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## **ANALYZING DELIVERY AREA/ZONE TAGGING TECHNIQUES WITHIN FULFILLMENT CENTRES FOR LAST-MILE DELIVERY ORDERS**

**Muhammad Younus<sup>1</sup>, Achmad Nurmandi<sup>2</sup>, Suswanta<sup>3</sup>, Abdul Rehman<sup>4</sup>**

Department of Product Research and Software Development,

TPL Logistics Pvt Ltd, Karachi, Pakistan<sup>1</sup>

Department of Government Affairs and Administration,

Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia<sup>1,2,3</sup>

Department of English, Pakistan Air Force College, Sargodha, Pakistan<sup>4</sup>

mohammedyounusghazni@gmail.com

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### **ABSTRACT**

Last-mile delivery in e-commerce logistics is crucial and difficult, affecting consumer happiness and operational efficiency. Fulfillment centers use delivery area/zone marking to ease this operation. This study examines fulfillment center methods for optimizing last-mile delivery orders. This research first examines delivery area/zone labeling methods. These methods break geographical regions into smaller manageable parts for resource allocation and route optimization. Grid-based zoning, distance-based tagging, and contemporary machine learning methods for dynamic and adaptive zone identification will be investigated. The study then examines delivery area tagging implementation factors. Zone tagging success depends on population density, order frequency, traffic patterns, and delivery time windows. Emission regulations and sustainability targets will also be examined. Delivery area/zone tagging technology and tools are also examined. GPS tracking, GIS mapping, and real-time data analytics enable effective monitoring and modifications. IoT devices and predictive analytics will also be assessed for their impact on delivery performance. This study concludes with the benefits and drawbacks of delivery area/zone labeling. Delivery time, operational expenses, and customer experience improve. Fulfillment focuses face data privacy, algorithmic biases, and system scalability issues. In conclusion, this study examines fulfillment center delivery area/zone labeling for last-mile delivery orders. E-commerce and logistics stakeholders may maximize last-mile delivery by knowing the different methods, technology, and factors affecting them.

**Keywords:** delivery zone, delivery area, last-mile, fulfillment center, logistics.

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Corresponding Author: Muhammad Younus  
E-mail: mohammedyounusghazni@gmail.com



### **INTRODUCTION**

The last mile delivery is a crucial aspect of the supply chain, and its efficiency and accuracy are essential for customer satisfaction (Xenou et al., 2022); (Modgil et al., 2021). The last mile delivery is the final stage of the delivery process, where the product is delivered to the Customer's doorstep. The last-mile delivery is often the most expensive and time-consuming part of the delivery process. One of the critical challenges in last-mile delivery is the accurate tagging of delivery zones within fulfillment centers (Gdowska et al., 2018). Delivery zone tagging techniques can be manual, automated, or hybrid, each with advantages and disadvantages.

The effectiveness of these techniques in improving the efficiency and accuracy of last-mile delivery is an area of active research (Wu et al., 2021). This study analyzes delivery zone tagging techniques for last-mile delivery orders within fulfillment centers. The research will investigate the

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various methods used to tag delivery zones and explore their effectiveness in optimizing last-mile delivery operations. The study will be conducted through literature reviews and case studies of fulfillment centers implementing different tagging techniques. The results of this research will provide insights into the best practices for delivery zone tagging and help fulfillment centers improve their last-mile delivery operations (Tian & Zhang, 2021). It is of the utmost need to do urgent research on the topic of examining delivery area/zone tagging strategies employed by fulfillment centers for last-mile delivery orders. Optimizing the effectiveness of delivery operations is essential in the face of rising e-commerce demand and the exponential expansion of last-mile deliveries. Last-mile delivery precision, efficiency, and effectiveness can all be improved by familiarity with and application of effective area/zone tagging strategies. Researchers can determine the best ways for specific contexts and operational restrictions by analyzing and comparing alternative tagging methods, such as geofencing, postcode-based zoning, and machine learning algorithms (Ni et al., 2019). The results of this study may have a profound impact on last-mile delivery systems, leading to greater efficiency, shorter wait times, lower prices, and happier customers. Research in this field is essential for driving innovation and creating sustainable solutions for the future because of the enormous influence last-mile delivery has on the e-commerce business and the daily lives of consumers.

