MASTER OF TECHNOLOGY

INTELLIGENT REASONING SYSTEMS (IRS)

Logistic Company Recommender System

Team KICS

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1 Executive Summary

Over the last two years, the demand for courier services has risen significantly because of the threat of the Covid-19 pandemic. Community quarantines, work from home and online classes due to the pandemic have pushed people all over the world to resort to the use of courier services to buy their needs and essentials. Courier services play an immense role in offering a safe yet convenient method for acquiring necessities and wants during the pandemic. And this fluctuation of the pandemic and the way it influences our shopping habits will likely continue in the foreseeable future. Unpredictable spikes in virus cases in certain geographies may temporarily accelerate online orders and the need for home delivery from time-to-time.

For consumers who wish to send and receive parcels, it can be quite challenging and confusing to decide which shipping company to select that would suit their specific needs and requirements. As the competition in this industry heats up, we notice an almost daily increase in the number of logistics companies available for consumers to choose from. This further adds to the consumers' confusion and makes the process of selecting the most suitable shipping service very time-consuming and complicated.

We plan to address this issue by creating an intelligent reasoning system that can ease these pain-points for consumers. Our system would help the users determine the weight and dimensions of their package in a simple manner, and then provide them with an interface to compare the shipping services best suited to their needs. The system would also consider some user preferences inputs, such as cost or time sensitivity, to accordingly recommend services that are the most economical or the fastest.

2 Business Problem Background

As the demand for shipping services increases, so does the number of logistics companies that enter the market and try to make a place for themselves in the industry by differentiating their service offerings from their competitors. As a result, consumers are left with a very wide variety of services to choose from, based on their specific needs. Some factors that influence the choice of a particular shipping service over others are as follows:

1. Price of service (including base rates, extra surcharges, etc.)
2. Time of transit / delivery (including coverage of services to various countries around the world)
3. Insurance / accidental damage coverage
4. Additional services (home pick-up, Saturday delivery, etc.)
5. Availability of packaging options

2.1 Choosing a shipping service

Looking at the above non-comprehensive list of factors, it may not be very difficult to imagine the pain-points of a consumer who wants to simply get a parcel package delivered. To select a particular service from the available list of logistics companies, the consumer would have to trudge through the website of each individual logistic company and compare the service offerings manually. This pain-point is further exasperated by the fact that the logistics companies do not follow a consistent format in the explanations of their services and the various terms and conditions that are generally attached to these services. Furthermore, even the process of choosing the additional services is very confusing as these service offerings vary from company to company. All these factors make this process extremely time-consuming and frustrating for the consumer.

2.2 Deciding on packaging options / Measuring dimensions of goods

Another pain-point that most consumers of shipping services face is the process of packaging the goods they wish to send. While some of the logistics companies provide packaging services as an option, most of these require the consumers to visit a shipping centre physically with the parcel for it to be assessed by the logistics company representatives/staff. This adds further inconvenience to the already confusing and time-consuming process.

3 Market Research

In recent COVID times, the demand for courier services have increased as people continued to shop online for their needs and essentials. How do users choose a Logistic company from a wide array of service providers, they are interested in? A recommendation system should be implemented. And the recommendation system is to recommend logistic service providers sorted on price as price is the main factor that people always consider in sending out their parcels. More economical approach is considered to be the optimum solution in creating a recommendation system for courier service providers.

Business values like Revenue, Customer Satisfaction, Operational efficiency and degree of innovation proves the value of the Intelligent System (Logistic company Recommender System) that has been developed.

To start off with, market analysis and market trends have been studied and explored in ways relative to the execution of project.

3.1 Commonly Shipped Items

To study on the commonly sent items by courier services, we did extensive research on websites and came out with 200 items that people prefer to send more often. Then an effective filtering of items was done upon which we managed to categorise those items under 10 different main categories namely Documents, Clothing, Electrical and Electronic Items, Lifestyle essentials, Toiletries and Personal care, Kitchen essentials, Food, Health and Fitness and Entertainment. This data collected and refined has been used as the knowledge base of the Chatbot developed in the system. The unit size information for the chatbot to retrieve is stored on Google Sheet.

3.2 SingPost Centre Observation Visit

In order to further understand the entire process of packaging and shipping parcels in-depth, we visited a SingPost outlet at SingPost Centre (located at 10 Eunos Rd 8, Singapore – 408600). We documented our visit by taking pictures of the various offerings provided at the centre.

SingPost has undertaken a massive effort over the last few years to bring their services closer to their consumers by installing automated kiosks, called SAM, all around the island. These kiosks offer a variety of services, such as the ability to weigh parcels and measure dimensions, track parcels, pay bills, etc. SingPost also provides a variety of packaging materials in various shapes and sizes to meet the consumers' shipping needs. Understanding the efforts made by SingPost to make the process of shipping parcels easier for consumers, and observing some consumers at the centre, was crucial for us as it enabled us to discover the previously mentioned pain-points and understand them better.

More pictures from our visit to SingPost Centre can be found in Appendix F.

3.3 Logistics Customer Behaviour Study Survey

To understand the consumer behaviour more in-depth, we also decided to conduct an online survey. The survey focused on gathering feedback around the most commonly sent types of parcel packages, thoughts behind choosing a particular logistics company, most important factors in choosing any additional services, ways of determining the package weight and dimensions, etc.

We received a total of 68 responses to our survey. The following results summary was derived from the survey responses:

1. 5 most commonly sent types of packages are documents, clothing, home needs, electronics and food items.
2. While choosing a logistics company, most people rely on recommendations from their friends, family members or colleagues (46%). The next most common factor in choosing a logistics company is proximity to home/office (27%).
3. Most important factors while choosing a service offering are price (55%), followed by delivery / transit time (34%).

4. In general, people are comfortable with either packaging the parcel themselves, or having a logistics company representative package it for them.
5. SingPost, DHL, SF Express, FedEx and UPS are the top 5 most preferred logistics companies for consumers.
6. While most consumers find the logistics companies' services in Singapore to be satisfactory, about half of them think the waiting time at the physical centres is generally too long and about a quarter of them think the service offerings are too expensive.

Refer to Appendix G to see the survey form, and Appendix H to see a summary of the responses.

4 Project Objectives & Success Measurements

4.1 Project Objectives

Based on our understanding of the business problem, and after conducting market research around this topic, we can now define the following objectives for this project:

To uplift the user experience of consumers of shipping services by designing an intelligent reasoning system that:

1. ***helps the user to determine the weight and dimensions of the parcel package they wish to send.***
2. ***helps the user to choose a shipping service (from offerings from multiple logistics companies) best suited for their needs based on user-preferences such as cost-sensitivity, time-sensitivity, need for insurance, need for additional services, etc.***

By uplifting the user experience through this intelligent system, we aim to provide the users with significant time-savings and clarity that the current process glaringly lacks.

4.2 Success Measurements

Based on the above project objectives, to measure the success of our project, we would measure the effectiveness of our intelligent reasoning system in uplifting the user experience. The main metric to measure this effectiveness and uplift in the user experience would be the projected time savings our system would provide to any user who wishes to send a parcel package.

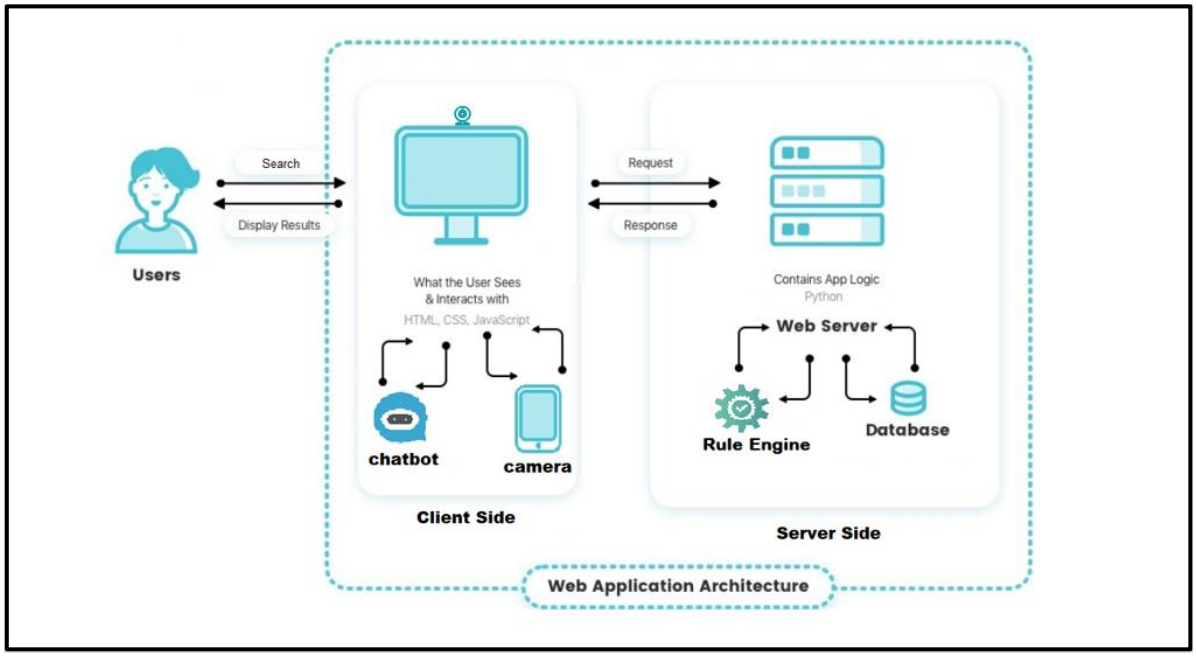
Apart from the time-savings, we may also consider other metrics of success, such as the ease of use of our system, the quality and relevancy of insights provided by our system, etc.

5 Project Solution

This project is to build an intelligent recommendation platform for logistic services across different companies. We use a chatbot and a camera utility to help users get the needed measurements and recommend the most suitable logistic services based on their requirements and priority.

The solution includes a web site for users to access to fill in a form and get the results. On the homepage, there is also a chatbot that the users can interact with to obtain packing sizing just through conversations. This is possible as we built a knowledge for 100 over types of commonly bought and sent items. As an experiment, we also added a camera utility for the users to measure object dimensions using phone camera or PC camera.

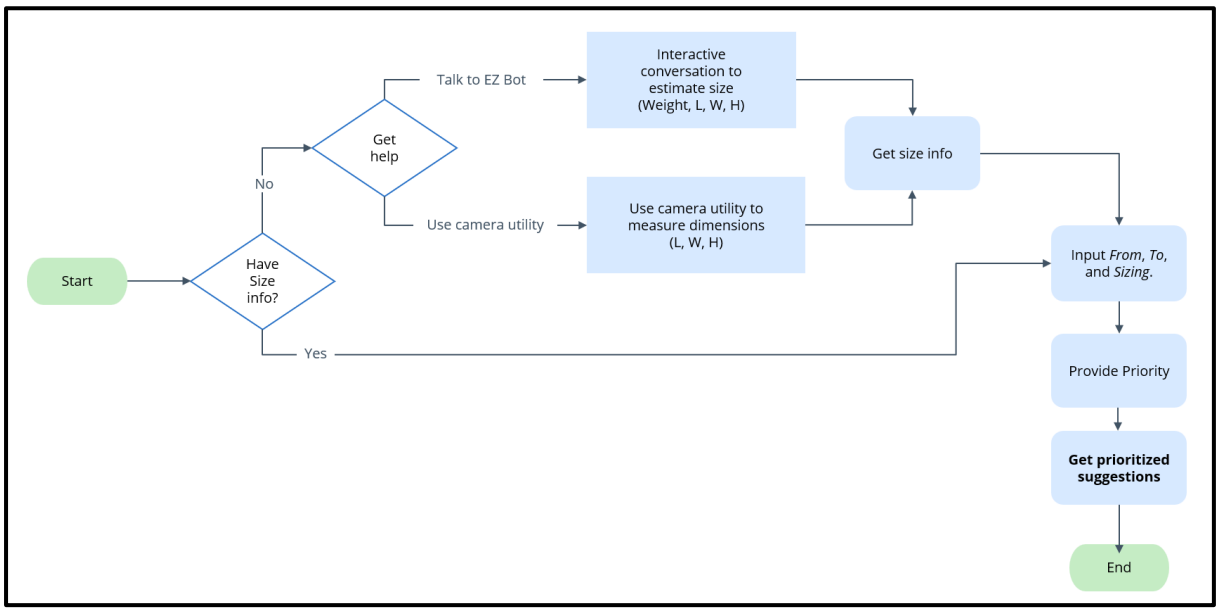
At the backend, once the user input is submitted from the web page, they will be analysed and processed, and logistics service information will be recommended accordingly by the rules engine. The result will be displayed on the webpage to the users. The users can further refine the results on the result page with the filter panel on the left.



