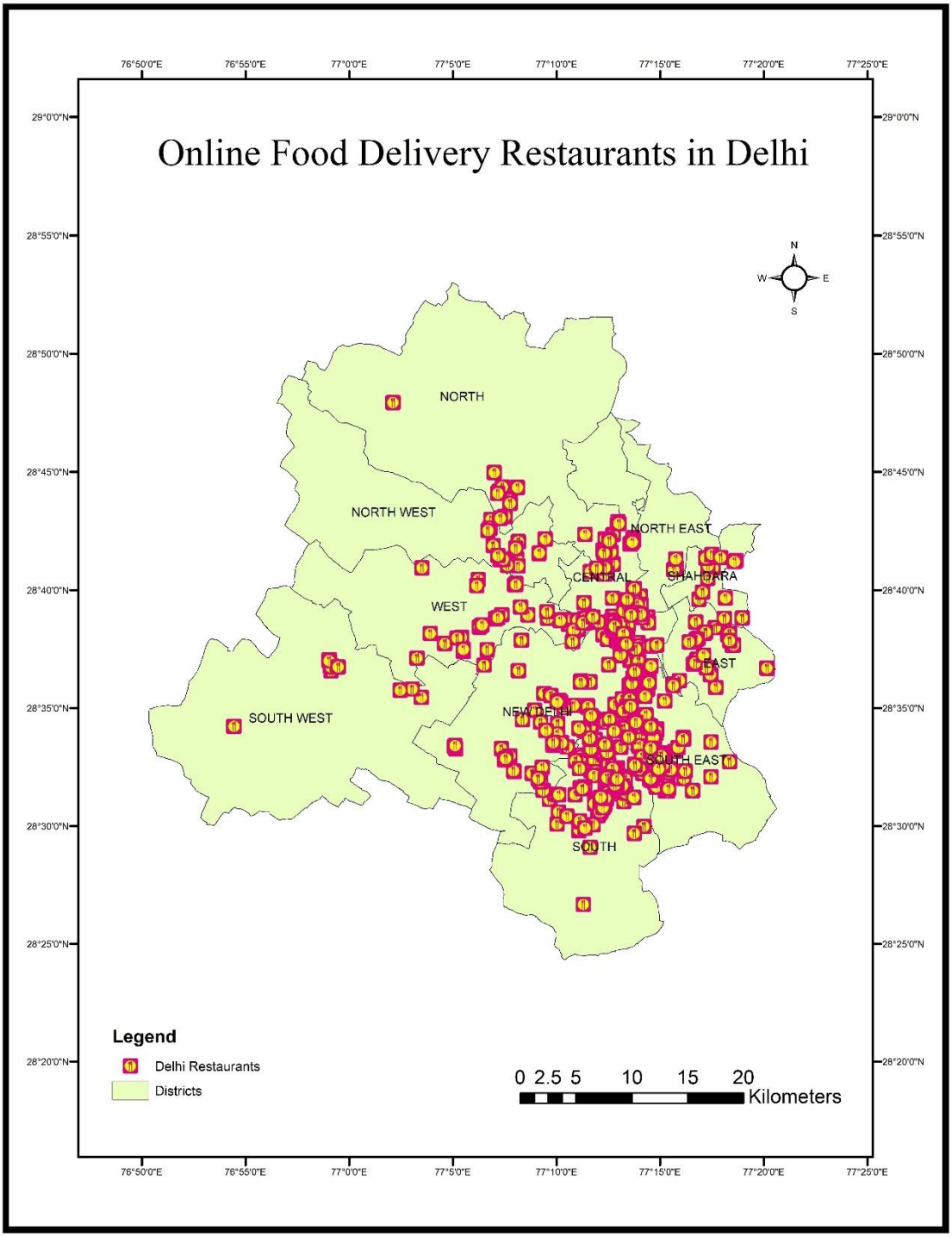


Figure. 9. Restaurants and Food Joints Offering Online Food Delivery in Delhi

4.3.4 Analysis of Spatial Data in ArcGIS Pro Online

Esri's ArcGIS Pro is the company's most recent professional desktop GIS product. We may use ArcGIS Pro to explore, visualize, and analyse data, as well build 2D maps and 3D scenes and publish our work using the ArcGIS Online or ArcGIS Enterprise portals. The user interface is usually intuitive and simple to interpret [55].

In ArcGIS Pro, a project is made up of well-organized maps, scenes, layouts, data, tables, tools, and external resource connections [55]. Project files are saved with the .aprx extension. The geodatabase is a file with the extension .gdb, meanwhile the toolbox is a file with the extension .tbx. The projects made can also be exported in shapefiles format making it easier for cross platform usage. In this study density analysis and proximity analysis are observed to be the mort optimum for analysis of delay and customer behaviour in online food delivery.

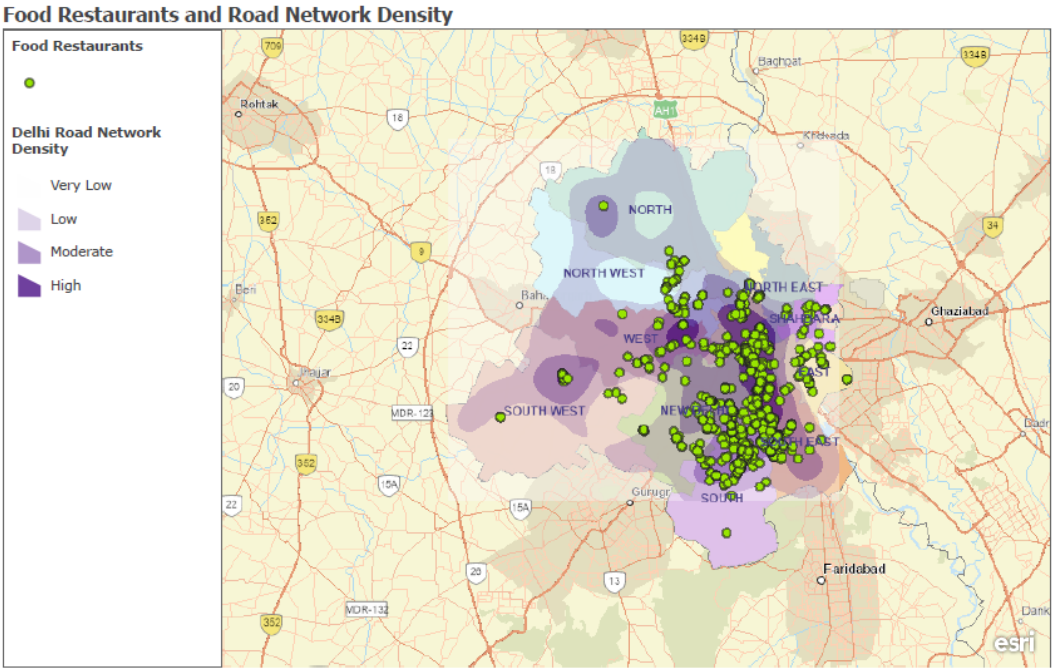
I. Density Analysis:

The density values in ArcGIS Pro online are based on the Kernel Density algorithm. It uses a cell size which is equal to one- fourth of the default value. Theoretically, the Kernel Density algorithm fits a smooth curved surface over each point [55]. The surface value seems to be highest at the location of the point and diminishes with increasing distance from the point and becomes zero at the search radius distance from the point. Therefore, only a circular neighborhood is possible. The volume under the surface is stored as the Population field value for the point [47], [55]. It is kept as 1 if NONE is specified. The density at each output raster cell is calculated by adding of all kernel surfaces that overlap with the raster cell center.

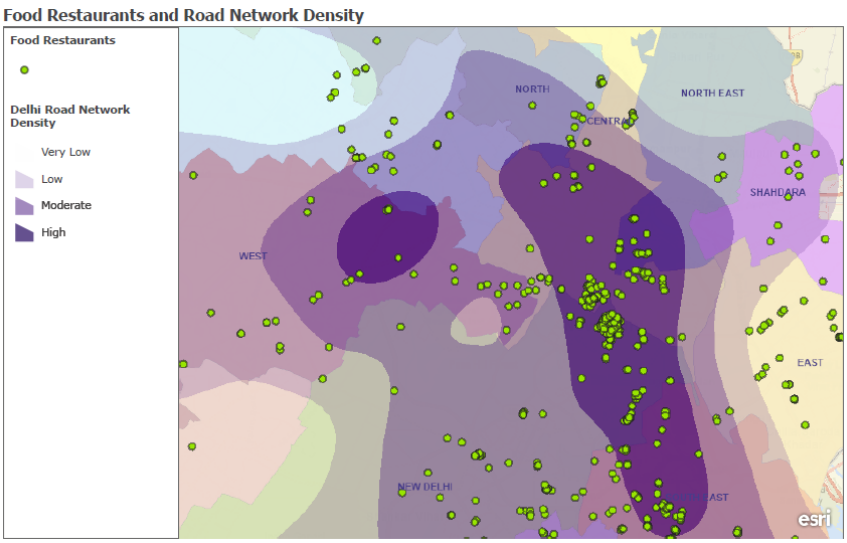
When the input features are points, the distances are measured using the geodesic approach. On the contrary, when the input features are lines, the distances are measured using the planar approach. The calculate Density tool also uses the Reclassify and Raster to Polygon geoprocessing tools [55], to convert the raster to polygons so that results can be displayed on Arc Map Viewer Classic. It is because the Kernel density tool creates a raster output layer rather than vector layer.

The density analysis was performed on the major road network of Delhi over which the restaurant layer has been overlayed to understand the connectivity of the food restaurants with the major routes. This will enable us to understand the delays that happen while ordering through online delivery apps.

The road network layer has been exported from DIVA.GIS.org website [56], that provides accurate open source data. Then, it is imported in ArcGIS Pro online over the Open Street Map base layer. The food restaurant layer is then overlayed to identify the patterns. Consider, Figure.10 (a) and Figure.10 (b) which shows the relationship between food restaurants and road network density developed by analysis.



(a)



(b)

Figure. 10. Density Analysis of Food Restaurants and Road Network (a) Map Developed and (b) Closer View

II. Proximity Analysis:

This analysis is one of the most vibrant form analyses which is supported by the ArcGIS Pro online software. It comes with a collection of tools for performing proximity operations. This toolset includes tools for determining feature closeness within one or more feature classes, as well as between two feature classes [47], [57]. These tools can discover which features are nearest to one another and calculate distances between and around them [57].

In concern to our analysis, Create Drive-Time Areas tool within proximity analysis is useful as it will make us view and observe the number of customers within a particular reach of a restaurant. It uses Esri Service Areas which calculates the region that may be reached within a specified travel time or travel distance along a street network on basis of travel mode.

This tool can take a single layer of points with up to 1,000 features as the input. The drive-time zone can be based on a variety of travel modalities that use time or distance as a parameter [57]. We can create multiple output areas by separating different time or distance by a space. Traffic conditions are also available which can be used along with various travel modes such as walking time, driving time, driving distance, walking distance, trucking time and trucking distance. These conditions either be based on live information or aggregated values for a specific day and time of the week. Live traffic conditions have an offset of around 4 hours from the current time. If we want to analyse for entire day and night, we can set a suitable interval like 15 minutes for gathering details [48]. The direction of travel can also be altered either away from facility or towards the facility. The direction plays an important role in finding out the streets that have to be used in drive-time areas by considering traffic rules.