Numerous advantages and avenues for study present themselves when fulfillment centers examine delivery area/zone tagging strategies for last-mile delivery orders. First, fulfillment centers can improve their operations and last-mile delivery efficiency by proper tagging and categorization of delivery areas/zones. This modification has the potential to decrease delivery times, boost customer happiness, and enhance logistics efficiency (Lagorio et al., 2016). In addition, researchers can learn more about the spatial distribution of delivery requests by carefully analyzing tagging methodologies in order to spot trends, improve route planning, and make more efficient use of available resources. In addition, learning from the experiences of others who have already applied such methods can illuminate the way forward for the creation of smarter and more automated delivery systems as we include cutting-edge technologies like AI and ML into fulfillment center processes (Bijmolt et al., 2021). Ultimately, this study has the potential to change last-mile delivery by increasing our understanding of delivery area/zone tagging methodologies, leading to more environmentally friendly, cost-effective, and customer-centric logistics solutions.

The effectiveness of delivery zone tagging techniques in improving the efficiency and accuracy of last-mile delivery is an area of active research. This study aims to investigate the various methods used to tag delivery zones and explore their effectiveness in optimizing last-mile delivery operations. The research will be conducted through a literature review and case studies of fulfillment centers implementing different tagging techniques. The results of this research will provide insights into the best practices for delivery zone tagging and help fulfillment centers improve their last-mile delivery operations.

## **METHOD**

This study analyzes delivery zone tagging techniques for last-mile delivery orders within fulfillment centers. The research methodology used in this study is a mixed-method approach that combines qualitative and quantitative research techniques. The mixed-method approach is

appropriate for this study as it comprehensively analyzes the various delivery zone tagging techniques used within fulfillment centers. The qualitative research component of this study involves a literature review of existing research on delivery zone tagging techniques. The literature review will provide insights into the various tagging techniques used within fulfillment centers and their effectiveness in optimizing last-mile delivery operations. The literature review will also identify the challenges associated with delivery zone tagging techniques and the best practices for implementing these techniques within fulfillment centers. The quantitative research component of this study involves case studies of fulfillment centers that have implemented different delivery zone tagging techniques. The case studies will provide insights into the effectiveness of different tagging techniques in improving the efficiency and accuracy of last-mile delivery operations. The case studies will also identify the factors that influence the effectiveness of delivery zones tagging techniques, such as the volume of orders, the complexity of the street layout, and the quality of the data used to train the system. The sampling method used in this study is purposeful sampling. Purposeful sampling is a non-probability sampling technique that involves selecting participants based on specific criteria.

In this study, the fulfillment centers selected for the case studies will be purposefully sampled based on their size, volume of orders, and the tagging technique used within the fulfillment center. Data collection for the qualitative research component of this study will involve a systematic review of existing literature on delivery zone tagging techniques. The literature review will use online databases such as Google Scholar, Semantic Scholar, and PubMed. The search terms used will include "delivery zone tagging," "last mile delivery," "fulfillment centers," and "delivery optimization." Data collection for the quantitative research component of this study will involve case studies of fulfillment centers that have implemented different delivery zone tagging techniques. The case studies will be conducted through interviews with fulfillment center managers and employees, observation of the delivery process, and analysis of delivery data. The data collected will be analyzed using statistical methods such as regression analysis and ANOVA.

