

Design and Implementation of a Multi-agent on-demand Courier Application

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Abstract- *The advent of on-demand courier services has caused a major shift in the logistics sector in recent years. These platforms make use of technology to offer delivery services that are quick, dependable, and convenient and that are catered to the requirements of contemporary businesses and consumers. Same-day delivery is becoming more and more popular among online shoppers, who need quick, affordable, and adaptable on-demand delivery options. This work uses direct peer-to-peer transshipment to suggest, design, and evaluate a new multi-agent on-demand, same-day delivery approach. The analysis of existing literature has provided valuable insights into the technological advancements, market trends, and user preferences shaping the landscape of on-demand courier services. The use of flutter flow, flutter and firebase technologies were used to create a multi-agent on-demand courier application that connects users in need of delivery service to the nearest delivery agent for a seamless delivery service. Based on the waterfall model adopted to create the application, the user creates an account, verifies the account, enters a pickup, drop off location and package needs according to the vehicle type then proceeds the app matching the user to the nearest delivery service, alongside confirmation and transaction details. The developed application output performed as expected, user's data can easily be added and removed from the database and the application works well with a device type.*

Indexed Terms- *Courier Management, Delivery Scheduling, Dispatch Algorithm, Front-End Development, On-Demand Service.*

I. INTRODUCTION

On-demand delivery is a service that offers prompt and easy delivery of goods or services to meet the needs of customers in the moment. Anna Thompson DHL (2023), On-Demand Delivery is a fully flexible service that puts customer convenience at its center. It is driven by modern technology like automation and data analytics, meaning it can evolve to keep up with increasing customer demands. A smartphone application that links customers with drivers in the vicinity is usually used to get an on-demand delivery. The procedure goes as follows: the driver gets the order and picks up the items after the customer places an order using the mobile application. A multi-agent system is made up of multiple agents that may work together to solve complicated issues in a distributed manner without requiring knowledge of the entire problem at hand from each agent. It is made up of several interacting agents, each of which is a separate, coarse-grained computational system. *Multi-agent systems* are groups of agents that communicate between themselves to share information and resources, coordinate their activities and cooperate in the joint efficient solution of a distributed problem (Wooldridge, 2009). In order to fully automate the courier service, connect customers to nearby delivery services more quickly, and function beyond the capabilities of any one agent in the setup, the multi-agent on-demand courier service application aims to create an application that connects independently developed courier service agents. Traditional courier services may need protracted processes, including phone calls, paperwork, and uncertain arrival dates. Opportunities for disruption in the industry have arisen due to inefficiencies and a lack of clarity.

Multi-agent on-demand courier apps, which provide a seamless and practical platform for package shipping and receiving, overcome these problems. Multi-agent on-demand courier apps have brought about a great deal of innovation and disruption to the courier and logistics industry. The emergence of on-demand services has transformed our interactions with a range of businesses, including food delivery and transportation. The need for quicker, more dependable delivery services is greater than ever in the digital age. Customers now want prompt and effective service, thus the logistics and courier sector has looked to technology to meet these demands. This is where the creation of multi-agent on-demand courier apps comes into play, completely changing how companies and clients communicate with these services. This in-depth guide covers all the essentials for creating a profitable on-demand courier app, emphasizing features, advantages, and tactics to make your app stand out in the crowded industry. The seamless integration of technology is essential for the efficient operation of on-demand courier apps.

A. Motivation of study

The transformational power of multi-agent on-demand courier applications on contemporary logistics and consumer behavior is the driving force behind their study. Comprehending the driving forces behind the utilization of these applications helps illuminate the changing inclinations of customers and the difficulties encountered by courier service providers in effectively fulfilling their requests. Furthermore, through identifying areas for innovation and development within the sector, multi-agent on-demand courier applications can improve service offerings and customer experiences.

B. Statement of The Problem

In contrast to multi-agent on-demand courier services, on-demand courier services are typically manual in operation. The courier service process can be problematic for both users and the delivery agents waiting for delivery agent to get to your location from the delivery company may take a long time, dishonesty about delivery time in the system causes lack of trust among users and delivery agents People these days are so busy that they rarely have

time to follow up on deliveries, which makes the job difficult for the delivery agents. In addition, it can be very challenging to find a logistics service in a new place, and it can also be challenging for courier services to find clients. Therefore, the goal of this project is to automate the procedure by creating a global multi-agent on-demand logistics service application that helps locate nearest delivery agent to save time, transparency between users and delivery agents also improves delivery systems for both parties.