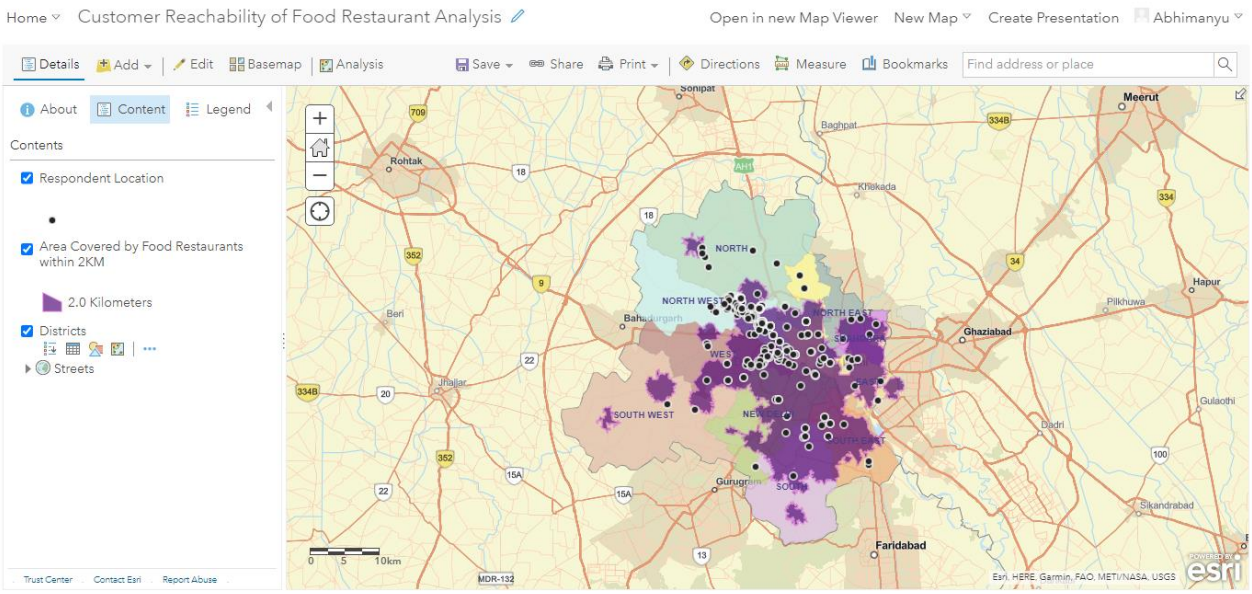
The meeting point travel areas from different points can be set as overlap, dissolve and split [57]. In overlap, the common areas are kept, in dissolve the common areas are combined while in split the common areas are splitted in the middle. We can also set the whether to show reachable areas or not in the map. The show unreachable [57], areas predicts whether the output area is a continuous polygon. Moreover; the include reachable streets shows the streets in the output layer that were used in creating drive-time areas.

In this study we have performed the Create Drive-Time Areas analysis to identify the number of online food ordering customers in the proximity of the food restaurants associated with

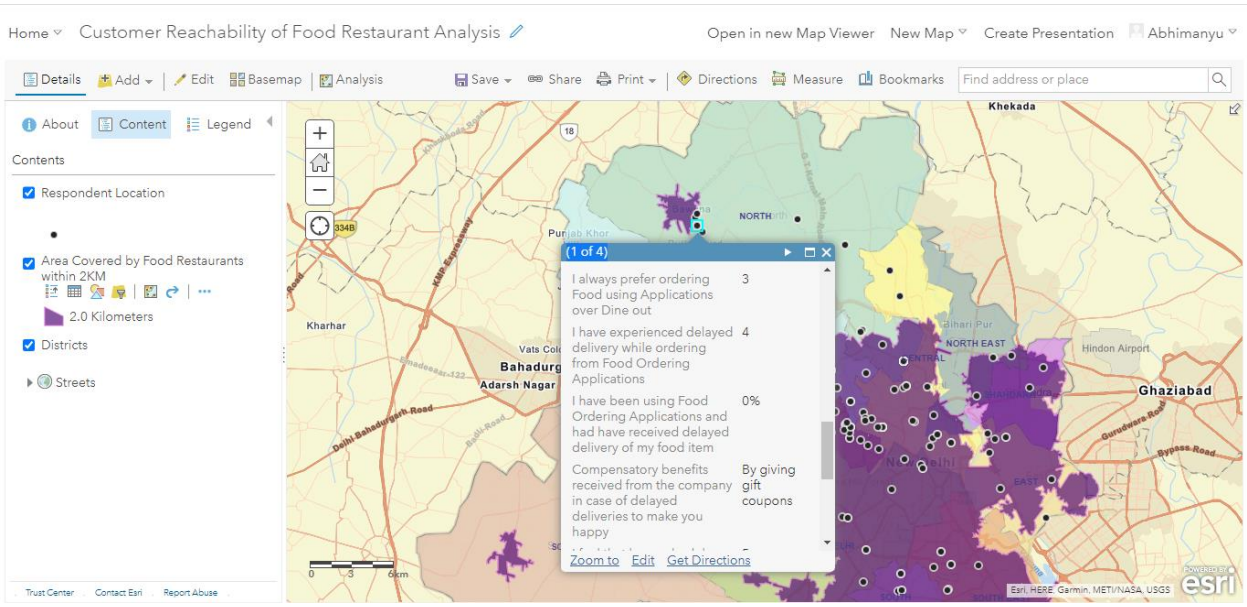
the online food ordering app [47]. The analysis was run on food restaurants data by keeping travel mode as driving distance and meeting areas as dissolve. The distance for the Drive-time area were developed was taken as 2Km.

The distance is kept small because of the fact that Zomato, Swiggy etc. are now focusing on reducing delivery time to maximum extent [58]. These online ordering apps have even declared that they can delivery food in 15 minutes to the customer [6], [58]. Therefore, this feature is taken into consideration while selecting the distance.