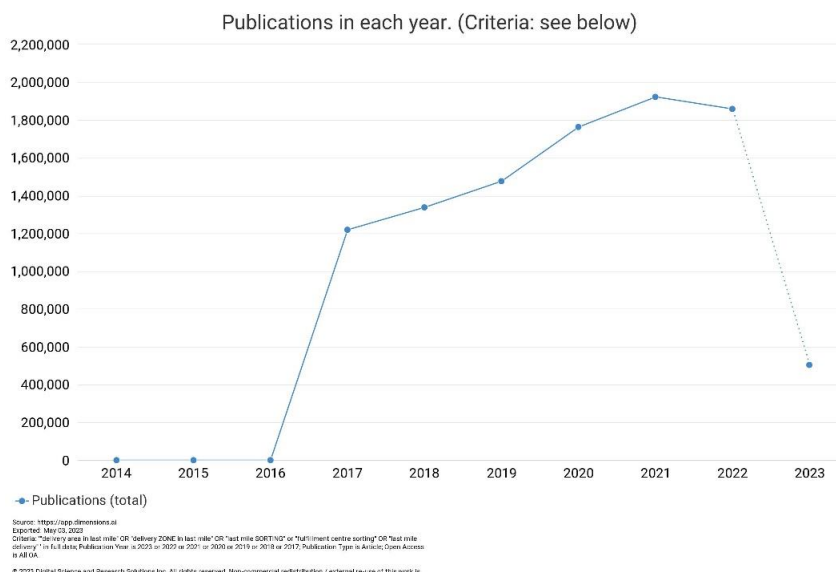
Searching Criteria for Research Data;

2023 OR 2022 OR 2021 OR 2020 OR 2019 OR 2018 OR 2017 Publication Year

All OA Open Access

Article Publication Type

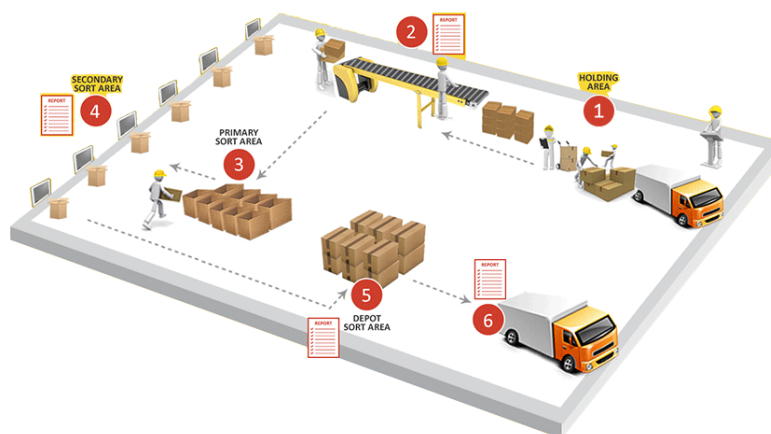
"Delivery area in last mile" OR "delivery ZONE in last mile" OR "last mile SORTING" or "fulfillment center sorting" OR "last mile delivery"



**Figure 1.** The visualization shows the number of publications published each year

## RESULTS AND DISCUSSION

After Research and Development, the Following are Options to make Possible Ops Delivery Zone Visibility for Checking.



**Figure 2.** it shows journey of order in warehouse

### Delivery Area Input with Each Scanned Order

One potential solution for improving last-mile delivery efficiency is implementing a delivery area input with each scanned order. This technique involves assigning a delivery zone or area to each order and inputting this information into the scanning device when the order is received at the fulfillment center. This allows for more accurate tracking of the order's progress and provides delivery drivers with a clear understanding of the areas they will be servicing. Additionally, it can help fulfillment centers optimize their delivery routes and improve overall efficiency. To determine this technique's effectiveness, various delivery zone tagging techniques within fulfillment centers can be analyzed to evaluate their impact on last-mile delivery operations.