In the next two subsections, we will elaborate on both user flow and technical solution architecture.

5.1 User Flow

From user perspective, this is how they can use the system as illustrated in the flowchart below.

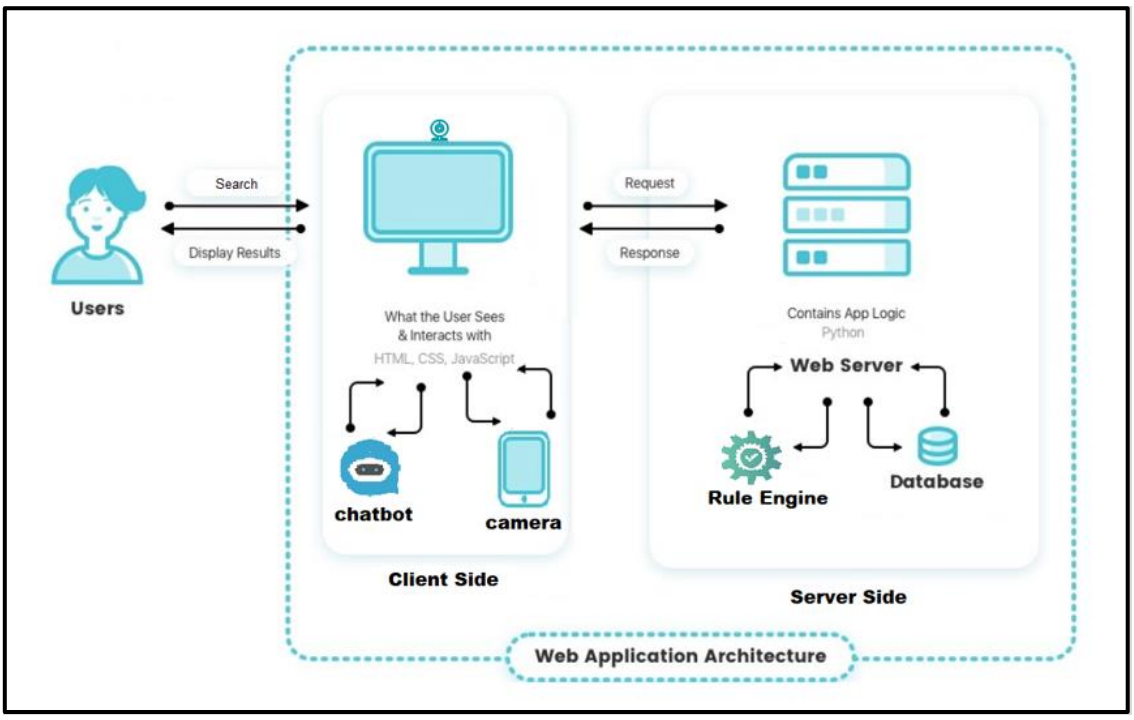


1. To start with, we check if the user needs help with getting size info of the items they want to send. If they don't have size info and needs help, we have two tools that can help.
2. Helper tools
    a. Chatbot. Through a conversation with the user, the chat is able to understand what the user trying to send and provide a recommended box size and weight as input for the rules engine.
    b. Camera Utility. User can connect their mobile phone through Wi-Fi to allow the utility to use phone camera. The length and width of the object can be measured. By rotating the object, the user can measure all sides of the object, namely length, width and height. This is an alternative to get size info for the next steps.
3. Fill in package delivery information, including From, To, Length, Width, Height and Weight.
4. Fill in other requirements such as priority and preferred mode of transportation.
5. Submit the form and get recommended courier services for different company sorted based on priority.
6. Users can further filter the result if they want.

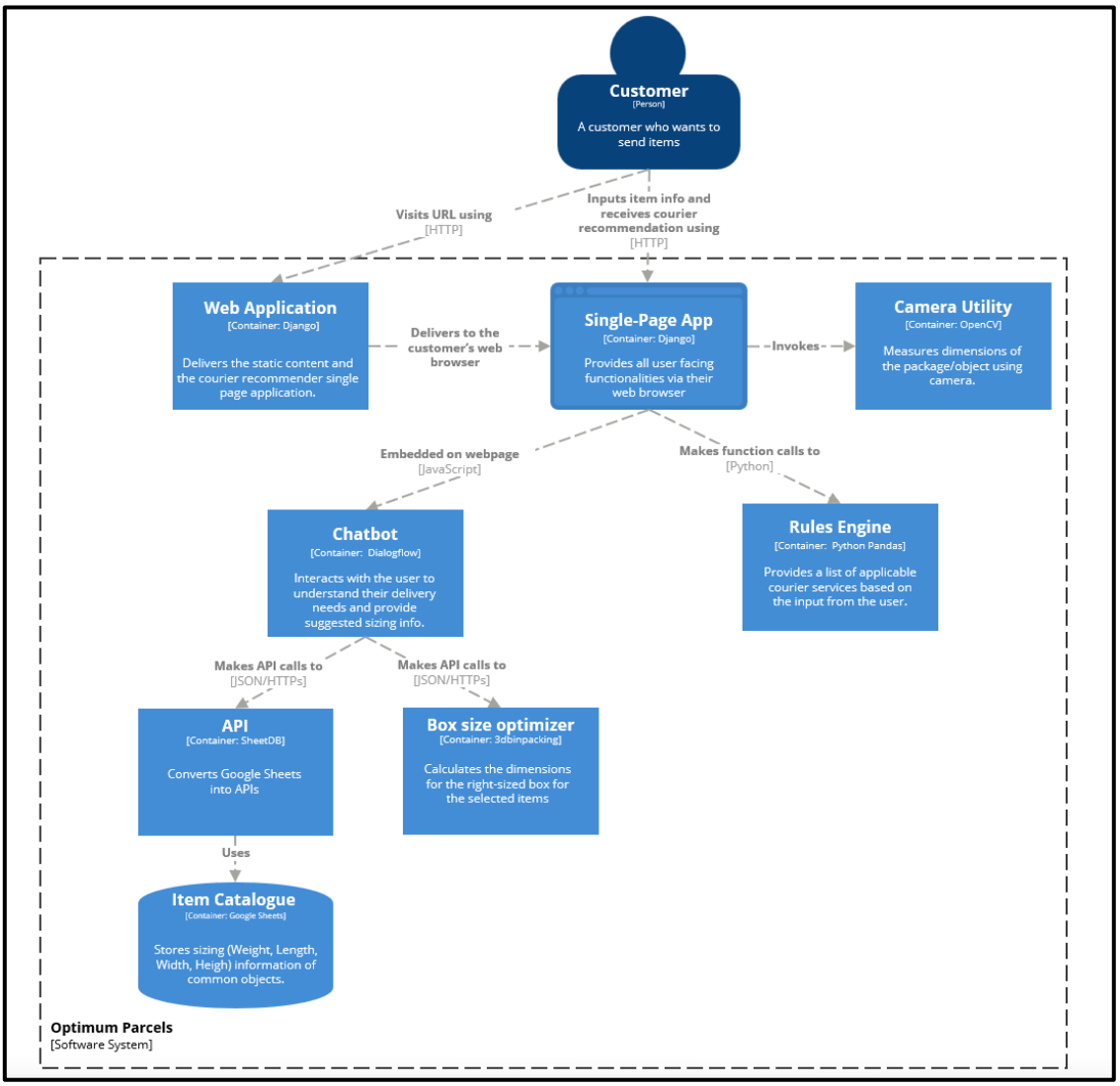
5.2 Solution Architecture

5.2.1 System Architecture

Below is the architecture diagram for our intelligent system. Users interact with client side embed with chatbot and connect with the phone's camera through Wi-Fi to get the corresponding dimensions. After filling all the required information, a request will be made to server side to fetch data through rule engine and database, then the data with all the details will be returned to client side in list format and display to user.

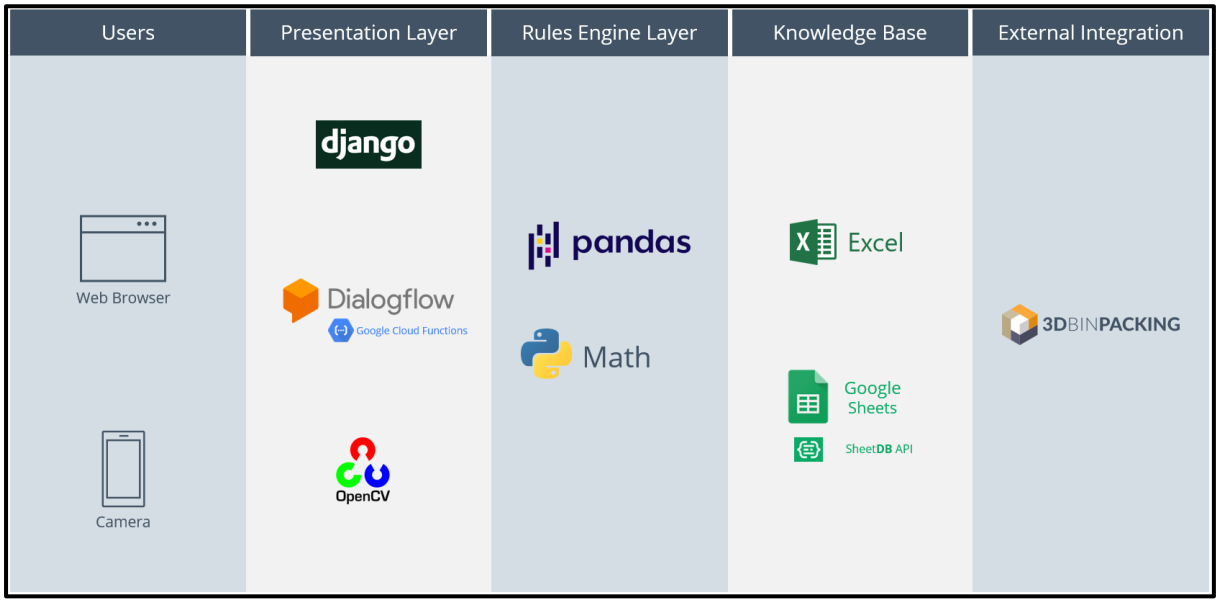


Following the C4 model for system architecture diagrams, the complete system architecture (at container level) is represented below.



5.2.2 Technology Stack

The system is built with the technologies summarized in the picture below.



Users

- **Web Browser**. Users can use web browser to access the system.
- **Mobile**. They can also use their mobile phone camera to measure item dimensions.

Presentation Layer

- **Django**. There is a web UI that users can visit and interact with. The UI is based with Django framework.
- **Dialogflow**. On the web page the user interacts with, there is an embedded chatbot pop-up window for the users to talk to the chatbot. The chatbot is built with Google Dialogflow.
- **Google Cloud Functions**. To extend the capability with custom fulfilment functions, a webhook hosted on Google Cloud Functions is implemented. APIs calls to external systems are implemented here.
- **OpenCV**. There is also a camera utility as an experiment. It is built with OpenCV. It detects the length and width objects.

Rules Engine Layer

- **Pandas**. Data from knowledge base for each logistics company are loaded into Pandas data frame for further processing.
- **Python Math library.** The calculation and filtering functions for generating the recommended logistics services and their pricing.

Knowledge Base

- **Excel**. Knowledge base for service and pricing information are stored in Excel.

- **Google Sheet**. The unit size information for the chatbot to retrieve is stored on Google Sheet.
- **SheetDB**. SheetDB turns Google Sheet into an API.