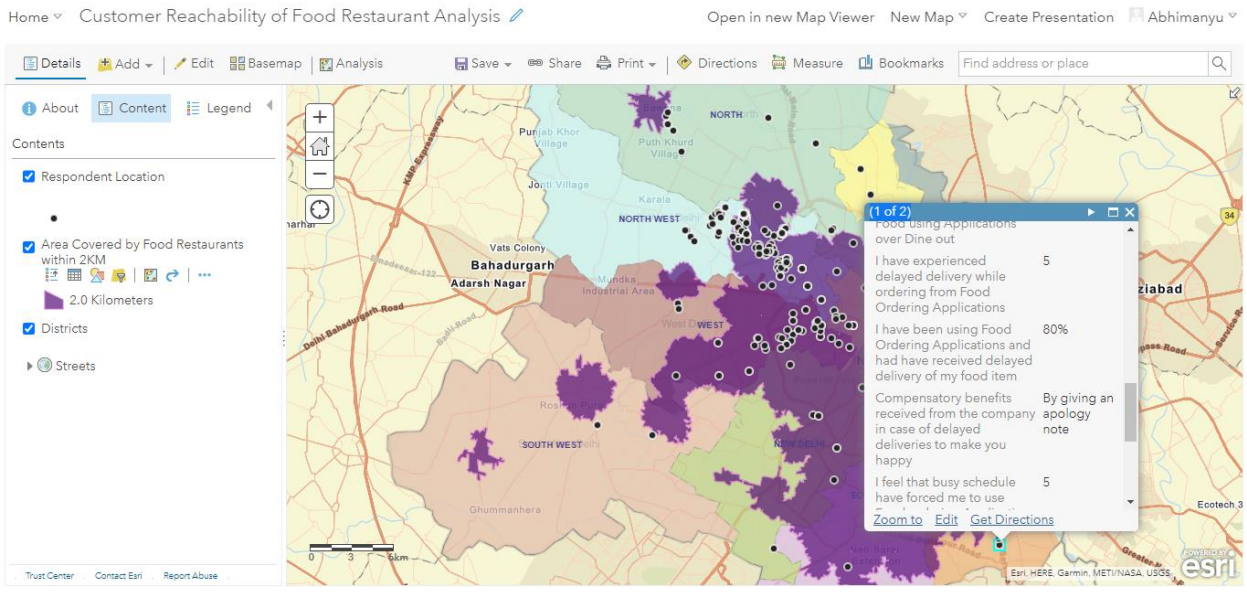
Data of customers locations was embedded over the Create Drive-Time Areas to know the spatial distribution of the customers around the restaurant facilities. The analysis is demonstrated by, Figure.11 (a), Figure.11 (b), Figure.11 (c) and Figure.11(d), providing the details of customer delays in getting the food delivery.



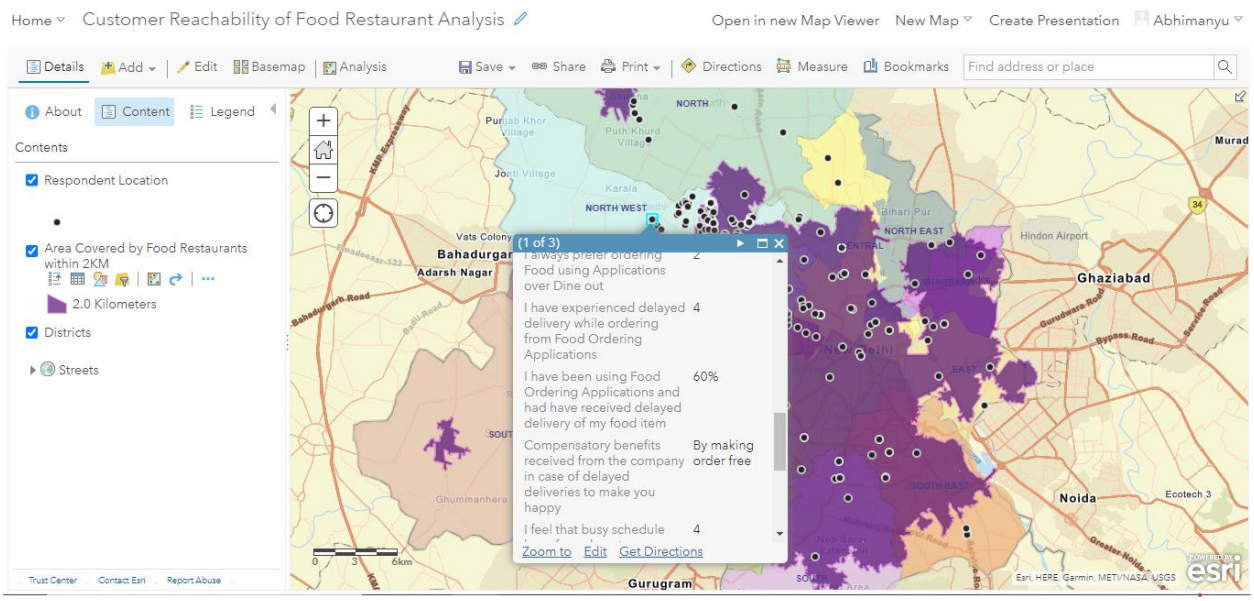
(a)


Home
Customer Reachability of Food Restaurant Analysis
Open in new Map Viewer
New Map
Create Presentation
Abhimanyu
Details
Add
Edit
Basemap
Analysis
Save
Share
Print
Directions
Measure
Bookmarks
Find address or place
About
Content
Legend
Contents
Respondent Location
Area Covered by Food Restaurants within 2KM
2.0 Kilometers
Districts
Streets
Trust Center
Contact Esri
Report Abuse
(1 of 4)
I always prefer ordering Food using Applications over Dine out 3
I have experienced delayed delivery while ordering from Food Ordering Applications 4
I have been using Food Ordering Applications and had have received delayed delivery of my food item 0%
Compensatory benefits received from the company in case of delayed deliveries to make you happy By giving gift coupons
Zoom to
Edit
Get Directions
Khekada
NORTH
Kharhar
Bahadurgarh
Adarsh Nagar
NORTH EAST
Hindon Airport
Ghaziabad
Delhi Bahadurgarh Road
Esri, HERE, Garmin, METI/NASA, USGS
esri

(b)


Home
Customer Reachability of Food Restaurant Analysis
Open in new Map Viewer
New Map
Create Presentation
Abhimanyu
Details
Add
Edit
Basemap
Analysis
Save
Share
Print
Directions
Measure
Bookmarks
Find address or place
About
Content
Legend
Contents
Respondent Location
Area Covered by Food Restaurants within 2KM
2.0 Kilometers
Districts
Streets
Trust Center
Contact Esri
Report Abuse
(1 of 2)
I have experienced delayed delivery while ordering from Food Ordering Applications 5
I have been using Food Ordering Applications and had have received delayed delivery of my food item 80%
Compensatory benefits received from the company in case of delayed deliveries to make you happy By giving an apology note
I feel that busy schedule have forced me to use
Zoom to
Edit
Get Directions
Punjab Khor Village
Puth Khurd Village
Jonti Village
Karala
NORTH
NORTH WEST
Vats Colony
Bahadurgarh
Adarsh Nagar
Mundka Industrial Area
WEST
SOUTH WEST
Ghummanhera
Delhi Bahadurgarh Road
Esri, HERE, Garmin, METI/NASA, USGS
esri