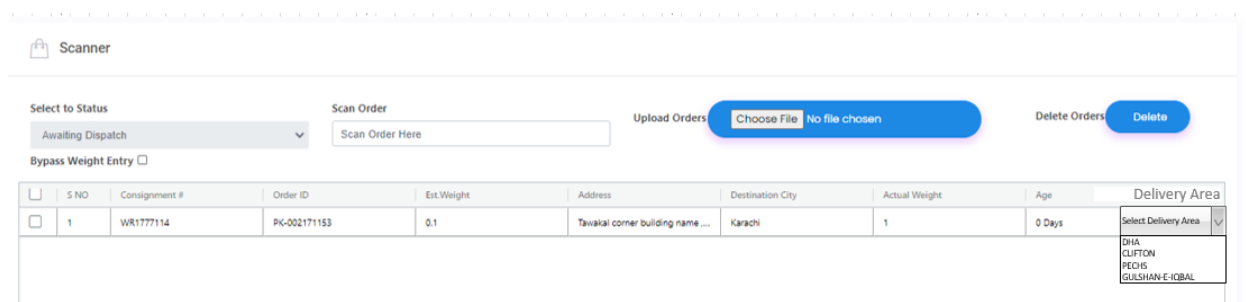


Figure 3. it shows the way of input data against order

### Smooth Flow Implementation of this Solution

For Quick Scanning with Delivery Area Input Following Process will be Followed

- Parcels will be Placed on the Sorting Table.
- Then Area Wise Sorting will be Done of Parcels.
- After Area Wise Sorting, Area Wise Scanning will be Done of Parcels in Excel.
- When Scanning Completed Input Delivery Area of Parcels.
- Lastly, Upload Excel File on System. Then Orders will be updated with the Delivery Area.
- Also, Instead of Uploading Excel File Area Wise after Each Area Parcel is Scanned. What we can Do is After One Area is Scanned, Then Drag & Drop Areas with Them and Continue Scanning from below of Next Area where the last area Parcels ended. Lastly, After All, Areas are Scanned, and Drag & Drop Areas are done, Upload it One time. In That way, Multiple Uploading Area Wise will not be needed.

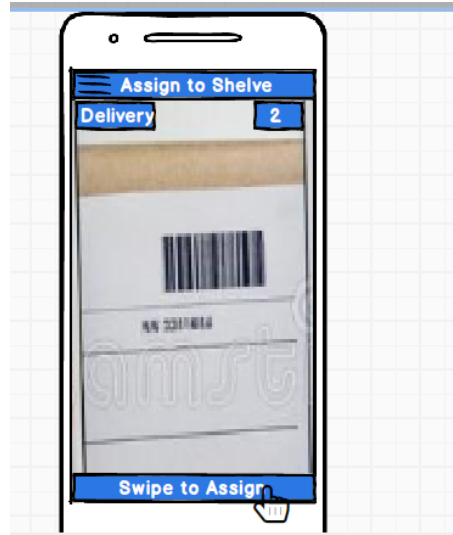
### Benefits of this Solution

- The Benefit of the above Process Flow is;
- To Break down the Process of Scanning, Address Reading, Delivery Area Input, and Physical Sorting. Because if we do all four Processes simultaneously, it will take time, and Per Parcel Processing time will increase. So doing one Process at a time will Increase Processing Speed.
- 3 of 4 Processes Operations are already done, and it is fast. Just one Process of Delivery Area Input is new, which will take significant time, So with the help of Area Wise Scanning in Excel and no delivery Area Input with Scanning. So, after Scanning is Done, we know the Parcels I have Scanned are of DHA (Delivery Zone Example). Then lastly, I will input DHA (Delivery Zone Example) in the Excel 1st row and then Drag Drop DHA (Delivery Zone Example) value with each Row and Upload it. Our Process is Done. The extra time taken by Delivery Area Input is minimized.
- Also, limiting the Ops Assistant is essential if we do all 4 Processes simultaneously. He needs to improve at all 4 Processes simultaneously, Scanning, Address Reading, Delivery Area Input, and Physical Sorting. So, with Process Breaking, we can deploy Ops Assistant to the Process in which he is Good, increasing work efficiency.

### Assign Orders to Shelves Barcode

In the realm of last-mile delivery, the efficient management of orders within a fulfillment center is essential for timely and cost-effective delivery to customers. One potential solution is to utilize a barcode system to assign orders to specific shelves within the fulfillment center. This approach enables workers to quickly and accurately locate and prepare items for delivery, reducing the time and effort required to fulfill orders. By analyzing delivery zone tagging techniques within fulfillment centers, it becomes clear that using barcodes is an effective way to streamline order

management and improve the overall efficiency of last-mile delivery operations. This approach can enhance customer satisfaction by ensuring timely and accurate delivery while reducing costs and increasing productivity within the fulfillment center.