C. Aim and Objectives of the Research

The aim of this study is to design and implement a multi-agent on-demand courier application that meets the evolving needs of both users and courier service providers.

The objectives of this study are;

1. To Carry out a feasibility study on the existing courier service processes.
2. To design the proposed multi-agent on-demand courier logistics application.
3. To test app effectiveness and performance on devices.

II. RESEARCH ELABORATIONS

1. Literature Review

The multi-agent on-demand courier apps have garnered significant attention due to the growing demand for convenient and efficient delivery services. This literature review explores existing research and industry practices related to the design, development, and operation of on-demand courier apps, focusing on key themes such as user experience, technology integration, and operational challenges. QiweiPang, et al (2023) With an increase in online retail services during pre and post pandemic, delivery couriers have been overloaded and have worked for approximately 12 hours a day in 6 days a week, Couriers also faced work related injuries in their duty hours (Choe, S.H.- 2020). Workload and safety concerns of couriers also increased which in turn had adverse effect on delivery services thus customers faced satisfaction issues SanjeetWalia (2020) Dependence only on Manpower would impact negatively and may be a

hindrance in smooth Last Mile Experience. Innovation and technological development would be the key to improved Last Mile Delivery experience by investing money on drones, parcel stations etc. T. Aravind, P. Dileep Kumar (2019) With inventions of new technologies, courier companies are getting themselves revamped. Services are getting automated such as documentation which was done handwritten has been removed and technical bar updated software is implemented. Data loss is minimized as it can now have backed up on the reliable media. Password system has been generated which has nearly eliminated the fear of unauthorized access to the data. Xin Goo (2018) Relationship between new technology and urban patterns gives planners direction and instruction to make the city plan more comprehensive and adaptable in the future. Parcel delivery in a planned manner with the help of technological development becomes easier. Alisha Fernandes (2017) Study emphasizes on the use of software which identifies the optimum path, traffic free route which can be assigned to couriers to avoid delivery delays, optimize maximum deliveries and reduce cost. Harish Kumar (2017) Financial development of any country is largely based on its services enabled by IT which are available to citizens. Well planned cities have proper street names, house or building addresses which are being used by postal services, courier services, and logistics services deliveries. Delivery services are often failed due to inappropriate delivery address or delivery locations could be found by the courier. This reason has given idea to digitize the system of house address in order to deliver accurate and faster services to the citizens. The couriers and in house operations staff of delivery companies can save the address data in centralized database and reduce the amount of time wasted on writing lengthy address for generating run sheets of delivery.

III. RESEARCH METHODOLOGY

The most common approach to this SDLC is structured methodology based on Waterfall model. It adopts a formal step-by-step approach to the SDLC phases, in which the activities of one phase must be completed before moving to the next phase and at the completion of each activity or phase, a

document that must be approved by the stakeholders will be produced before moving to the next activity or phase of the SDLC, in this application there are different phases that must be completed before moving to the next phase, the first phase is the creation of account phase an verification which must be approved before entering the next phase of placing orders by entering pick up, drop off location and package needs which could be by vehicle type then after this phase is approved it takes the user to the final stage of agent and transaction details. The structured approach looks at a system from a top down view. The center of the structured approach is the process model, which depicts the business processes of a system, and the primary model that presents the processes is the dataflow diagram (DFD). The DFDs and their associated data dictionary contain information about the systems components (inputs, outputs, processes, and data storage) that need to be designed and ultimately built.