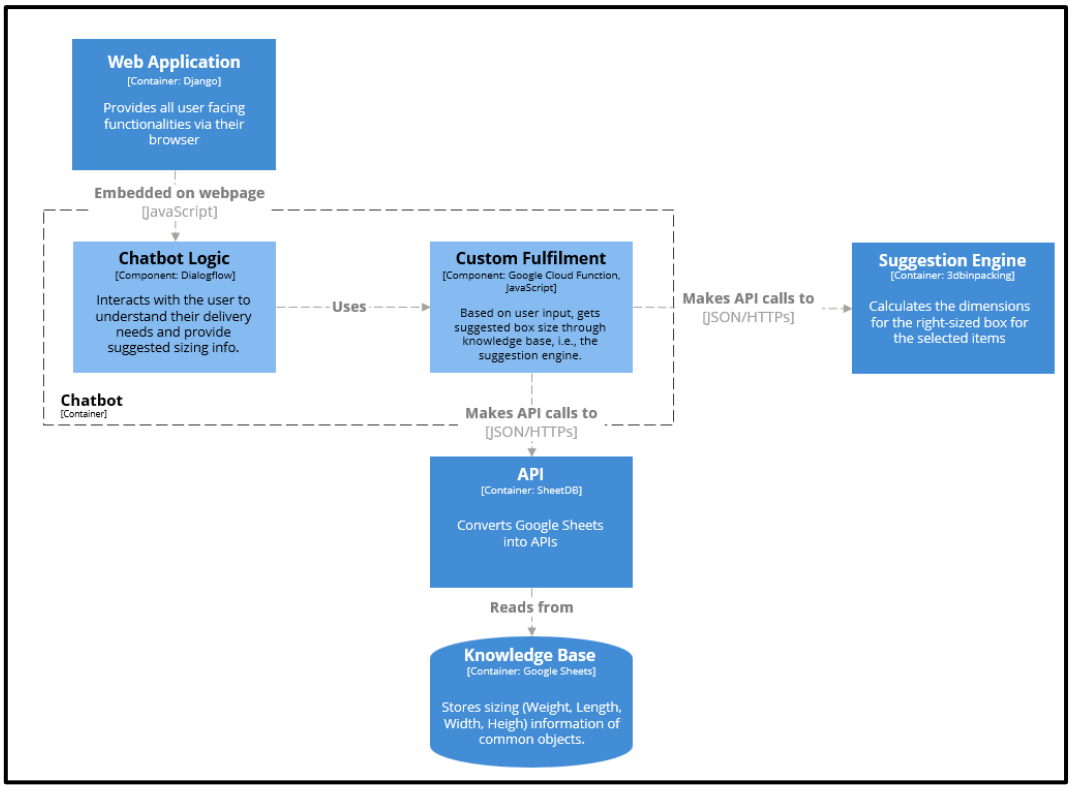
External Integration

- **3DBinPacking.** For calculating the optimal size for a box to pack all items to ship, we are using 3DBinPacking.

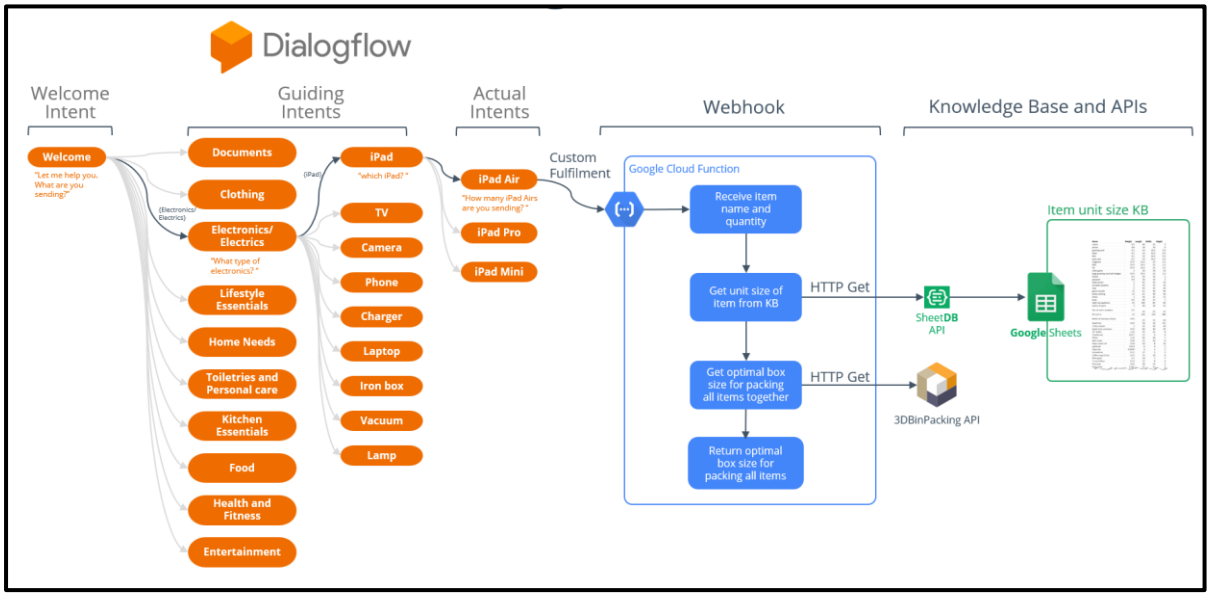
5.2.3 Chatbot Design

The purpose of the Chatbot is to help users gauge the size of the package needed to pack the items they are sending without the need to have the user measure the sizes themselves. Chatbot interacts with the user and within 4 questions, it can find out what the user is sending (e.g., iPad), the size (e.g., for iPad, is it iPad Air, mini or Pro) and quantity (e.g., 3 iPad Airs). It then retrieves the item unit size information from the knowledge base (0.5kg, L: 25cm, W: 18cm, H: 7cm). With the unit size and the quantity, the Chatbot then turns the users the recommended shipment sizing with a friendly message "For your shipment, please fill in the form with the following info: Weight: 1.5 kg, Length: 21 cm, Width: 25 cm, Height: 18 cm". User can then directly use this information to fill in the form on the web page and receive the recommended courier services for their priority.

To realise the outcome described above, the Chatbot is designed into the following components: Google Dialogflow for the chatbot engine, SheetDB + Google Sheet as the knowledge base, and 3DBinPACKING API for box size recommendation. They are represented in the diagram below following the C4 model.



The diagram below illustrates the implementation of our EZ Bot. It consists of a network of Intents, a webhook hosted on Google Cloud and two external APIs: SheetDB that turns Google Sheet into a database and 3DBinPacking.



The implementation details are elaborated in the 6.1.3 Chatbot (Google Dialogflow).

5.2.4 Camera Utility Design

Similar to the Chatbot above, the purpose of the Camera Utility is to help users determine the dimensions of the package they intend to ship in a simple manner. The Camera Utility gives the user the ability to quickly measure the dimensions of their package using just a webcam and a printout of a marker (which is used as a size reference). The camera utility is built using the OpenCV package available in Python and an Aruco marker, and has been adapted from this tutorial on Pysource.

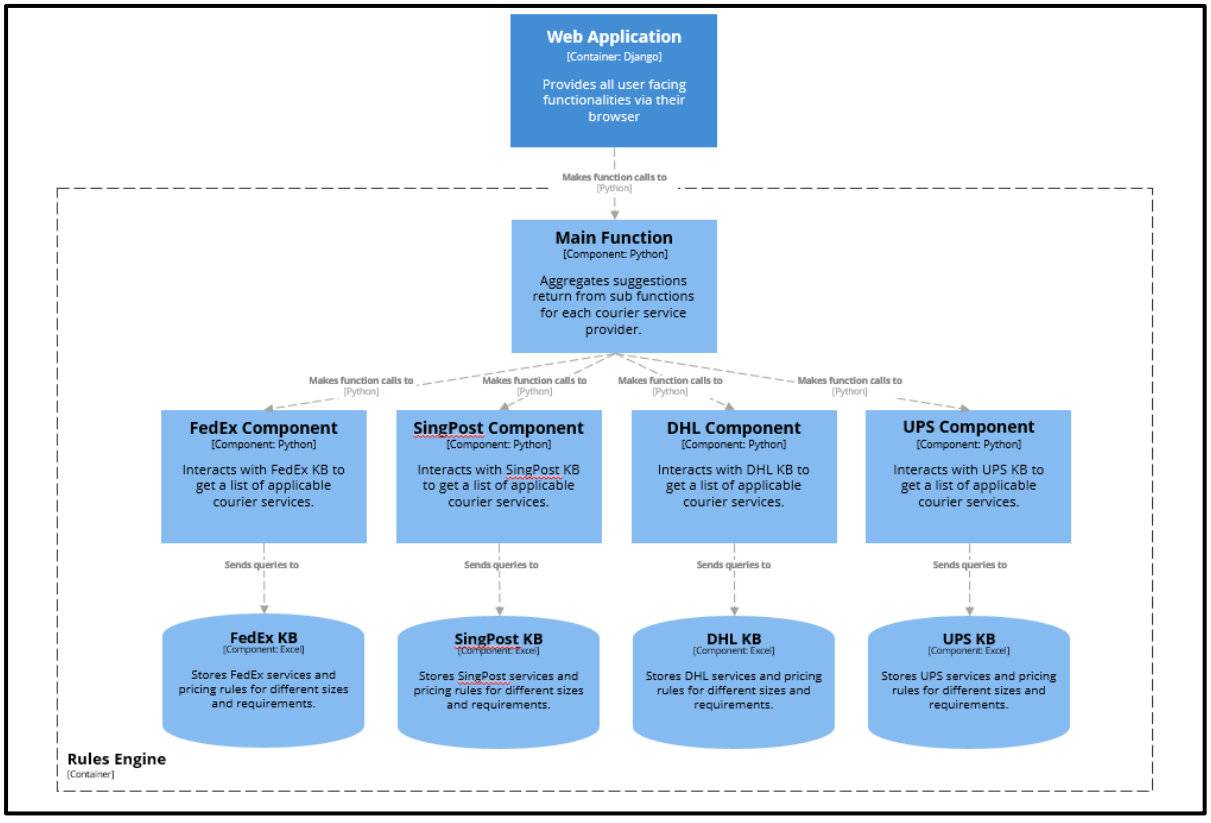
The utility requires the user to print out a marker (known as Aruco marker) and place it on a flat surface. The user is then required to place the package beside the marker and position the camera above the package and marker to take a picture/video. By using the marker as a size reference, the utility is then able to return the exact length and width of the package placed beside it in the picture/video frame. The user can then measure the height of the package by repeating the process by turning the package about its face. Having measured all the dimensions, the user can then continue to fill in the form on the web page to receive recommendations for shipping services best suited to their needs.

5.2.5 Rules Engine Design

The Rules Engine receives the parcel package details (weight, length, width, and height) and the destination country as inputs and provides a detailed list of all applicable services from four major global logistics companies (FedEx, DHL, UPS and SingPost) as the output. This

output list is then returned to the frontend webpage to be displayed to the user after being sorted according to their preferences (time or cost sensitivity, need for insurance, etc.). To achieve this objective, the Rules Engine relies on a few key components:

1. **Knowledge Base**. Individual knowledge bases were prepared for each of the logistics companies which include all details about the different services being offered by the company, such as the rates tables, the estimated transit times, zone tables for countries around the world, and other additional services like insurance and home-pickup.
2. **Rules Logic Component**. To access and extract the correct knowledge from each of the knowledge bases, individual rules logic components were prepared for each of the logistic companies. Each rules logic component incorporates all the conditions to calculate the service rates as outlined on the company website and in the available service guides.
3. **Aggregator Function**. The aggregator function performs the task of parsing the inputs to ensure they're in the correct formats, calling each rules logic component and receiving the relevant outputs, and aggregating these outputs together to return them to the system to be displayed to the user.



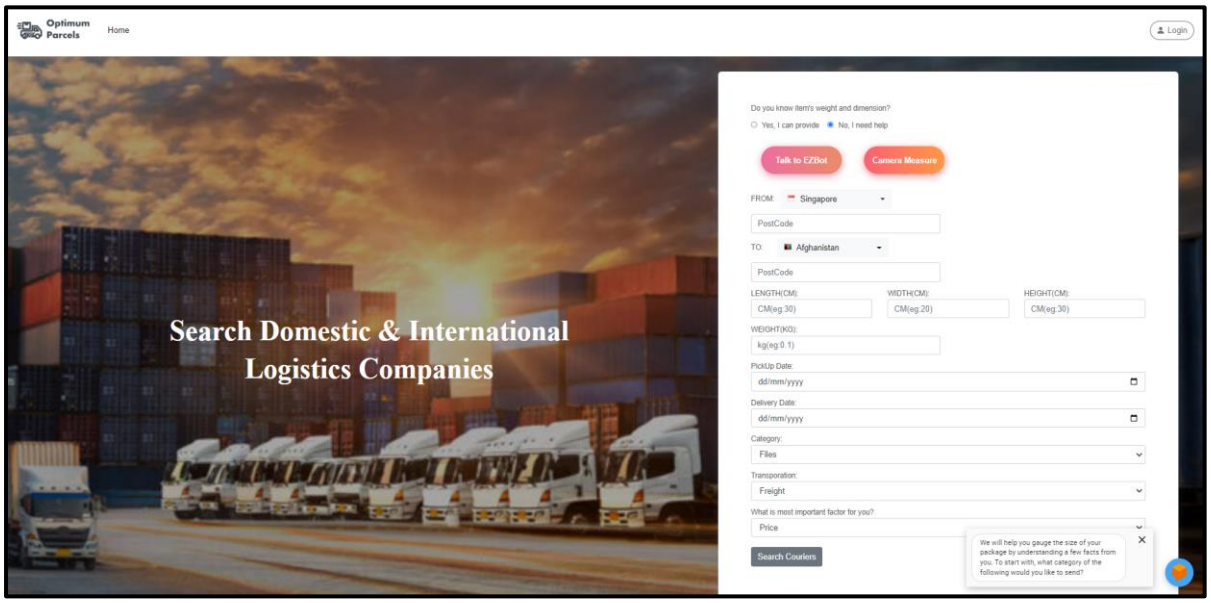
A key consideration for the design of the Rules Engine is to provide ease of addition (and removal) of logistics companies into the system in future. Implementing this design in a modular way as described above helps to achieve this objective to a large extent. A new logistics company can easily be incorporated into the system by simply creating a relevant Knowledge Base and a Rules Logic Component, and then including a call to the component from the Aggregator Function.