**Figure 3.** it shows the way to input data through App

#### **Benefits of this Solution**

The Benefit of the above Process Flow is:

- a. Simple Process Flow.
- b. Give us Visibility of Order in a Specific Zone.

#### **Gray Areas of this Solution**

- a. The Gray Areas of the above Process Flow are;
- b. Development is Required for it on Our End.
- c. Human Intervention is Highly Required.
- d. If Space in Rack is Finished, then Ops Places Orders in Sack Bags on Floor or Trolleys. This process will be skipped.
- e. If, Because of a Load or any issue, Parcels Processing is delayed, then Ops Usually will skip this Process in the Morning.
- f. One Additional Scan Process is Added.
- g. More Manual Work Means More Human Error.

#### **Auto Area Picking Algorithm in the Portal**

In recent years, last-mile delivery has become increasingly important in e-commerce. Fulfillment centers play a crucial role in ensuring timely and accurate delivery of products to customers. To achieve this, delivery zone tagging techniques identify and assign orders to specific delivery areas. However, manually selecting and assigning delivery areas can take time and effort. An auto area-picking algorithm has been developed and implemented to address this issue in the Portal of fulfillment centers. This algorithm utilizes machine learning techniques to assign delivery areas to orders based on delivery location, product type, and order volume. By automating the area-picking Process, this algorithm helps to increase efficiency and accuracy in last-mile delivery, ultimately leading to improved customer satisfaction. In this research article, we aim to analyze the

effectiveness of the auto area-picking algorithm in fulfillment centers and its impact on last-mile delivery.

**Benefits of this Solution**

The Benefit of the above Process Flow is;

- a. No Human Intervention Required.
- b. Give us Visibility of Order in a Specific Zone.
- c. Less Manual Work Means Less Human Error.
- d. Skipping This Process will be Difficult Because Each Order will be Passed Through at Booking.
- e. Offline Working Support Because It Runs on the Backend.

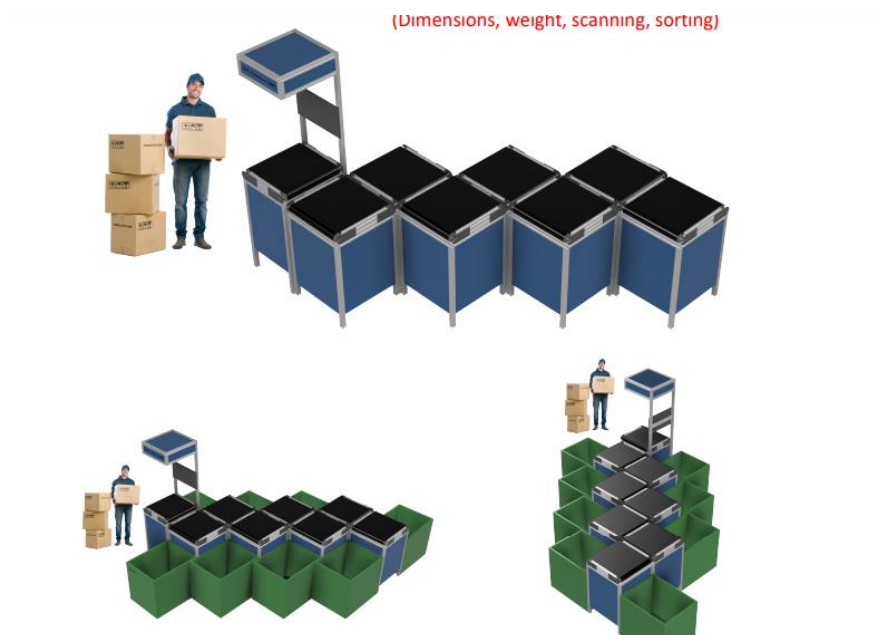
**Gray Areas of this Solution**

The Gray Areas of the above Process Flow are;

- a. Development is Required for it on Our End.
- b. Have to Continuously Correct the Formula for Optimizing the Zone Picking Logic.