I. Dataflow Diagram

A data flow diagram (DFD) is a graphical representation of the "flow" of data through an information system, modeling its process aspects. Often they are a preliminary step used to create an overview of the system which can later be elaborated. DFDs can also be used for the visualization of data processing (structured design). The diagram as shown in Fig 1 is a data flow diagram for the multi-agent on-demand Courier Service logistics application

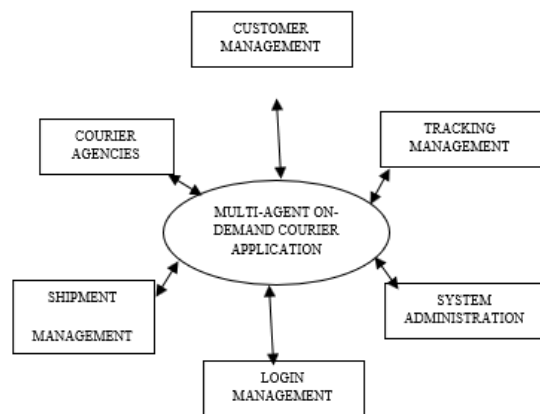


Figure 1: data flow diagram of the application

II. Technology Used

The technology stack used to develop the multi-agent on-demand courier service logistics application, including:

1. Front end development; flutter flow and flutter for the cross platform app development.
2. Backend development: fire base was the backend technology used for the server side operations.
3. Database management: Firebase for storing user data, order details and tracking information.

III. Data dictionaries

A data dictionary in a database design is a component that stores the collection of names, definitions and attributes for Data elements that are used in a database. The data dictionary stores meta data I.e. data about the database. Table 1 as shown below is the data dictionary for an agent in a multi-agent on-demand courier courier application. Table 2 shows the user table for any user using the application.

Table 1: Agent’s table

FIELD NAME	DESCRIPTION	TYPE	LENGTH
Agent Fname	First name of agent	Varchar	50
Agent Lname	Last name of agent	Varchar	50
Agent ID	Agent ID	INT	7
Company address	Address of company	Varchar	100
Contact	Contact of company	Varchar	30

Table 2 : User’s table

FIELD NAME	DESCRIPTION	TYPE	LENGTH
User_ID	User ID	INT	11
User_name	username	varchar	50
password	password	varchar	50
First_name	First name of user	varchar	50

Last_name	Last name of user	varchar	30
contact	Phone no	varchar	50
address	Address of user	varchar	300

IV. Flowchart of The Application

Here users will login into the App and a default profile is set up which will be stored in the database, then as soon as the user enters his pickup, drop off location and package type the request will be sent with the help of an API to find the nearest agent for the package type after which the user will be able to see the name of the delivery agent, price, time and distance away from the user as soon as the user clicks on the confirm button it generates the details of the delivery between the agent and user and once delivery is completed the receiver confirms the delivery and it ends.

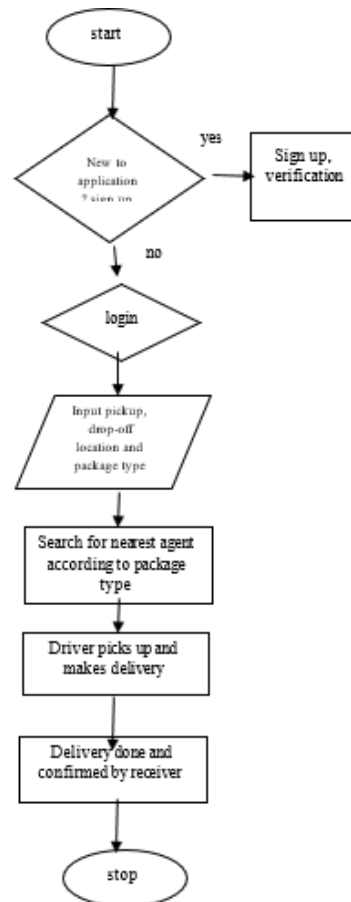


Fig 2: flow chart of a multi-agent on-demand courier application

V. User Module

The users of the application will interact with the application through an easy to use log in by use of the mobile application. The home page contains a sign up option with phone number and email and then authentication is done through OTP sent to the phone number, a form for users first and last name to register the account and the dashboard with a clear view of the map location and history of delivery. Some functions can only be seen by the admin while others the user only. The only part the user/agent cannot see is the total courier agents in the system.

1. How The Backend Works

The Backend pulls records that have entered by the user and stored in the database and it display the records for manipulation by an administrator of the backend. The administrator can update add new users, check the parcels and also see the reports; the administrator can also see all the users, agent, parcel details and transactions.