6 Project Implementation

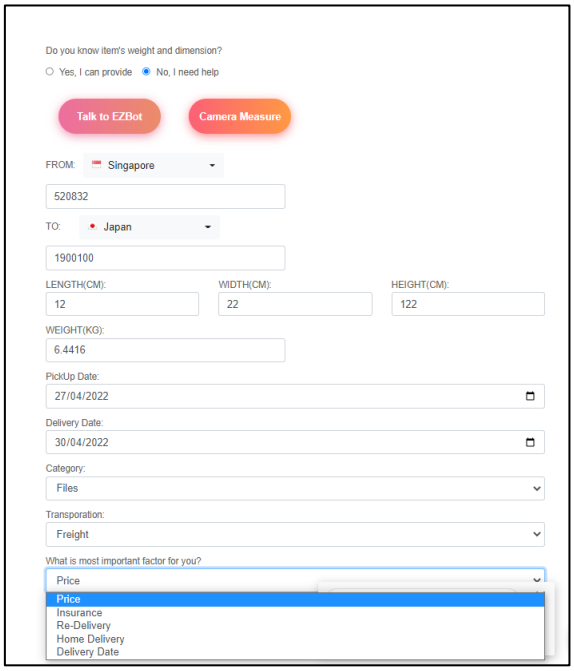
6.1 System development

6.1.1 Web development

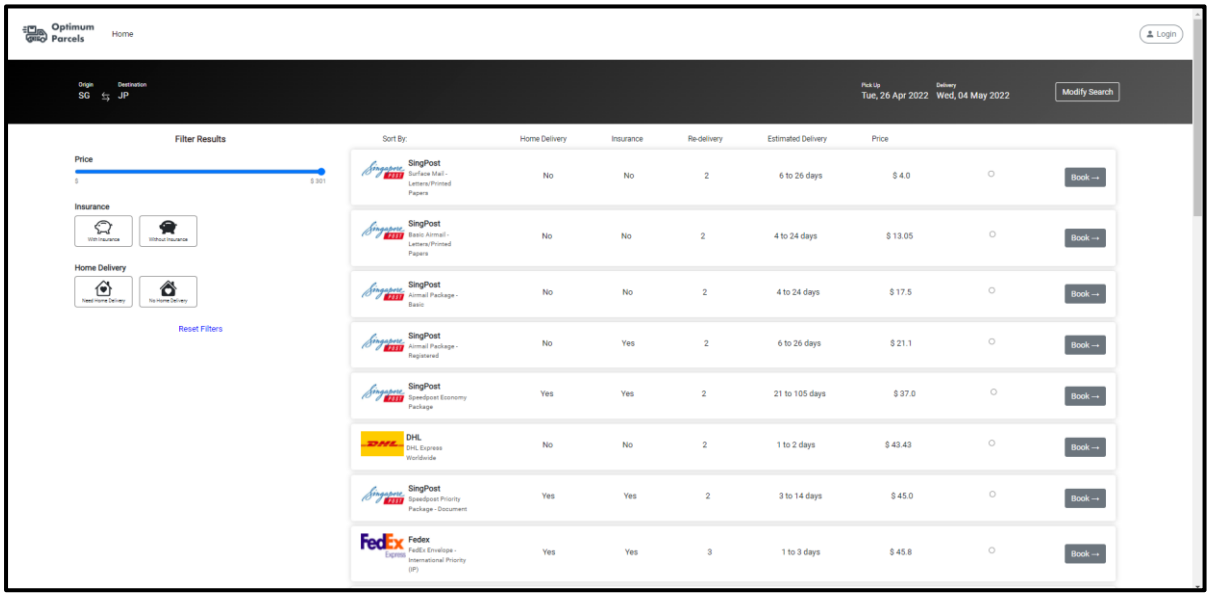
A website is built using Django framework, which allows users to key in the departure and destination and details of the parcel they plan to send, chat with Chatbot or using camera to get the item dimensions, search for certain logistic company, filter the results based on their priorities (i.e., price, home delivery, insurance, etc.), and select the most suitable option/logistic company service based on his/her own requirement.



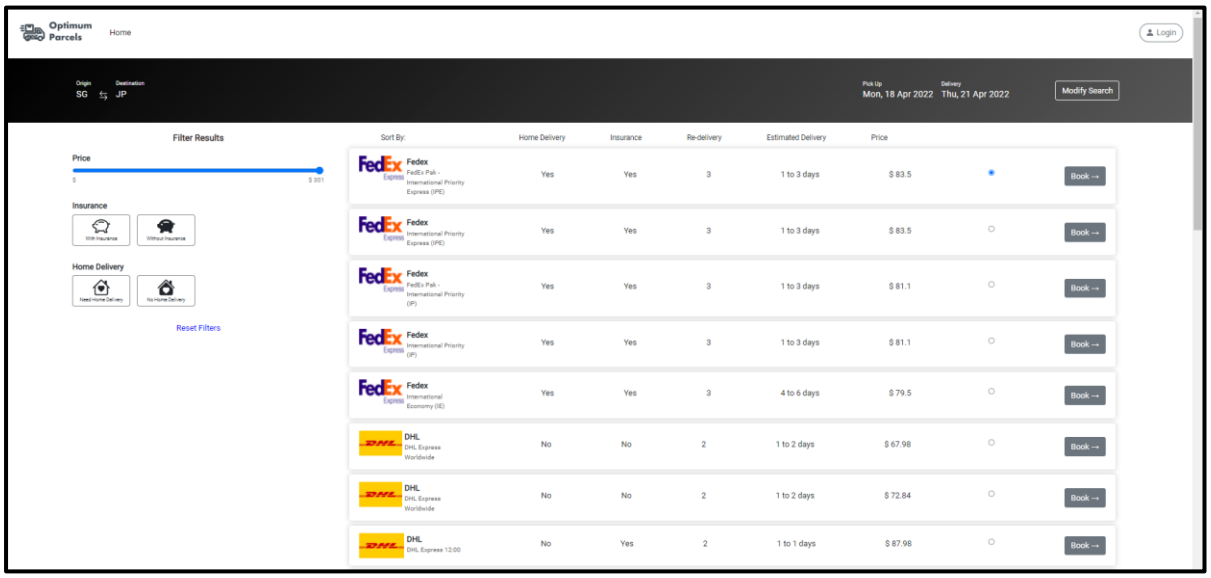
Given length, width, and height, system will automatically calculate volumetric weight (length x width x height (cm) / 5000) of the item. Alternatively, the user can key in the weight of the item manually if they have information on hand.



System will list all available courier options based on user's preference. In this case, price is selected as user's most important factor for their courier choice thus Sing Post which has lowest price offered was displayed in the top.



If user selects re-delivery as most important factor for his choice, table displayed will show courier which has highest re-delivery option available as per below.



User can further filter the search result by using price range or insurance/home delivery requirements.

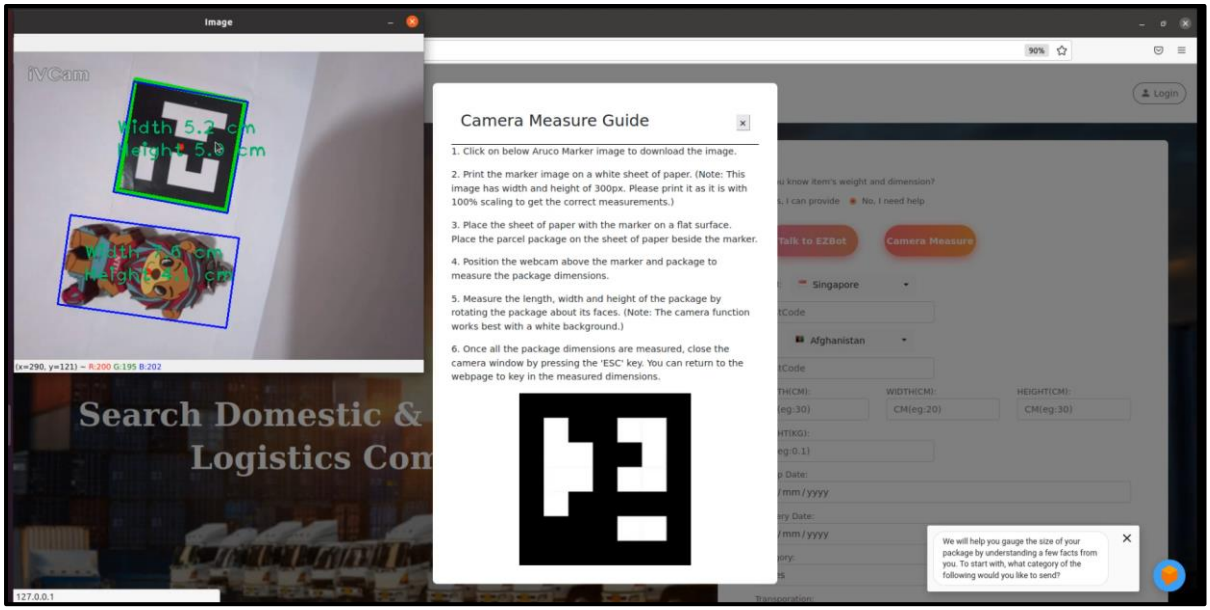
In the case user is not aware of the parcel's size (height, length, and width), we are also providing two options for users to measure.

1. This application will use object detection model using OpenCV and Aruco marker to measure item's height, length, and width.
2. Dialogflow chatbot which will also use 3D Bin Packing API webhook to identify the item based on user's input.

6.1.2 Camera Utility

As mentioned above, the Camera Utility serves the purpose of helping the users determine the dimensions of the parcel package. The utility is built using the OpenCV library available in Python and an Aruco marker, and has been adapted from this tutorial on Pysource.

In order to use the camera utility, the user may click the 'Camera Measure' button available on the webpage. The button would enable a pop-up window which guides the user through a step-by-step process on how to measure the package dimensions using this utility. The user is required to print out the provided Aruco marker image without changing the scaling (ie. 100% size). The marker image and the parcel package should then be placed on a flat surface next to each other, and the camera should be positioned above them. By using the marker as a size reference, the utility is then able to return the exact length and width of the package placed beside it in the picture/video frame.



The functionality of this utility can be explained by unpacking a few key components that are used within this utility. Firstly, the utility employs a simple object detection model (available within OpenCV library) to detect edges of objects placed within the picture/video frame. A simple minimum area rectangle is then estimated around this detected object, and the dimensions of this rectangle are determined in pixels. The utility also employs the Aruco functions (available within OpenCV as well) to detect the predefined square-shaped marker within the picture/video frame, which has the dimensions of 5cm X 5cm when printed without any changes in scaling. As the dimensions of the rectangle around the detected object and the Aruco marker have now been determined in pixels, the real-world dimensions of the object (in cm) can easily be calculated using simple proportions.