(c)



(d)

Figure. 11. Proximity Analysis of Food Restaurants and Customers (a) Overlay (b)Feature within 2Km (c) Feature Outside 2Km and (d) Feature very far from 2Km

4.4 Clustering

Clustering is the process of splitting a population or set of data points into many groups so that measured values in the same group are more similar than data points in other groups [59]. To put it another way, the goal is to separate groups with similar characteristics and assign them to clusters. In our study clustering has been done by using the Kmeans clustering model. Scikit Learn is the library that we have used as it provides Python's most helpful machine learning library [60].

Classification, regression, clustering, and dimensionality reduction are just a few of the useful functions in the SKlearn toolkit for achine learning and statistical modelling. With the help of Scikit Learn our journey of creating a model has become successful [59], [60]. The Pandas library of Python is also used to fetch the data from various file formats. It allows us to perform calculations and manipulations on multidimensional data [61]. These large sets of data are usually referred as DataFrames. The DataFrames facilitates in better applicability of machine learning techniques [62].

Kmeans is an algorithm for an unsupervised learning approach used in machine learning and data science to tackle clustering issues [63]. This approach of Kmeans that has allowed us to restrict the cluster size in our case we have used ten clusters as it was giving appropriate results but further classification can be done in future [64].

After creation of the clustering model, we have calculated the cluster [60], probability for sorting them in such a order to get the top 3 minimum delay clusters with us. For calculating the probability the user input data have been used and results of restaurants coming under top 3 clusters intentionally being converted [59], into restaurants name and the clusters probability is also shown for comparing the top 3 results. Consider, Figure.12, which shows the pseudo code for the Kmeans clustering model for food restaurants.

Algorithm 1: Clustering of nearby restaurants

Input: df

/* df dataframe of addresses with (lat,$long$) latitude and longitudes of restaurants */

Output: Top clusters probability of delay in delivery

1 **Initialization:**
$k, KMeans(), clusters[k], probClusters < clusterNo : Probability >$;
/* K no of clusters */
/* $KMeans()algorithmforclustering$ */
2 $all_prediction = KMeans(df)$;
3 clusters[k] = $make_prediction(all_prediction)$;
4 **for** *i in range(n)* **do**
5 **for** *each prediction p in* $all_prediction$ **do**
6 *c=0;*
7 *z = len(clusters[i]);*
8 **if** *p["response"] == "delay in deliver"* **then**
9 *c+=1;*
10 **end**
11 *probClusters[i] = c/ n;*
12 **end**
13 **end**
14 sort the $probCluster$;
15 print(top clusters data);

Figure. 12. Clustering Model Pseudo Code for Implementation

CHAPTER 5

5. RESULTS

The results obtained from the data analysis of the responses collected by circulation of Google form are illustrated using Figure.13, Figure.14, Figure.15, Figure.16 and Figure.17.

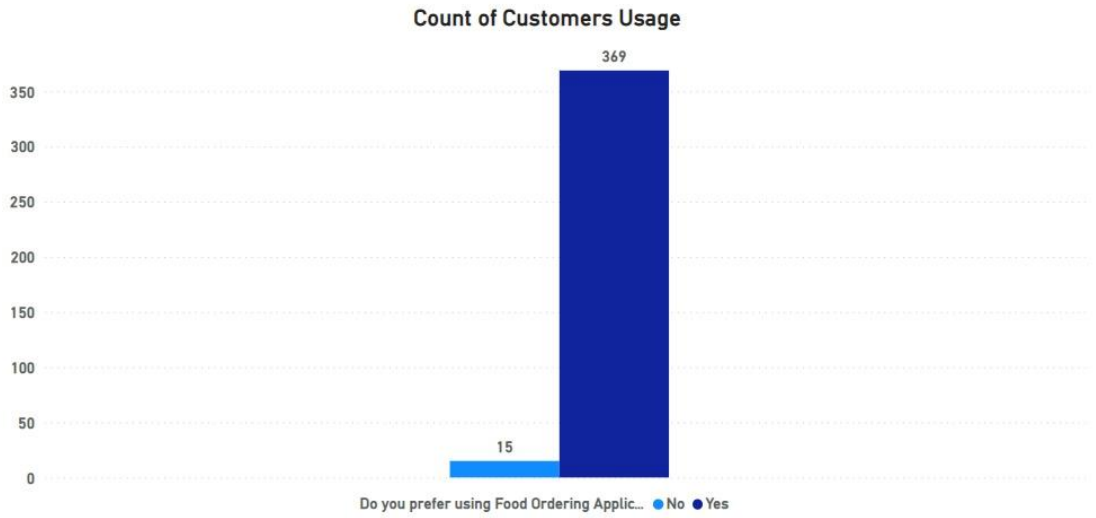


Figure13. Customer Usage of Online Food Ordering Apps

In the count of customers' usage of the online food ordering app Histogram, it is visible that the majority of the participants are in the favor of usage of the apps.