**Auto Area Sorting Through Automation Machine**

Delivery zone tagging techniques play a critical role in last-mile delivery operations. Properly tagging delivery zones help logistics companies optimize their operations, reduce delivery times, and increase customer satisfaction. However, manual sorting of delivery areas can be time-consuming and prone to errors, leading to delays and mistakes in the delivery process. To address this issue, automation machines such as Auto Area Sorting have been developed to automate the sorting process of delivery zones. Auto Area Sorting uses machine learning algorithms to recognize and sort delivery areas, eliminating the need for manual sorting. This technology could revolutionize last-mile delivery operations by improving efficiency and reducing errors. In this research article, we will analyze the effectiveness of Auto Area Sorting and other automation technologies in fulfillment centers for last-mile delivery orders and explore the benefits and challenges associated with these technologies.



**Figure 5. it shows way to sort data in warehouse**

### **Benefits of this Solution**

The Benefit of the above Process Flow is;

- a. No Human Intervention Required.
- b. Give us Visibility of Order in a Specific Zone.
- c. Less Manual Work Means Less Human Error.
- d. Skipping This Process will be Difficult Because Each Order will be Passed Through at the Entrance.
- e. Decrease the need for Sorter Cost Saving.

### **Gray Areas of this Solution**

The Gray Areas of the above Process Flow are;

- a. The cost of the Machine is High and will be Required in Every Warehouse.
- b. Have to Continuously Correct the Formula for Optimizing the Zone Picking Logic.
- c. Process Has to be Done Online if Any case, Offline Flow will not Work.
- d. Some Development is Also Required for it on our end.

### **Scanner Fixed Placed on Shelves**

In recent years, the growth of e-commerce has led to an increased demand for efficient and accurate last-mile delivery. One area of focus for fulfillment centers is the development of effective delivery zone tagging techniques. To improve the accuracy of these techniques, a possible solution is implementing a fixed scanner placed on shelves. This technology would allow for real-time inventory tracking and its location within the fulfillment center. By tagging delivery zones with these location data points, delivery personnel could have more precise information on the location of packages and optimize their routes accordingly. This approach could improve efficiency and accuracy in last-mile delivery, resulting in higher customer satisfaction and decreased delivery times.



**Figure 6. it shows way of placing order in warehouse**

### **Benefits of this Solution**

The Benefit of the above Process Flow is;

- a. Simple Process Flow.
- b. Give us Visibility of Order in a Specific Zone.
- c. Track of Order on Specific Shelve.

### **Gray Areas of this Solution**

The Gray Areas of the above Process Flow are;

- a. No Human Intervention Required.
- b. Give us Visibility of Order in a Specific Zone.
- c. Less Manual Work Means Less Human Error.
- d. The cost of the Scanner is High and will be Required on Every Shelf.
- e. One Additional Scanning Step of the Order will be added to the Process.
- f. Some Development is Also Required for it on our end if we want that in Info in Our Portal.
- g. Needed Staff to Press the Button of the Scanner, so Ideally, Auto Start Scanner should be there. Otherwise, One Step is added to the Process.
- h. If Space in Rack is Finished, then Ops Places Orders in Sack Bags on Floor or Trolleys. So, This Process can be Skipped.
- i. If, Because of a Load or any issue, Parcels Processing is delayed, then Ops Usually will skip this Process in the Morning.

### **Define Delivery Zone Against Rider Profile**

At the time of Rider Enrollment, we can Define the Delivery Zone where he will work on its profile in the Portal. In the context of last-mile delivery, the accurate and efficient tagging of delivery zones is critical to ensure delivery riders are assigned to appropriate areas. One solution to this challenge is to define delivery areas or zones based on the delivery rider's profile. This approach considers factors such as the rider's experience, language proficiency, and knowledge of the local geography. By considering these factors, delivery zones can be tagged more accurately, and riders can be assigned to areas where they are best equipped to navigate and communicate with customers. Here we aim to analyze different delivery zone tagging techniques within fulfillment centers and assess the effectiveness of defining delivery zones based on the delivery rider's profile.