2. Parceling

When a user wants to send a parcel, he/she inputs the name of the sender and the receiver and their details also the details of the parcel and size. They then verify the payment of the parcel and hand over a receipt to the sender. The receiver then receives a message with the details that the courier is in transit to them. This makes sure that the receiver can already see the goods in transit to their destination.

3. In Transit

Once a user/clerk declares the parcel in transit and is entered into the database then pulled and Displayed in the receiving station clerk and admin account.

Change status: This is where the status of the parcel is changed from in transit to deliver to collect. Helping in accountability and the follow up of the parcel usually done by the receiving party.

4. Parcel Process

The parcel is process is a detailed process done after a parcel has been shifted from one status to another. The agents and the users can easily check and follow up on the parcel. Moreover, they can also easily navigate through the system through the easily made interface. Once the parcel is added with the details required it's changed to in transit and out for

delivery. In all this pages the reference number remains the same and the tag number. This is mainly for accountability and ease of finding and retrieval of parcels/couriers.

IV. RESULTS AND DISCUSSION

From the test conducted all the tables in database and multi_login and all the tables, in all the browsers the system was operational, however on other browser the system was slower to launch such as Microsoft edge which took 100 seconds as opposed to the rest which ranged from 40 seconds to 55seconds. Once a registration was made it reflected in the database and in the back-end where the administrator can add or remove a user or upgrade a user. The second test conducted, I simulated sending a parcel and the changing the status to see if it will reflect to the database and it happened as expected. In all instances the system functions properly and the widgets and screen-shots adapted according to size of the screen and I was easy for users to use on the different devices.

The creates an account with the application in figure 3, and get verified as a user in figure 4.