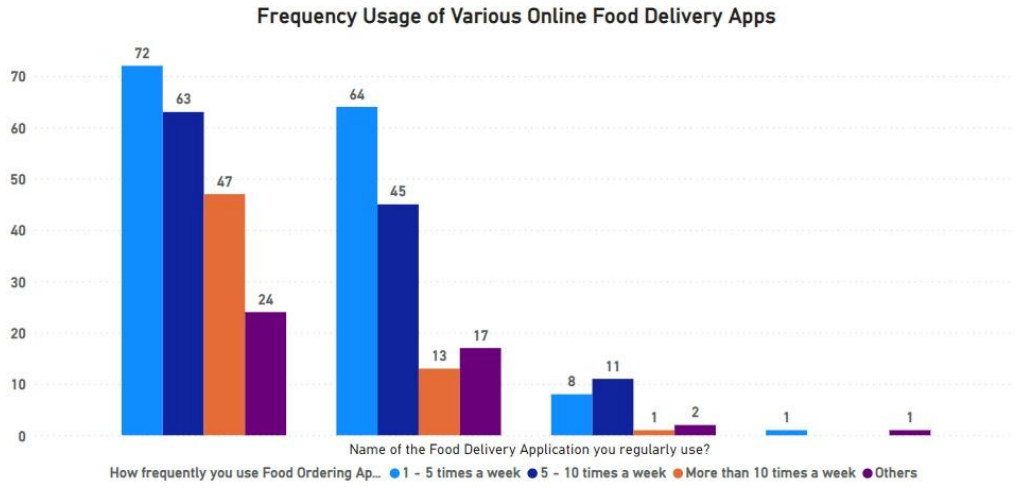


Figure14. Frequency of Customers Usage of Online Food Ordering Apps

In frequency usage analysis of the various online food ordering apps, the clustered chart data shows that maximum number of people are ordering 1-5 times a week. Moreover, frequency 5-10 times usage is second highest.

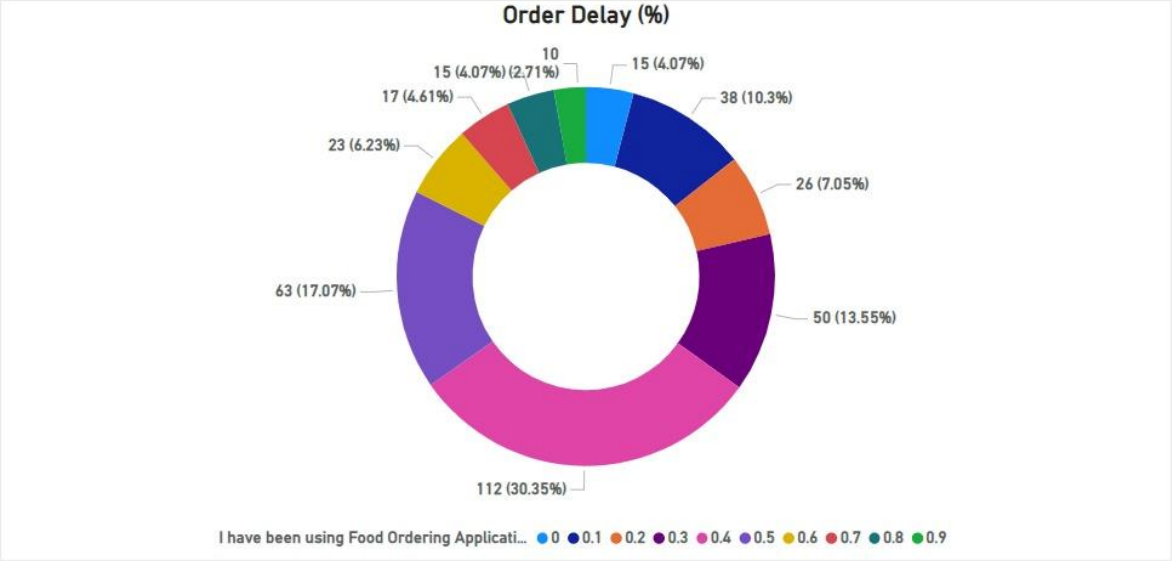


Figure15. Delay Experienced by Customers

In order delay percentage analysis, doughnut chart shows that approximately 30% of people are expecting a delay of 40% time and 17.7 % of people are experiencing a 50% delay.

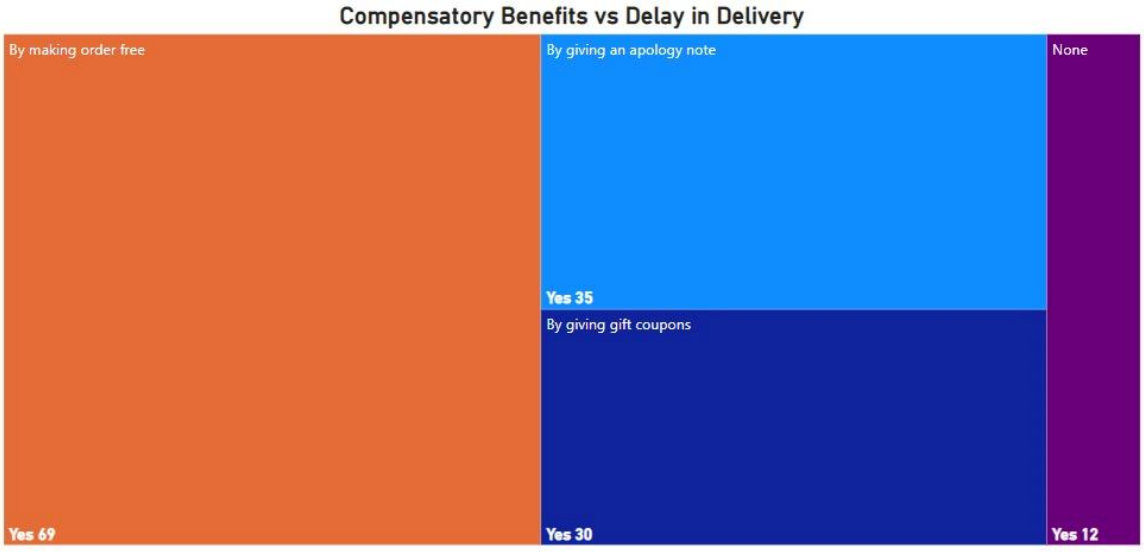


Figure16. Compensatory Benefits Received by Customer on Delay

Compensatory benefits vs delay in delivery treemap show that majority of the people are getting their order free if they get the last order delayed.