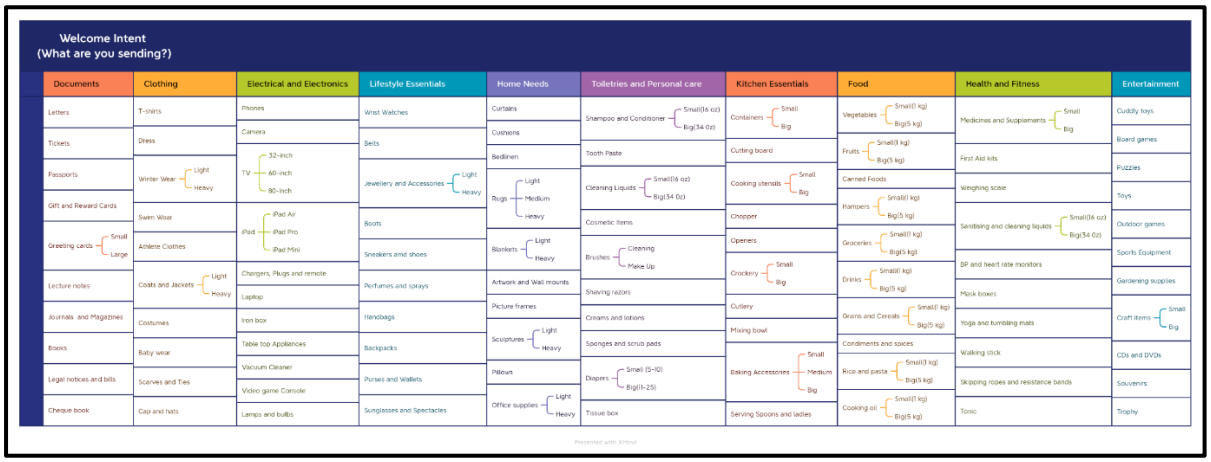
To enhance the user-experience of this utility function even further, we recommend using the iVCam application instead of the laptop embedded webcam to measure the package dimensions. iVCam allows the user to convert their handheld device into a laptop webcam by directing the handheld device video feed to the laptop device via either a Wi-Fi connection or a USB cable. In order to achieve this, the application needs to be installed on both the

handheld device and the laptop, and both devices need to be connected to either the same Wi-Fi connection, or via a USB cable.

6.1.3 Chatbot (Google Dialogflow)

6.1.3.1 Intents

The core of the chatbot on Dialogflow is the intents. We make sure there is a properly structure of intents that provides users with a smooth conversation experience and quickly return to the users to desired information with intelligence from the backend. For our implementation, we are able to provide recommended shipment sizing for 100+ commonly used and delivered types of items, saving the users the effort to measure it themselves. This list of item types can be easily expanded further by adding more intents and more entries in the knowledge base. To provide the user with the experience, a structure of 180 intents is implemented in Dialogflow. As illustrated below:



With the Welcome intent, the user is asked about the category of the item to be sent. Based on our market research, we have concluded with a list of 10 categories. This is by no means exhaustive but it covers most of the items types. For exceptions that are not in the list, we also covered it with a general response which is elaborated later in this section.

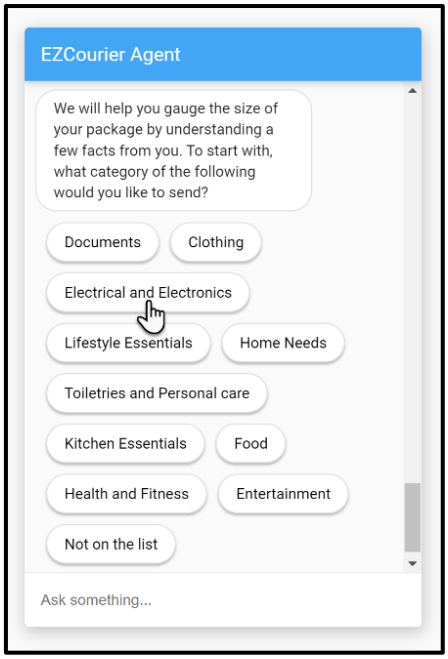
1. Documents
2. Clothing
3. Electrical and Electronics
4. Lifestyle Essentials
5. Home Needs
6. Toiletries and Personal care
7. Kitchen Essentials
8. Food
9. Health and Fitness
10. Entertainment

For each category, there is a list of common types of items. Some items also comes with different sizes. Below is a complete outline of the options implemented.

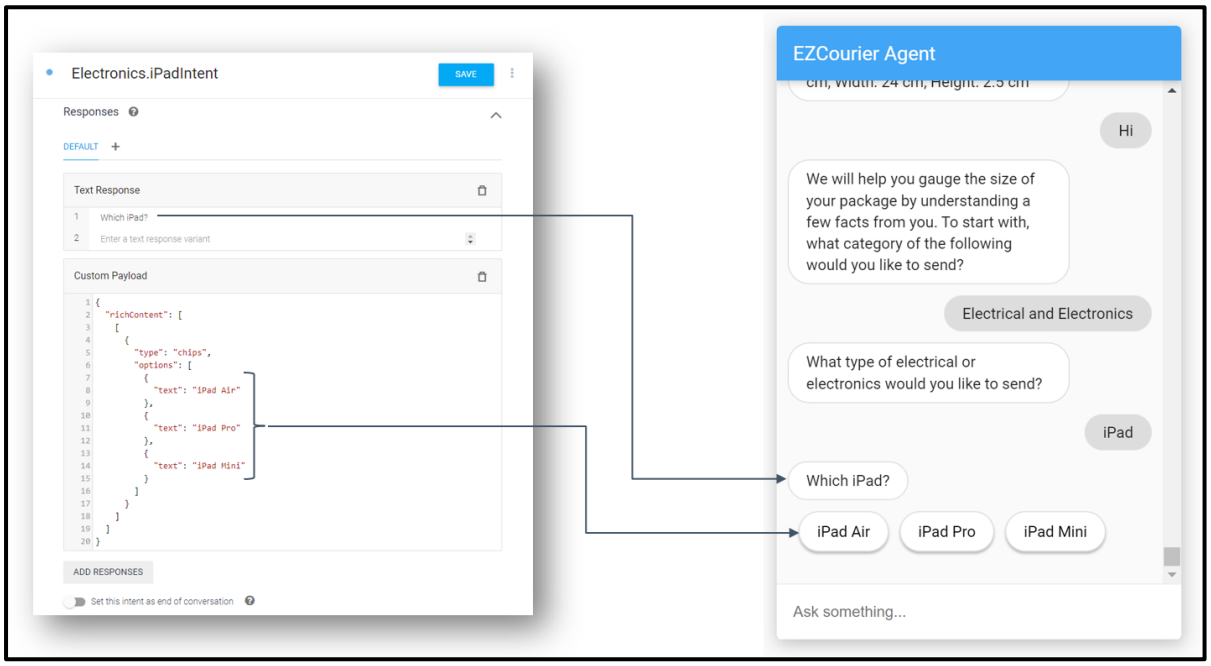
Chips

We have also used chips on the chatbot to guide users in providing answers. The chip that user clicks will become the input to chatbot that has been well mapped to the right intent. This has two benefits:

1. It helps users decide faster. The user does not need to think hard. They just need to choose from the given options.
2. It eliminates user errors such as typos or very rare items that are not covered by the chatbot.

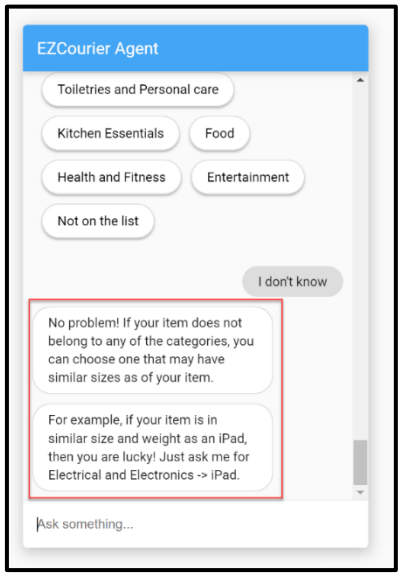


This can be implemented through the custom payload for response.



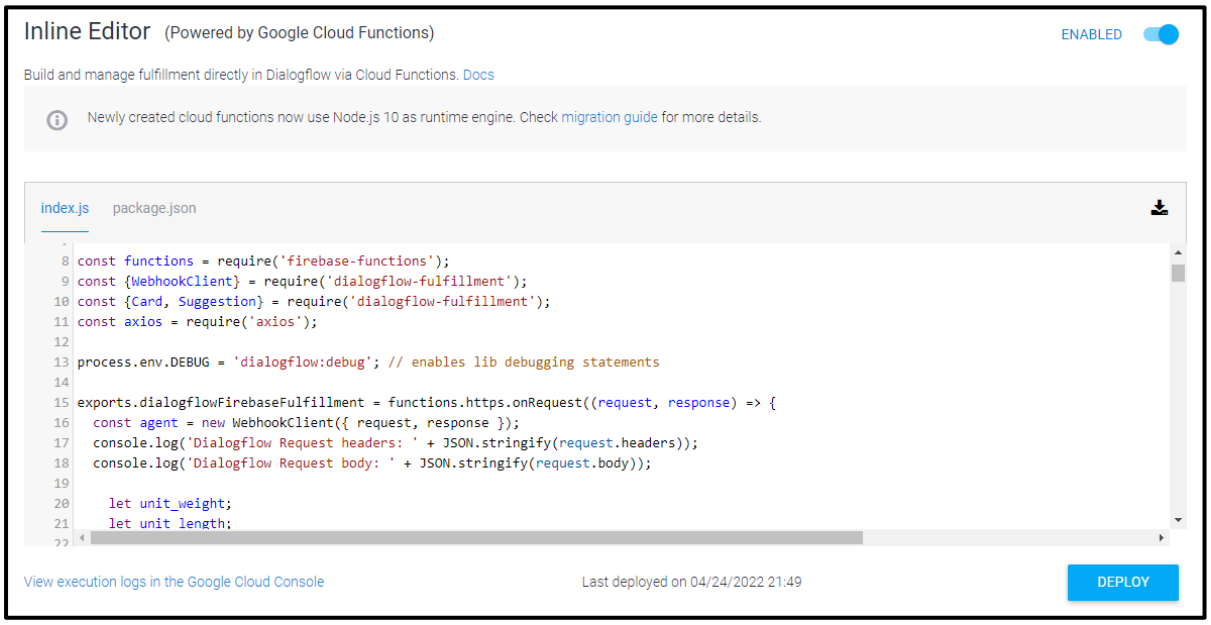
Exception handling

No matter how well the chatbot is designed and how big the knowledge base is, there are always cases that cannot be covered. We have added the one option at the end of the list to cater for such scenarios. If the item the user is sending is not on the list, they can use “Not on the list”, or can just tell the chatbot “I have no idea”, our chatbot will let them know how our tool can still be helpful.



6.1.3.2 Webhook

A key requirement for the chatbot is to be able to retrieve data from a database. Dialogflow itself does not provide database functions that can fulfil our needs. However, it allows extension to the chatbot by implementing webhooks which essentially can call external APIs and process the returned data. The webhook is hosted on Google Cloud Function. In ES edition of Dialogflow, there is an inline editor to implement custom functions which is sufficient for our implementation. In the function, we added API calls can data handling logic to extend the capability of the chatbot.

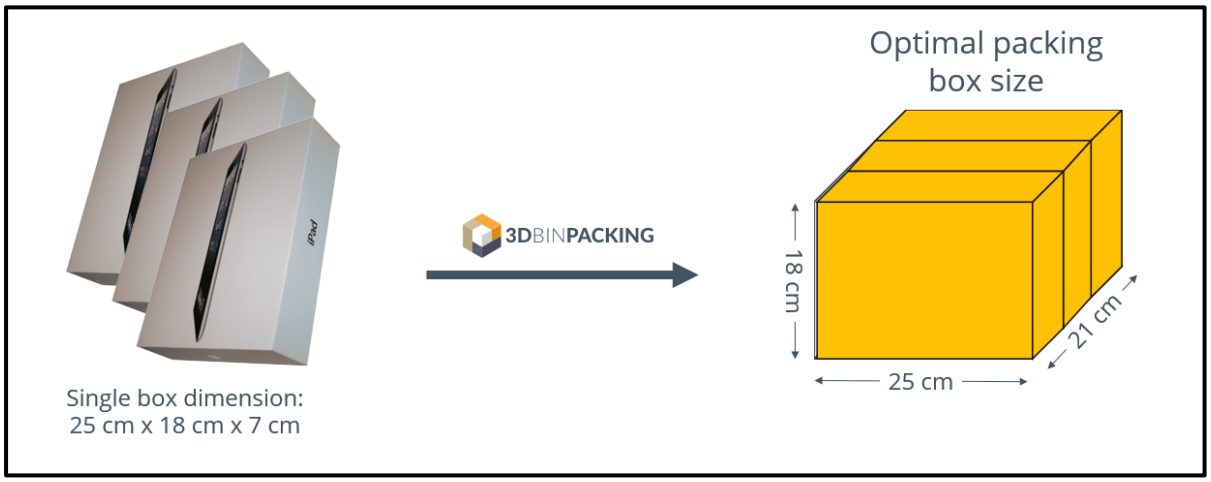


6.1.3.3 Database integration for Chatbot

As the chatbot can be extended with Google Cloud Function, we are able to build more complex functionalities into it. In our implementation, we have a knowledge base of the size information of 100+ types of items. We decided to store it in a Google Sheet. Through SheetDB, the Google Spreadsheet is turned into a JSON API.