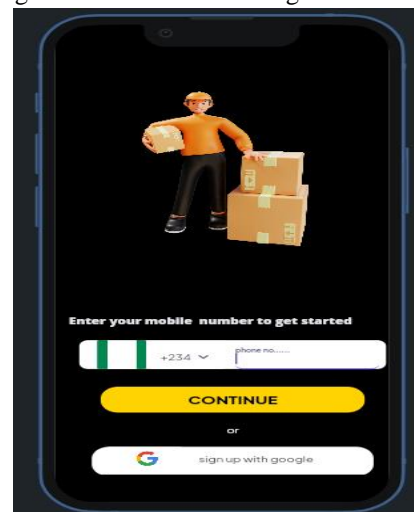


Figure 3: sign up of the application

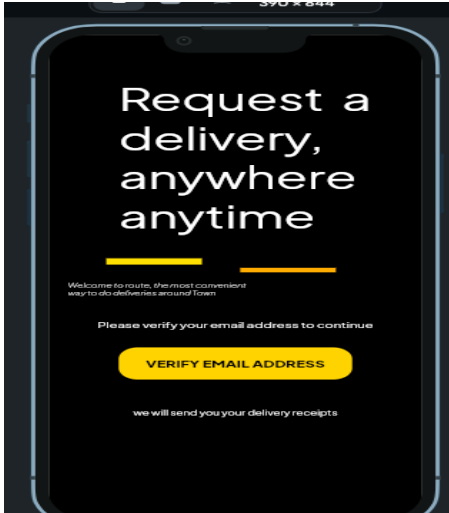


Figure 4: verification of the user in the application

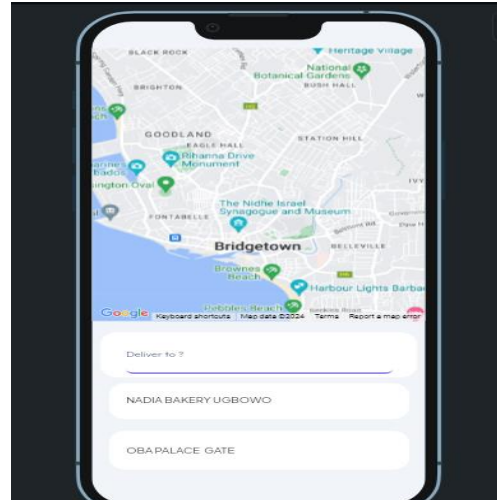


Figure 6: user enters pickup address and drop off location

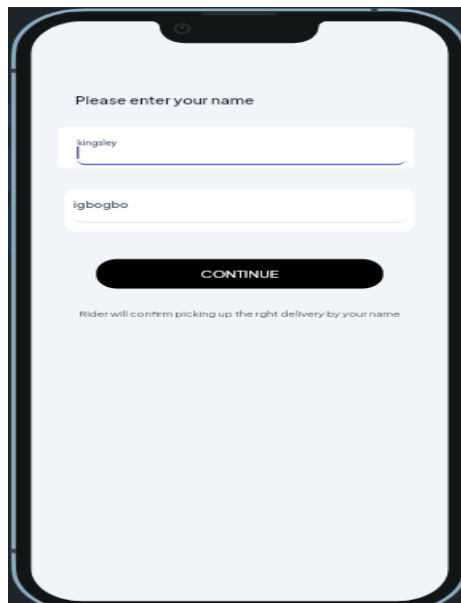


Fig 5: sign up details of the user in the application

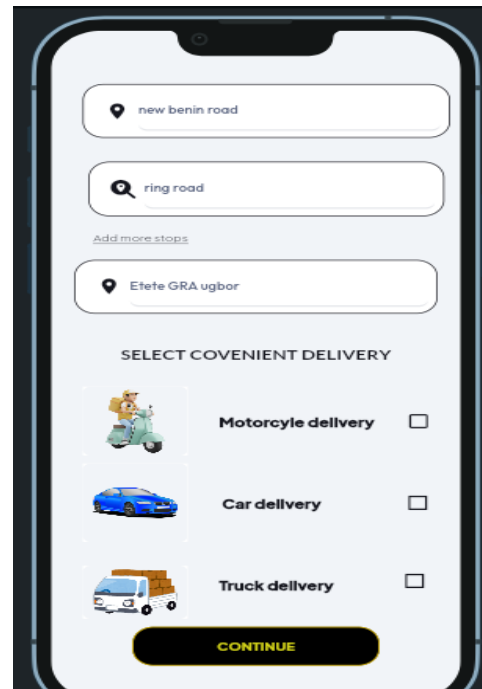


Figure 7: selects the convenient delivery type in the application

User enters sign up details (first name and last name) in figure 5, also the pickup location in the pickup input box, an API call will be made to the Map box through which search suggestions (address) will come through Map box API and the user will select the desired destination. Then the user will enter his drop off location in the second input box, as soon as the user enters his drop off location in figure 6 and 7.

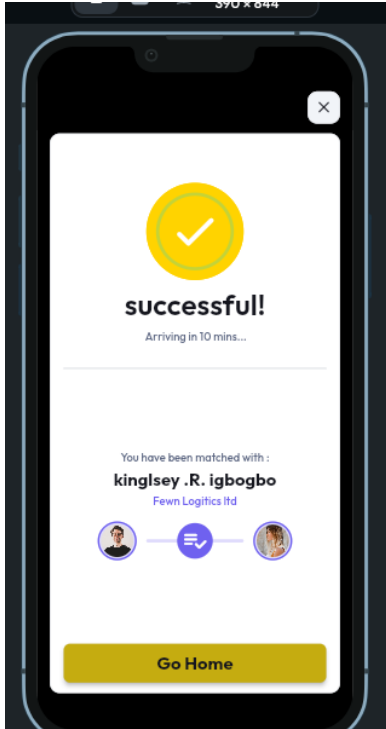


Figure 8: showing the pop-window to confirm delivery and see transaction details.

As soon as the user fills the pickup and drop off location, there is also an option for adding more stops location then user can select the delivery/package type according to his/her need Now, the user selects the car, and there is a confirm button at the bottom. As soon as the user clicks that button, a pop-up window comes up where they can see all their transaction details.

CONCLUSION

To sum up, the emergence of multi-agent on-demand courier services signifies a noteworthy development in the logistics sector, providing consumers across the globe with unmatched ease, effectiveness, and dependability. We have looked at the design, implementation, and effects on user experiences and operational efficiency of multi-agent on-demand courier apps throughout this research study. The examination of extant literature has yielded significant insights into the ways in which technology developments, market patterns, and customer inclinations are influencing the terrain of on-demand courier services. These programs, which streamline the entire process from booking to

final delivery, have altered the way parcels and items are transported by utilizing

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