### **Benefits of this Solution**

The Benefit of the above Process Flow is;

- a. Simple Process Flow.
- b. Give us Visibility of Order in a Specific Zone.
- c. Less Manual Work Means Less Human Error.
- d. One Time Updation Required.
- e. No Additional Step or Process will be added.

### **Gray Areas of this Solution**

The Gray Areas of the above Process Flow are;

- a. Development is required for it.
- b. We will not Get Delivery Zone Visibility Until the Rider is Done Out for Delivery.
- c. We will not Get Delivery Zone Visibility of Orders on Backlog in Shelves.

### **Data Entry Zone Value**

In the world of last-mile delivery, accurately tagging and categorizing delivery zones is critical to ensuring efficient and timely delivery of orders. To this end, various tagging techniques have been employed within fulfillment centers to improve delivery accuracy and speed. One such technique involves data entry to input delivery area/zone values for each order, which can then be used to direct orders to the appropriate delivery zone. By analyzing the effectiveness of this technique, we

can gain insights into the impact of accurate delivery zone tagging on last-mile delivery operations. This research article seeks to explore the use of data entry for delivery zone tagging and evaluate its effectiveness in optimizing last-mile delivery operations.

**Benefits of this Solution**

The Benefit of the above Process Flow is;

- a. Simple Process Flow.
- b. Give us Visibility of Order in a Specific Zone.

**Gray Areas of this Solution**

The Gray Areas of the above Process Flow are;

More Manual Work Means More Human Error.

**Get Delivery Zone from Merchant at The Time of Booking**

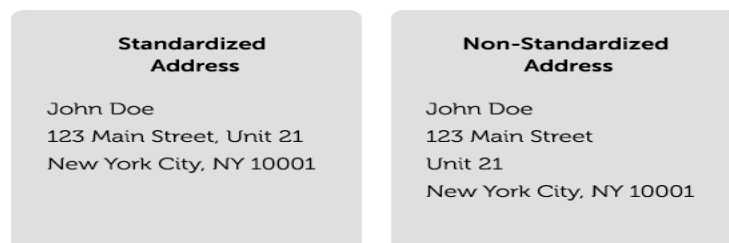
The last-mile delivery process has become increasingly important as e-commerce continues to grow. One of the challenges in the last-mile delivery process is accurately determining the delivery zone for each order. This is critical for optimizing delivery routes and ensuring timely delivery. In this context, a solution that has been proposed is to obtain the delivery zone information from the Customer at the time of order booking. This solution could improve the accuracy of delivery zone tagging and reduce delivery time, as the delivery zone can be determined in real-time. In this research article, we analyze different delivery zone tagging techniques within fulfillment centers for last-mile delivery orders and evaluate the effectiveness of obtaining the delivery zone from customers during order booking.

**Ways of Implementing Solution**

The following are the ways of implementing this solution;

**Delivery Address Standard**

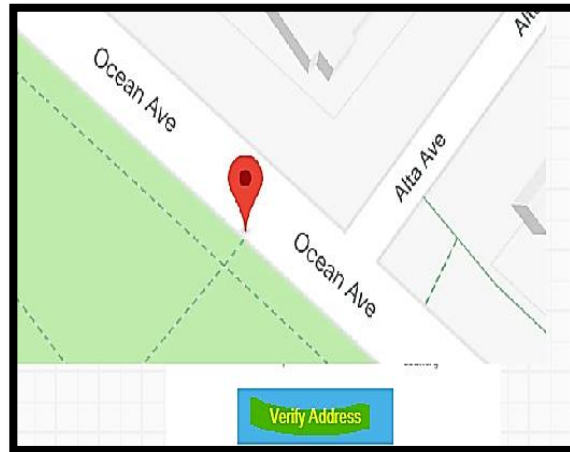
Delivery Address Standard Should be Shared with Customers on the Merchant Website, and They Aware That It is Important for a Smooth Delivery Process. Example Should show for Easiness of Customers.