6.1.3.4 Box size recommendation

To provide the optimal sizing for a box to pack all the items to be shipped, we have also included 3DBinPACKING in our solution. Its API takes the unit sizing information (dimension and weight) as input and provides a recommended smallest box size. This makes sure that the user does not oversize the box, so that it helps optimizes the shipping cost.



6.1.4 Rules Engine

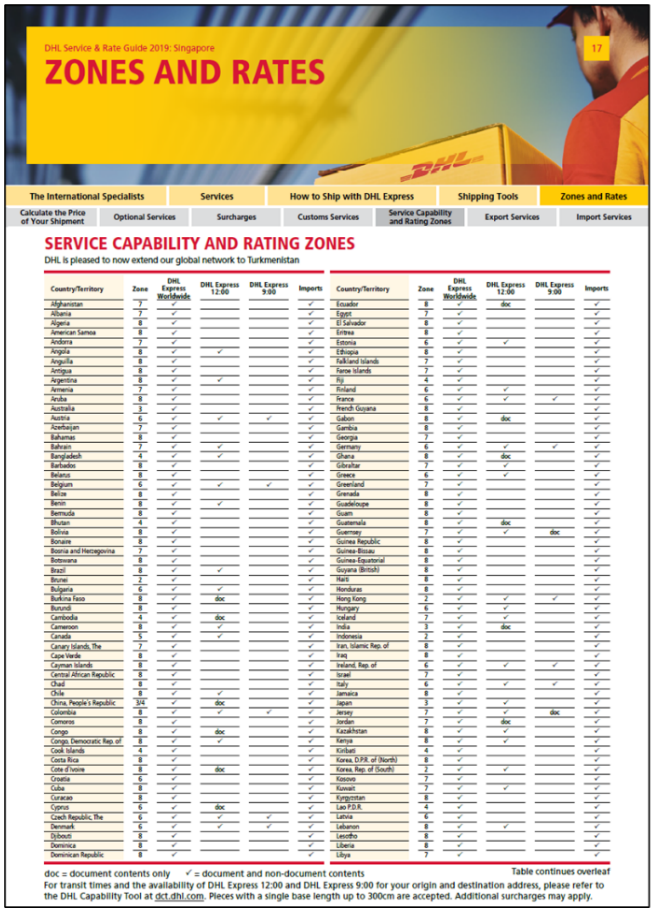
As explained in the sections above, the Rules Engine consists of three key components: the Knowledge Bases, the Rules Logic Components and the Aggregator Function.

6.1.4.1 Knowledge Base

The Knowledge Bases (KBs) for all logistics companies were prepared using Microsoft Excel. A key consideration in the choice of MS Excel as the tool to be used in the preparation of these KBs was the fact that the KBs had to resemble the tabular structure seen in the published service guides as closely as possible.

The KBs were mostly prepared from the information available on the logistic companies' websites and contained within their published service guide documents. It was important for the KBs to resemble the service guides as closely as possible, so as to allow for quicker updates and maintenance should the details (service rates, zone divisions, etc.) in the service guides change in the future. As shown in the sample image below, the DHL service guide lists all their services to various countries around the world according to zone divisions in a table. The KB

prepared using MS Excel resembles this table structure quite closely, thus allowing for easier understanding by anyone who is familiar with the DHL service guide.



	A	B	C	D
1	Territory	DHL Express Worldwide	DHL Express 12:00	DHL Express 9:00
3	Afghanistan	7		
4	Aland Islands			
5	Albania	7		
6	Algeria	8		
7	American Samoa	8		
8	Andorra	7		
9	Angola	8	8	
10	Anguilla	8		
11	Antarctica			
12	Antigua and Barbuda	8		
13	Argentina	8	8	
14	Armenia	7		
15	Aruba	8		
16	Australia	3		
17	Austria	6	6	6
18	Azerbaijan	7		
19	Bahamas	8		
20	Bahrain	7	7	
21	Bangladesh	4	4	
22	Barbados	8		
23	Belarus	8		
24	Belgium	6	6	6
25	Belize	8		
26	Benin	8	8	
27	Bermuda	8		
28	Bhutan	4		
29	Bolivia	8		
30	Bonaire, Sint Eustatius and Saba	8		
31	Bosnia and Herzegovina	7		
32	Botswana	8		
33	Bouvet Island			
34	Brazil	8	8	
35	British Indian Ocean Territory			
36	Brunei Darussalam	2		
37	Bulgaria	6	6	
38	Burkina Faso	8	doc	
39	Burundi	8		
40	Cape Verde	8		
41	Cambodia	4	doc	
42	Cameroon	8	8	
43	Canada	5	5	
44	Cayman Islands	8		
45	Central African Republic	8		
46	Chad	8		
47	Chile	8	8	
48	China	3	doc	
49	Christmas Island			
50	Cocos (Keeling) Islands			
51	Colombia	8	8	8
52	Comoros	8		
53	Congo, the Democratic Republic of the	8	8	
54	Congo	8	doc	
55	Cook Islands	4		
56	Costa Rica	8		
57	Croatia	6		
58	Cuba	8		
59	Curacao	8		
60	Cyprus	6	doc	
61	Czech Republic	6	6	6
62	Cote D'Ivoire	8	doc	

Shipment Rates - DHL Express WW | Zone Index

6.1.4.2 *Rules Logic Components*

The Rules Logic Components for all the logistics companies were written in Python, and the pandas library was used to read the KB Excel files as dataframes into the system. A few alternatives to implement the rules logic, such as Drools and PyKE rules engines, were considered and evaluated at the beginning stages of the project. However, they were not chosen for the final implementation due to the fact that Python is a familiar tool that provides the range of versatility in logic needed for this task. Another reason for not choosing the rules engines mentioned above was the sheer number of rules that would have to be programmed in order to create these logic components for each logistic company.

6.1.4.3 *Alternative Approaches*

As an alternative to the KBs and Rules Logic Components, various APIs provided by the logistic companies were also explored as a potential way to fetch all relevant details of shipping services for given inputs of the parcel packages. However, this proved to be an unfruitful approach, as only the APIs provided by FedEx returned useful details that could be used within the context of this project. APIs provided by DHL and UPS were not accessible by non-business users, while no APIs were provided by SingPost at all. So, in order to maintain consistency of approach across all shipping providers, we decided to create the KBs from scratch and then write the relevant Rules Logic Components to access and fetch the appropriate results.

6.2 Testing Approach

During the development process, we had different types of testing to make sure the system is working as expected. For our implementation, the two main types of testing were performed: Unit Testing and UAT Testing. The Unit Testing makes sure all the functionalities produce the expected result based on the input. Our Unit Test Cases cut cross the integrated system components so it in fact also covers System Integration Test. For example, in order for the chatbot to return the recommended box size for packing all the items to the shipped, all the following must be working correctly at the same time in the same test case:

1. The chatbot intents and their respective trigger for custom fulfilment powered by Google Cloud functions.
2. The custom functions on Google Cloud Function.
3. SheetDB API to retrieve data from the knowledge base stored in Google Sheets.
4. 3DBinPacking API to receive the current input and provides the output.
5. The output in returned to the Chatbot agent correctly to be displayed back to the user as a response.

The returned result will be filled into the web form by the user, so there is no system integration between the Chatbot and the web app. The function of the web app, and that of the Rules Engine retrieval, can also be validated through test cases from the web applications.

In this case, for the functional testing, we focused on the unit testing cases.

6.2.1 Unit Testing

The below are the methods we used to validate the functions are working as expected. For the Chatbot, before the commissioning of the final code, we had the following in the custom response based on the retrieved results.

During Testing

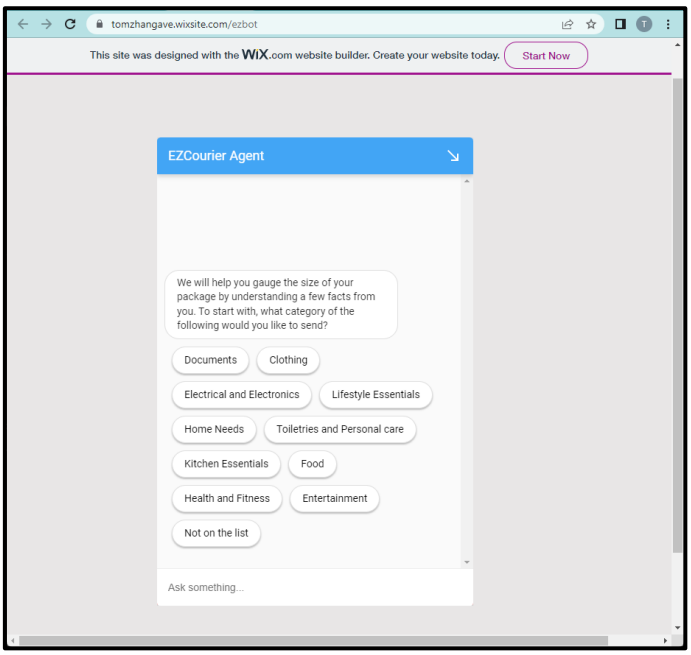
```
agent.add(`For ${quantity} of ${item}, please fill in the form with the following
info: Weight: ${final_weight} kg, Length: ${final_length} cm, Width: ${final_width}
cm, Height: ${final_height} cm`)
```

Final

```
agent.add(`For your shipment, please fill in the form with the following info:
Weight: ${final_weight} kg, Length: ${final_length} cm, Width: ${final_width} cm,
Height: ${final_height} cm`)
```

The `${quantity}` and `${item}` parameters are input from intents through the interactions with the users. Having these included in the response gives the tester the assurances that the desired parameters have been passed from the chatbot to the APIs based on user input.

For intents in Dialogflow that does not require integration with external APIs, we will be using a test site hosted on wix.com with the Dialogflow messenger integration experience. This is especially helpful for testing the chips in Dialogflow.



6.2.2 UAT

The developed Intelligent system was subjected to testing from end user/intended audience perspective. One cycle of UAT (end user testing)) had been performed to look for unidentified problems in previous rounds of testing. Test scenarios for UAT testing covered as many functional cases that end users would face. No bugs or issues were reported at the end of UAT testing and the system developed is tested to have met the end users requirements.

7 Project Performance & Validation

With this project implementation, we provide the users with the convenience of finding the right courier service at their fingertips, without the need to measure the dimensions and weight of the item, drastically reducing the amount of time needed. Based on our testing, using our system, the users can find the best courier service for their needs (weight and dimensions of the items) and based on their priority (e.g., short delivery time or cost-saving). Below is a comparison between the two scenarios:

Without Optimum Parcels		**With Optimum Parcels**	
Activity	**Time**	**Activity**	**Time**
1. Measure weight and Dimensions	**5 min** (with all tools at home) **Up to 2-3 hours** (To find the right tools to measure the items)	• Talk to EZ Bot	**1 min**
2. Search online to find all the possible choices and compare	**1 hour**. To search for courier service provider and compare them based on priorities.	• Fill in the form and get results.	**1 min**
Total time: 1 – 4 hours		**Total time: 2 minutes**	

8 Project Conclusions: Findings & Recommendation

8.1 Project Conclusion

After more than two months of effort, we have successfully finished the project meeting the objectives of the project design. More importantly, we have had the opportunity to apply what we have learned in the courses with actual complete implementation from scratch.

In this semester, we learned how software system can provide intelligent capabilities through cognition and reasoning. In the group project, we were able to implement a system that interacts with users through natural language and provide recommendation through backend processing with rules engine and knowledge base.

We take this as an essential extension to the workshops in the individual lessons which focused on specific knowledge points. With the implementation of the project, we went from problem selection, ideation, design, development, testing to marketing (with a video). This end-to-end go-to-market process has enabled us to take our knowledge learned in class to the next level and further prepared us to meet the needs in real world scenarios. We believe that with the practical project implementation on top of the courses in each of the graduate certificates in our MTech IS program, we will be well-positioned to solve real problems with complete ready-to-use solutions. We look forward to the learnings of next semesters.