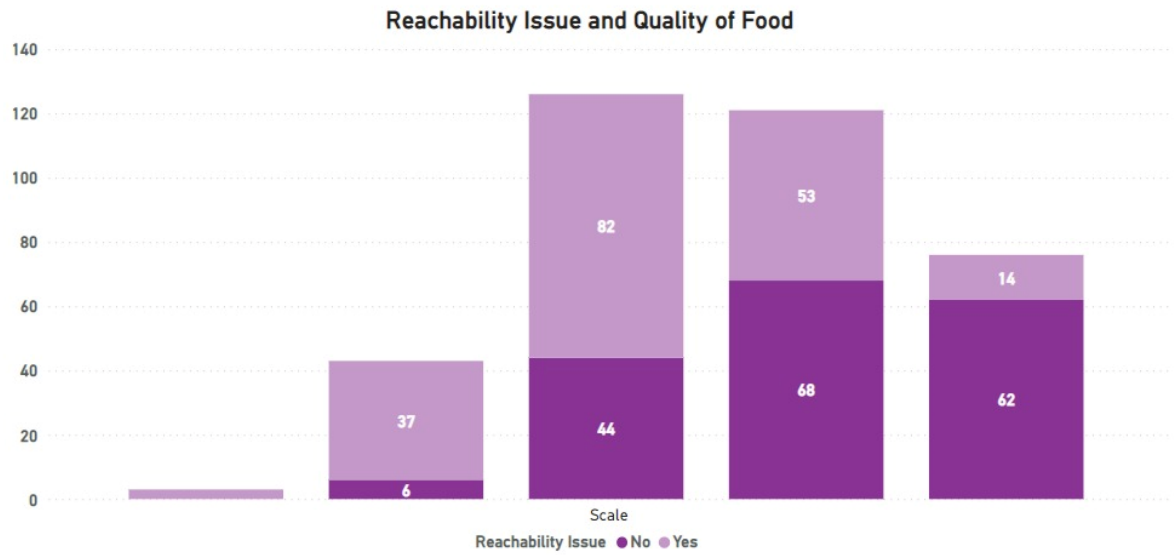


Figure17. Compensatory Benefits Received by Customer on Delay

In the reachability issue vs quality of food stacked chart, we were able to conclude that even though the order is not delivered on time, the quality remains good enough.

The density analysis done on the road network confirmed that maximum number of food restaurants and food joints are having good connectivity to major roads. It is because most restaurants lie in moderate to high density zone of the road network of Delhi.

A conclusive map of proximity analysis is prepared to spatially visualize the customers counts of Yes and No for the usage of online food ordering apps. This map also efforts to make a relation between the reachability of food restaurants to customers. Consider, Figure.18, which shows the proximity analysis map.

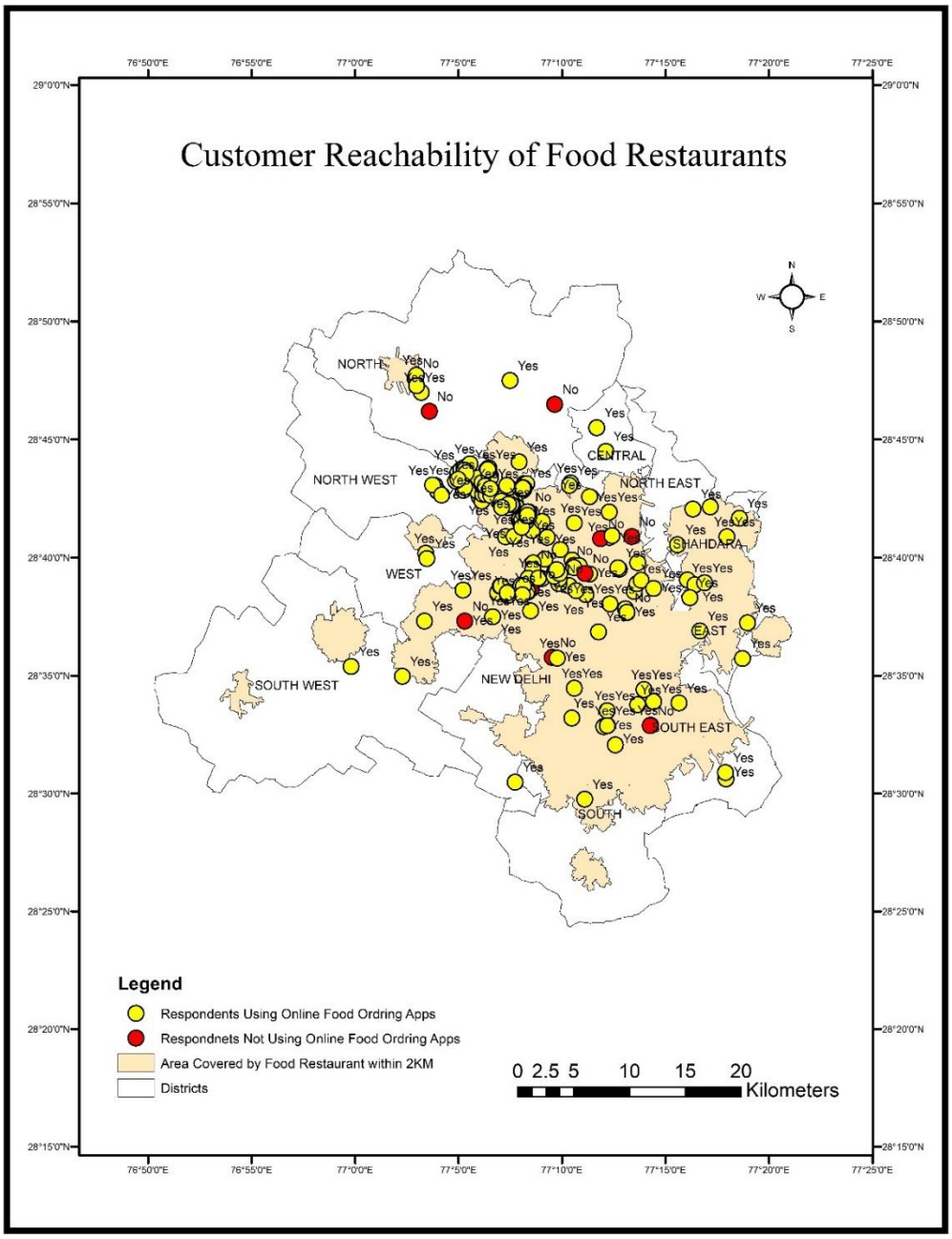


Figure18. Food Restaurant Reachability to Online Food Ordering Customers

The map shows that maximum number of customers who are within 2Km reach of the restaurant prefer ordering food online because of less delay. Some customers who are within 2Km reach but do not prefer to use the app is either because they prefer dine out over apps or quality of food delivered is not satisfactory in that area.