**Figure 7. it shows standard way of order address**

**Confirm Current Location**

When a Customer Inputs the Delivery Address in Order Booking Form, Then Merchant Website Should Ask from Customer its Current Location the Delivery Address. If Yes, Then Allow Location Service and Get the Customer's Current Location. Prefilled that Data in Delivery Address Fields. If no, then let him type the Address.



**Figure 8.** it shows pin point order address in Map

### **Delivery Address Validation API/Plugin**

Address Validation API Will be Created by Us for Merchants in Order to Get Clean and Clear Customer Addresses at the Time of Booking by the Customer on the Merchant Website, which will help in the Correct Lat Long Picking Process That Latlong will be Shared with Us at the Time of Booking. It will be implemented on Merchant Website".

A form for address verification. It has the following fields:

- Name: First Name and Last Name (two input boxes)
- E-mail: One input box
- Order Number: One input box
- Lob Address Verification: One input box (highlighted in yellow)
- Street Address: One input box
- Street Address Line 2: One input box
- City: One input box
- State / Province: One input box
- Postal / Zip Code: One input box
- Country: A dropdown menu with 'United States' selected

**Figure 10.** it shows the way to input address of order

### **Benefits of this Solution**

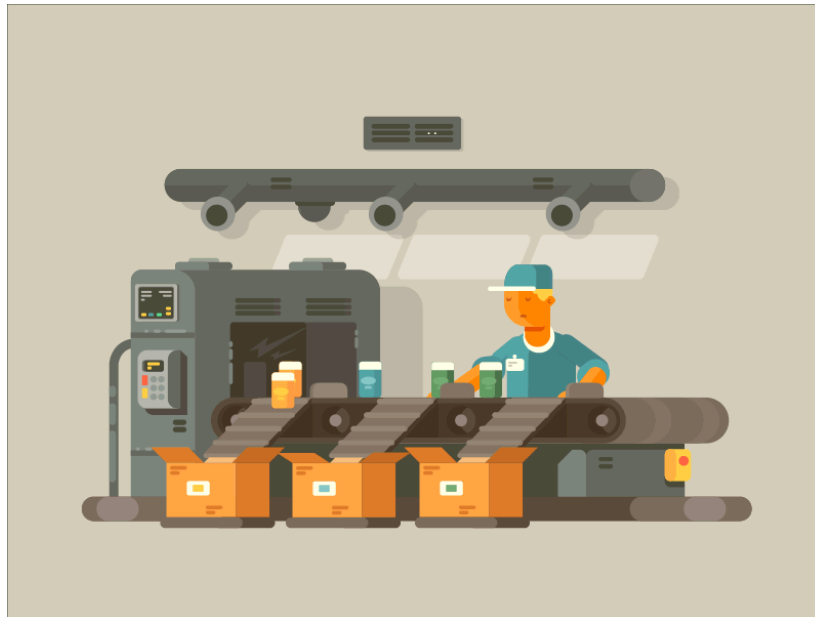
The Benefit of the above Process Flow is;

- Simple Process Flow.
- No Human Intervention Required.
- Give us Visibility of Order in a Specific Zone.

### **Gray Areas of this Solution**

The Gray Areas of the above Process Flow are;

- Convince Customers to do it.
- Development is required for it.



**Figure 11.** it shows movement of order through conveyer belt

## **CONCLUSION**

In conclusion, optimizing delivery zone tagging techniques is crucial for improving the efficiency and accuracy of last-mile delivery operations. The last mile delivery is the final stage of the delivery process, where the product is delivered to the Customer's doorstep. Last-mile delivery is often the most expensive and time-consuming part of the delivery process. Delivery zone tagging techniques can be manual, automated, or hybrid, each with advantages and disadvantages. The effectiveness of these techniques in improving the efficiency and accuracy of last-mile delivery is an area of active research. The results of this research can inform the development of more efficient and accurate delivery zone tagging techniques and help fulfillment centers improve their last-mile delivery operations. This study contributes to developing more efficient and accurate last-mile delivery systems by analyzing the various tagging techniques and their effectiveness. The study also highlights the importance of data quality in the effectiveness of automated delivery zone tagging and the need for further research in this area.

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