8.2 Future Improvements

This implementation is an initial launch for the product. Given more time, the following areas can be further enhanced in the future releases.

1. **Tighter integration between Chatbot and Web App**
   After users interact with the chatbot and get recommended sizing information currently, they need to manually copy and paste the value to the web form. In the future, this can be built as an automated integration. Once the results are returned, they will be added to the webform directly.
2. **To cover even more complex rules**
   In the current implementation, this system is able to provide a recommended logistics list sorted based on the user's priority. More requirements and preferences from the user can be taken in consideration in the future. For example, allowing users to indicate whether the item is fragile or dangerous, which will result in additional cost and further filtering of services.
3. **To expand the coverage of logistics companies**
   FedEx, SingPost, UPD and DHL are implemented currently in this project to demonstrate functionalities for both local and international deliveries. It takes effort to add additional logistics company to our system. However, with the current solution design established, there is an established framework for adding additional logistics

companies. Based on market demand, the knowledge and rules engine for additional logistics providers can be added.

4. **Further explore in the camera utility for dimension measurements**
   Currently the camera utility with OpenCV is added as a good-to-have add-on for idea experimentation. There are still some restrictions of our system based on limited computer vision knowledge we have as of now. It remains a challenge to obtain accurate 3D dimensions through camera easily by users. The current utility uses a marker with a fixed size as the reference to give better 2D measurements. It requires the user to have the marker at hand (likely printed beforehand). For the long term, we should find solutions that eliminates the need for users to prepare the marker.
5. **Integration to logistics company website for direct booking**
   For the providers that have APIs, we are supposed to integrate with them directly. For the ones without APIs, it is better to redirect the users to the official website of the provider. In the solution, once the recommendation results are turned to the user, the user should be able to select the service and book from the respective logistics company. Our judgement is that this function is not critical as an Intelligent System project, but it is good to have for a production ready product that provides users with extra convenience. Given more time, the APIs of all logistics providers will be studied and added to the web application. Taking even one step further, there can also be a button print the waybill (which can be generated as PDF) for the respective company as well.

Apart from the main areas of improvements, there are also other items that are good to be kept in the product backlog:

1. **Parcel delivery tracking**
   This will transfer the platform from a recommendation-only platform into a one-stop shop for the customer's delivery needs: *Search for the best deliver service -> book the service* with payment -> *Track delivery -> Rate the delivery service*, all from one place.
2. **iOS and Android native mobile application**
   This will be a necessity when we expand the platform into a one-stop shop. Our patrons will be able to conveniently search for and manage courier services from mobile devices. For example, they can receive mobile push notifications for status change in tracking or there are cheaper services available for their saved search criteria.

9 Appendix A: Project Proposal

GRADUATE CERTIFICATE: Intelligent Reasoning Systems (IRS)

PRACTICE MODULE: Project Proposal

Date of proposal:
28 February 2022

Project Title:
ISS Project – Intelligent Logistic Company Recommender system

Sponsor/Client: *(Name, Address, Telephone No. and Contact Name)*
Institute of Systems Science (ISS) at 25 Heng Mui Keng Terrace, Singapore
NATIONAL UNIVERSITY OF SINGAPORE (NUS)
Contact: Mr. GU ZHAN / Lecturer & Consultant
Telephone No.: 65-6516 8021
Email: zhan.gu@nus.edu.sg

Background/Aim/Objectives:

Community quarantines, work from home and online classes due to COVID-19 have pushed people all over the world to resort to the use of courier services to buy their needs and essentials.

Logistics can be a pain point for many small businesses, and it can be challenging to decide which shipping company would best suit their business needs. There is a wide array of genuinely good choices as competition keeps increasing daily in the logistics industry.

We plan to address this issue by creating a **Logistic Company Recommendation Platform**, which will be comparing the shipping companies based on the services they offer to help customers decide the best shipping option suited to their needs.

Requirements Overview:

- Research ability
- Programming ability
- System integration ability

Resources Identified:
Hardware proposed for consideration:

- CPU

Software proposed for consideration:

- OS: Windows 10 or Ubuntu20.04
- Software: Python 3 and above (Django)
- Pertained machine learning models, e.g., Rules Engine
- Knowledge Base: Excel, Google sheet
- Rules Engine Layer: Pandas, Math
- Programming Libraries: OpenCV
- Machine learning use cases, e.g., Orange3, R

- Chat-bots e.g., Chat-bot
- Cognitive systems, e.g., Google DialogFlow
- Cloud computing/server, e.g., Google, Azure, etc.
- Application container, e.g., Docker

Number of Learner Interns required: (Please specify their tasks if possible)

A team of 5 project members

1. Hwang Sion
2. Danyang
3. Muniyandi Vanitha
4. Prerak Agarwal
5. Zhufeng

Methods and Standards:

Procedures	Objective	Key Activities
Requirement Gathering and Analysis	The team should meet with ISS to scope the details of project and ensure the achievement of business objectives.	• Gather & Analyze Requirements • Define internal and External Design • Prioritize & Consolidate Requirements • Establish Functional Baseline
Technical Construction	• To develop the source code in accordance to the design. • To perform unit testing to ensure the quality before the components are integrated as a whole project	• Setup Development Environment • Understand the System Context, Design • Perform Coding • Conduct Unit Testing
Integration Testing and acceptance testing	To ensure interface compatibility and confirm that the integrated system hardware and system software meets requirements and is ready for acceptance testing.	• Prepare System Test Specifications • Prepare for Test Execution • Conduct System Integration Testing • Evaluate Testing • Establish Product Baseline
Acceptance Testing	To obtain ISS user acceptance that the system meets the requirements.	• Plan for Acceptance Testing • Conduct Training for Acceptance Testing • Prepare for Acceptance Test Execution • ISS Evaluate Testing • Obtain Customer Acceptance Sign-off
Delivery	To deploy the system into production (ISS standalone server) environment.	• Software must be packed by following ISS's standard • Deployment guideline must be provided in ISS production (ISS standalone server) format • Production (ISS standalone server) support and troubleshooting process must be defined.

Team Formation & Registration

Team Name: **Team KICS**
Project Title (repeated): **ISS Project – Logistic Company Recommendation Platform**
System Name (if decided): **Optimum Parcels**
Team Member 1 Name: Hwang Sion
Team Member 1 Matriculation Number: A0249263Y
Team Member 1 Contact (Mobile/Email): e0938868@u.nus.edu
Team Member 2 Name: Li Danyang
Team Member 2 Matriculation Number: A0176203M
Team Member 2 Contact (Mobile/Email): e0224941@u.nus.edu
Team Member 3 Name: Muniyandi Vanitha
Team Member 3 Matriculation Number: A0249302L
Team Member 3 Contact (Mobile/Email): e0938907@u.nus.edu
Team Member 4 Name: Prerak Agarwal
Team Member 4 Matriculation Number: A0116711R
Team Member 4 Contact (Mobile/Email): e0938637@u.nus.edu
Team Member 5 Name: Zhang Junfeng
Team Member 5 Matriculation Number: A0249266U
Team Member 5 Contact (Mobile/Email): junfeng@u.nus.edu

For ISS Use Only		
Program Name:	**Project No:**	**Learner Batch:**
Accepted/Rejected/KIV:		
Learners Assigned:		
Advisor Assigned: Contact: Mr. GU ZHAN / Lecturer & Consultant Telephone No.: 65-6516 8021 Email: zhan.gu@nus.edu.sg		

10 Appendix B: Mapped System Functionalities against knowledge, techniques and skills of modular courses: MR, RS, CGS

Functionality	Knowledge, Techniques, Skills	Course
Business Rules	The Rules Engine consists of three key components: the Knowledge Bases, the Rules Logic Components, and the Aggregator Function. It uses Knowledge base of all logistics companies to make it easy to compare different perspective of courier offering given user's requirement for the parcel delivery.	Machine Reasoning
Chatbot	Chatbot is built on Google Dialogflow and takes in different types of user inputs and identifies intents of users to help find solution, in our case is dimension and weight of different types of items. We are using advanced features of Dialogflow for our solution. Webhook hosted on Google Cloud Functions allows the chatbot to access external APIs and further process data before returning to users. The chatbot also recommends the optimal box size to pack all items to ship with the help of 3DBinPacking.	Cognitive Systems, Reasoning Systems
Knowledge Discovery	Based on the user's preference in terms of price, delivery date, insurance, re-delivery, and home delivery, the application searches all available couriers and provides most suitable courier on the top of the list, providing recommendation best suited for their needs and sharing alternatives as well.	Reasoning Systems
Camera	OpenCV library, along with Aruco Marker are used to provide easy measure of the parcel size to the users using vision cognitive system. More improvements can be applied to this system after learning computer vision.	Cognitive Systems

11 Appendix C: Installation and User Guide

Please refer to below link for the installation and user guide:

https://github.com/SionsML/IRS-PM-2022-01-29-IS04PT-KICS-Optimum_Parcels/blob/master/ProjectReport/Installation%20%26%20User%20Guide_Team%20KICS.docx

12 Appendix D: Project Member Report

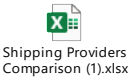
1-2 pages individual project report per project member, including: Individual reflection of project journey: (1) personal contribution to group project (2) what learnt is most useful for you (3) how you can apply the knowledge and skills in other situations or your workplaces

12.1 Hwang Sion

Name: Hwang Sion	Student ID: A0249263Y

Personal contribution to group project

- Performed analysis of different service providers and share with team.



- Learning and development of front and backend using Django and python.
- POC and integration of Dialogflow chatbot.
- Integration of Camera and Business rule engine function in front and backend.
- Installation & User guide document generation.

What learnt is most useful for you

- Learning and understanding overall workflow of front & back-end technologies and Javascript/HTML/CSS for the front end.
- Understanding how front and backend integration works in Django and python.

How you can apply the knowledge and skills in other situations or your workplaces

- I am working as Scrum master for the new web-based development project recently. Although work project is with React and Node.js, this experience can definitely help me gauge what is actual challenges in integration and plan better for the timeline of deliverable.
- Overall learning and understanding of front and backend development can be used again and will add value to next projects as well, as well as experience in integration with other team member's work.

12.2 Li Danyang

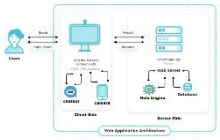
Name: Danyang Li	Student ID: A0176203M

Personal contribution to group project

- Composed 1st version project proposal, and my idea was selected by the team with the highest score after the voting

  Project Prososal_Logistic com

- Went to Singapore Post – General Post Office at Paya Lebar, took photos (Appendix F) and did the market research, tried to arrange an interview with them to understand customer behaviour better, however, it is not possible for them to do so
- Updated and composed the Logistics Customer Behaviour Study survey (Appendix G), and share the link to group chat in WeChat to get the responses, and analysed customer behaviour based on result
- Found the website template (i.e., flight project, as mentioned in Appendix E) and helped with 1st version home page development
- Figured out the way how to use the camera to measure objects with OpenCV and python without the need for calibration but using only the Aruco Marker standard (https://www.youtube.com/watch?v=lbgI2u6KrDU), how to use a phone camera through Wi-Fi connection, and embed the camera to the website which can be triggered via button click
- Composed the draft of the group project plan
- Draw the architecture diagram

- Made the web demo video with camera (https://nusu.sharepoint.com/:v:/r/sites/TeamKICS/Shared%20Documents/GrpPrj_IRS/Web_Demo_Video_20220425_Danyang.mp4?csf=1&web=1&e=GapYvy)

  Web_Demo_Video_20 220425_Danyang.mp4

- Made the business/marketing video using Animaker (https://www.youtube.com/watch?v=ZFsPG_avHy8)

  Business Video_Team KICS_20220427_Danya

What learnt is most useful for you

- Django which is a python-based web framework
- A new way to measure an object through camera using OpenCV library with python
- How to deal with problems and figure out the solution individually
- Better project management and high levels of execution of every member are required to finish this project on time and efficiently
- Never give up and try the best

How you can apply the knowledge and skills in other situations or your workplaces

- Chatbot is a good solution for can providing 24*7 support, which is efficient and saves manpower. Since I am also working for a logistic company, this maybe can be good idea for us to provide support
- Django web framework is quite useful with python as the programming language, which can be applied to future project in my company
- Those algorithms that we learnt in the classes are amazing, might be helpful to do data analysis or develop recommendation system in the future

12.3 Muniyandi Vanitha

Name: Muniyandi Vanitha	Student ID: A0249302L

Personal contribution to group project

- Performed Initial Analysis of different service providers in terms of services being offered and the factors to be considered.