The outcomes of the model are also showing pleasing results. The model developed is perfectly working and creating delay clusters effectively. The outputs of the model are explained using Figure.19.

```
1th Top Cluster's Probability is 0.08333333333333333 and Food Restaurants are :
        BTW- Dwarka
        Subway- south west delhi
        The Pizza Company ( TPC )- south west delhi
        Krispy Kreme - Dwarka
        Krispy Kreme - South west delhi
        Tastylicious - South west delhi
        Siya's Kitchen- South west delhi
        Chtore- Dwarka
        Oishi Kitchen - Dwarka
        Foody Singh- Dwarka
        Lazeez Kitchen- Dwarka
        The Crazy Food- Tilak Nagar


2th Top Cluster's Probability is 0.10526315789473684 and Food Restaurants are :
        BTW- Janakpuri
        Dunkin Donuts- Tilak Nagar
        sagar ratna- paschim vihar
        Sagar ratna - punjabi bagh
        Sagar ratna - naraina
        Wow Momo- Janakpuri
        Biryani Blues-  Kirti Nagar
        Biryani Blues- Tilak Nagar
        Patiaala House Restaurant- South west delhi
        ITC Dhaba- South west delhi
        Barbeque Nation- South west delhi
        Talli Station- South west delhi
        Eatery Royale - South west delhi
        The Pavors Reloaded - South west delhi
        TG'S Kithcen - South west delhi
        Delhi 6- south west delhi
        Punjab Grill Tagore Garden- West delhi
        Ikk Punjab - West delhi
        Talwars Sardar ji Family restaurant- West Delhi


3th Top Cluster's Probability is 0.14285714285714285 and Food Restaurants are :
        The Pizza Company ( TPC )- Narela
        DD South Chap Café - Bawana
        Spice of Bawana
        Chill and Grill Restaurant - Bawana
        Raj Singh's Amritsari Kulcha- Bawana
        The Food Planet - Bawana
        Shree Navratan Restaurant - Bawana
```

Figure19. Cluster Model Probability Output

The model on implementation shows the top 3 probability of clusters in decreasing order. The 1st cluster with lowest probability signifies minimum delay. The model also resulted out the list of restaurants from where the customer can get minimum delay on online food ordering.

CHAPTER 6

6. CONCLUSIONS

This study has been developed to compare the delay between different clusters obtained based on latitude and longitude i.e., coordinates. This idea has been implemented by creating a model in Python which uses the K-means (Clustering Algorithm). After that, we calculated the probability of each cluster and then sorted it in descending order which signifies minimum delay at the top. The Output of the model will present the top 3 clusters with minimum delay and the probability associated with it.

This idea will help the various food ordering apps in classifying the restaurant's list in their order preferences as it involves end-user observations which leads us to estimate the probability that helps in classification. The delay in delivery not only reduces the utility of the app but also affects the quality standards of the food. The delay can also happen from the restaurant side in preparation time or maybe due to any other factor which usually been manipulated by the restaurants. This model will give the delay analysis and make utilize the delay data given in the form of feedback. The road density analysis will benefit the delivery apps in identifying the road network connectivity between the end-user and the restaurant that impart future expansion goals of the apps. The proximity analysis will benefit the food ordering app to deliver fast in areas, the drive-time method is used to check the reachability of the restaurants to customers.

The limitation of this study is the ultimate quality of data is not there as quality matters for deciding the probability of the clusters. The clustering algorithm can be modified to take more parameters as input for better results. Power BI dashboard can be used to analyse the dataset for more meaningful insights that can help in deciding more factors for creating a problem of delay. Overall, this study can be taken up by machine learning approaches for picking up the restaurants which do not face delays but due to its proximity with a greater number of restaurants are getting delayed delivery it is not being got benefit can be picked up from the maximum delayed cluster and put it into the closest less delayed cluster. If a user is travelling and wants to see dynamic clusters of minimum delay that can also be happen by creating an API.

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APPENDIX: SOURCE CODE

The source code for the clustering model

Clustering Model Using Kmeans

```
# The Model is developed to form clusters on basis of delay
# It will take a CSV file from the User for implementation
# Display Output:
# Top 3 clusters having minimum probability of Delay will be displayed
# The list of Restaurants to corresponding clusters will also given in ouput


import pandas
from sklearn.cluster import KMeans

import os
print(os.getcwd())
os.chdir("E:\Mtech DTU\Mtech_Major")

df = pandas.read_excel('Restaurants_Delhi.xlsx')

model = KMeans(n_clusters = 10)
model.fit(df[['Latitude','Logitude']])

all_predictions = model.predict(df[['Latitude','Logitude']])

print("The Predictions are\n",all_predictions,"\n")

clusters= [[] for i in range(10)]

n = len(all_predictions)
for i in range(n):
    clusters[all_predictions[i]].append(df.iloc[i])

prob_clusters = {}

for i in range(10):
    c = 0
    n = len(clusters[i])
    for j in clusters[i]:
        if j['Delay in Delivery'] == 'Yes':
            c+=1

    prob_clusters[i] = c/n
```

```
final_data = [ ]

for i in prob_clusters.items():
    final_data.append((i[0],i[1]))

final_data.sort(key = lambda x: x[1])

#top 3 clusters
for i in range(3):
    print(f"{i+1}th Top Cluster's Probability is {prob_clusters[final_data[i]
[0]]} and Food Restaurants are : ")
    for j in clusters[final_data[i][0]]:
        print("\t",j['Name of Restaurant'])
    print("\n\n")
```