MR_Logistics_Prj_Research.xlsx

- Created Knowledge base in Google sheet after conducting through research of commonly shipped items and gauging the dimension of boxes for packing those items. This KB was used by Chatbot developed as a part of the system.

Knowledge Base_Chatbot -DataLit

- Created Business/Marketing video using Animaker App.

https://youtu.be/bjEnNhT_x2g

Optimum Parcels_Business vide

- User Acceptance Testing
- Report and Project proposal writing.

What learnt is most useful for you

- Learnt different knowledge techniques and the application of those techniques in developing an Intelligent system.
- Learnt on the technologies (both front end and back end) like Django, Python and Google DialogFlow used in developing this system, though not directly involved in coding.
- Learnt to create Knowledge Base and build on a ChatBot.

How you can apply the knowledge and skills in other situations or your workplaces

- Gained overall learning experience that would be beneficial to provide solution for building an Intelligent System from Scratch, which can be applied in any industry or situation given.
- Exposure to different technologies (front end and back end) in building this expert system coupled with my extensive business experience would pave a new path in implementing AI solutions in my business.

- Exposure to more tech stack and libraries would help me make a better decision at work when deciding on technical solutions.

12.4 Prerak Agarwal

Name: Prerak Agarwal	Student ID: A0116711R

Personal contribution to group project

- Explored potential ways to create a rules engine to extract relevant shipping services details from logistic companies based on given parcel package details and destination country.
- Explored APIs provided by various service providers, such as FedEx, DHL & UPS, to fetch relevant shipping services, rates and transit times based on given parcel package details.
- Created knowledge bases and rules logic components for all service providers after conducting thorough research of each individual company's service offerings.
- Unpacked the camera function to measure package dimensions using OpenCV. Tweaked the logic and the user-experience to provide a more intuitive experience to the user.
- Explored ways to serve final project as Docker image. Created Docker images with all dependencies for easy serving.

What learnt is most useful for you

- Understanding knowledge bases and how rules can be applied in the most optimal way to fetch relevant information as quickly as possible.
- Learnt a new way to measure objects using OpenCV library using a predefined marker (Aruco) as reference for size dimensions.
- Learnt about Docker and how it can be used to serve entire projects with all dependencies to run seamlessly across platforms. Even though we did not end up using this method for this project, this is a new skill that will be very useful for me in the future.

How you can apply the knowledge and skills in other situations or your workplaces

- Working on a project like this in a multi-disciplinary team with each aspect of the project being handled by a different member presents a lot of challenges in terms of managing timelines and deliverables. Experiencing all of it in this project gave me exposure to potential conflicts and how to better manage the project deliverables and the interests/expectations of the various team members.
- Getting exposed to frontend and backend coding and integration (even though I did not work on it directly in this project) is useful for me as I can apply this knowledge in my work.
- Exploring technologies/tools like Docker and OpenCV are important for me to grow in my role as a data scientist.

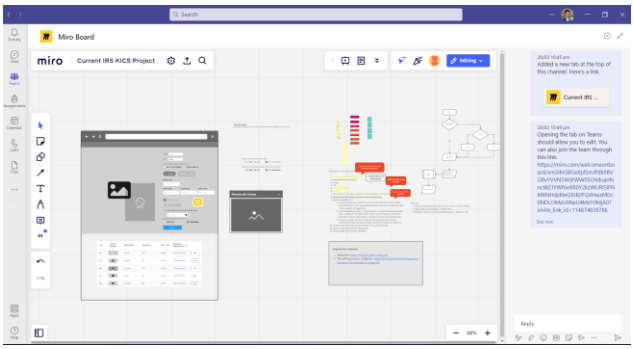
12.5 Zhang Junfeng

Name: Junfeng Zhang	Student ID: A0249266U

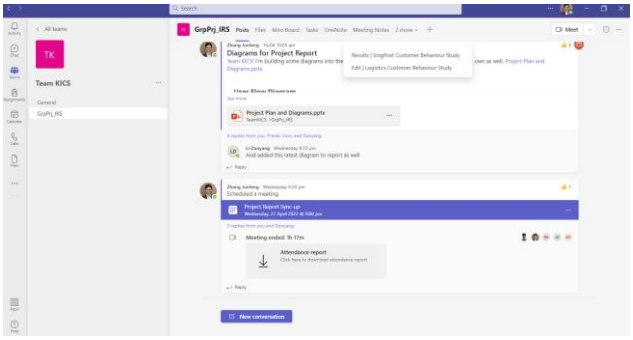
Personal contribution to group project

I played multiple roles in the project, trying to complement the team and bring the project to success.

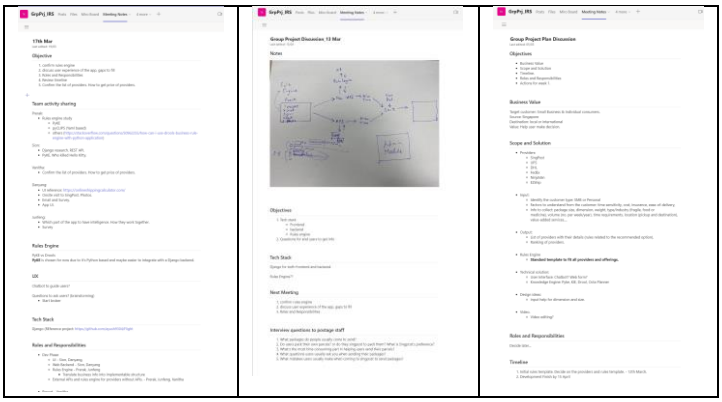
- **Solution Design**. I designed the solution architecture with the team. For the chatbot on Google Dialogflow, I designed and implemented the entire solution. I also provided UX/UI mockup on a Miro board which is a reference for Sion's web development.



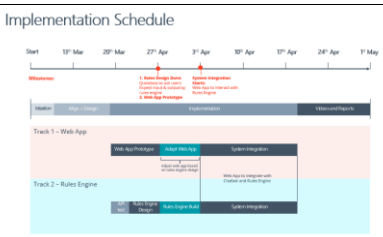
- **Project manager and collaboration enabler**. I want to make sure everyone can make positive contribution effectively, especially when everyone is juggling work, life, and study.
    - I built a workspace on Microsoft Teams to consolidate all collaboration (documents, materials, discussions etc.) in one place to facilitate efficient collaboration among team members.



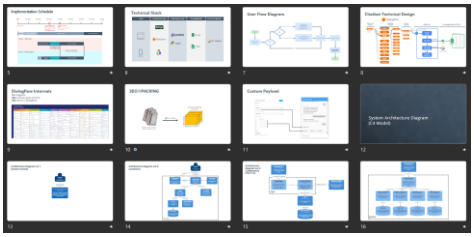
    - I initiated and organised all the discussion meetings. I took down the meeting notes and action items to make sure the outcome of our discussion is well preserved, executed, and utilised.



    - I kept track of project progress to make sure all milestones are delivered on time.



- **System implementation**. I implemented the technical solution for chatbot on Dialogflow and all the integration components (Custom Fulfilment function on Google Cloud Function, SheetDB + Google Sheets and integration with 3DBinPacking). (Credits to Vanitha for helping compile the list 100+ common item types with their unit sizes in Excel.)
- **System documentation.** I wrote the solution write-up for Chatbot, reviewed (and revised where necessary) our team's project report. Most of the system diagram and visualisation were built by me.



- For the technical presentation video……

What learnt is most useful for you

- I am now able to build a complex chatbot on Dialogflow for utilising custom fulfilment through a webhook. In the future, no matter it's personal project or even for work, Dialogflow will be one of the candidates, and I will be able to design and build it out.
- Although not used, I have researched and tried PyKE as a knowledge-based rules engine. It will be helpful for future implementation when it is applicable.
- I also learned about Django as a full-stack web development platform.

How you can apply the knowledge and skills in other situations or your workplaces

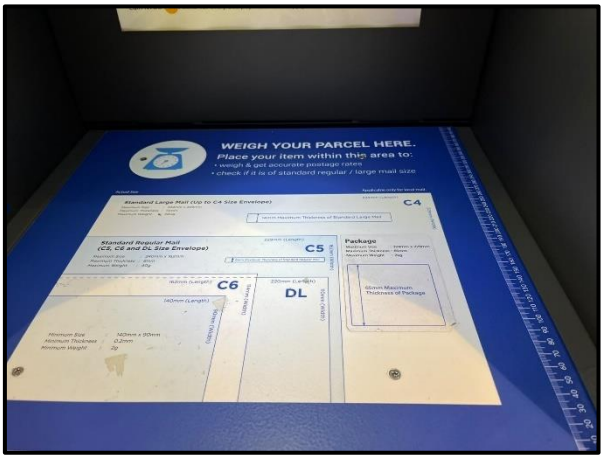
1. In the future, for personal projects or for work, Dialogflow will be one of the candidates, and I will be able to design and build it out, even for complex scenarios.
2. Having learned how a full-stack web application can be built using Django, it will help me built runnable POC/MVPs for project and solution ideas. Instead of just cells in Jupyter Notebooks.

13 Appendix E: References

1. Hillier, Lizzy. “Stats Roundup: The Impact of Covid-19 on Ecommerce.” *Econsultancy*, 19 Feb. 2021, econsultancy.com/stats-roundup-the-impact-of-covid-19-on-ecommerce/. Accessed 1 Mar. 2022.
2. Fryer, Victoria. “Understanding the COVID-19 Effect on Ecommerce + Trends.” *The BigCommerce Blog*, 12 Nov. 2021, www.bigcommerce.com/blog/covid-19-ecommerce/#covid-ecommerce-trends. Accessed 30 Mar. 2022.
3. Accenture. “Supply Chain Disruption & How to Respond | Accenture.” *Www.accenture.com*, 2021, www.accenture.com/us-en/insights/consulting/coronavirus-supply-chain-disruption. Accessed 1 Apr. 2022.
4. Content, Contributed. “Looking Ahead to the Post COVID-19 Supply Chain Ecosystem in Singapore.” *Singapore Business Review*, 31 Jan. 2022, sbr.com.sg/transport-logistics/commentary/looking-ahead-post-covid-19-supply-chain-ecosystem-in-singapore. Accessed 5 Apr. 2022BC.
5. “Find a Bin Size - Container Size Calculator | 3D Bin Packing.” *Www.3dbinpacking.com*, www.3dbinpacking.com/en/products/find-a-box-size. Accessed 23 Mar. 2022.
6. Canu, Sergio. “Measure Size of an Object | with Opencv, Aruco Marker and Python.” *Pysource*, 28 May 2021,
7. “FedEx | System Down.” *Fedex.com*, 2022, www.fedex.com/content/dam/fedex/apac-asia-pacific/downloads/fedex-apac-service-guide-en-sg.pdf. Accessed 1 Mar. 2022.
8. “FedEx | System Down.” *Fedex.com*, 2022, www.fedex.com/content/dam/fedex/apac-asia-pacific/downloads/fedex-how-to-pack.pdf. Accessed 1 Mar. 2022.
9. “Calculate Shipping Rates | FedEx Singapore.” *FedEx*, www.fedex.com/en-sg/online/rating.html#. Accessed 1 Mar. 2022.
10. “FedEx | System Down.” *Fedex.com*, 2022, www.fedex.com/content/dam/fedex/international/rates/fedex-rates-exp-en-sg-2022.pdf. Accessed 1 Mar. 2022.
11. “FedEx | System Down.” *Fedex.com*, 2022, www.fedex.com/content/dam/fedex/international/rates/fedex-rates-box-en-sg-2022. Accessed 3 Mar. 2022.
12. “FedEx | System Down.” *Fedex.com*, 2022, www.fedex.com/content/dam/fedex/international/rates/fedex-rates-if-en-sg-2022.pdf. Accessed 3 Mar. 2022.
13. “FedEx | System Down.” *Fedex.com*, 2022, www.fedex.com/content/dam/fedex/international/rates/fedex-rates-sur-en-sg-2022.pdf. Accessed 4 Mar. 2022.
14. “FedEx | System Down.” *Fedex.com*, 2022, www.fedex.com/content/dam/fedex/international/rates/fedex-rates-zi-en-sg-2022.pdf. Accessed 3 Mar. 2022.
15. “Singpost Local Delivery Services.” *Speedpost.com.sg*, 2022, speedpost.com.sg/what-we-offer/local-delivery.html. Accessed 3 Apr. 2022.
16. *Postage Rates & Mailing Guidelines*. Accessed 4 Mar. 2022

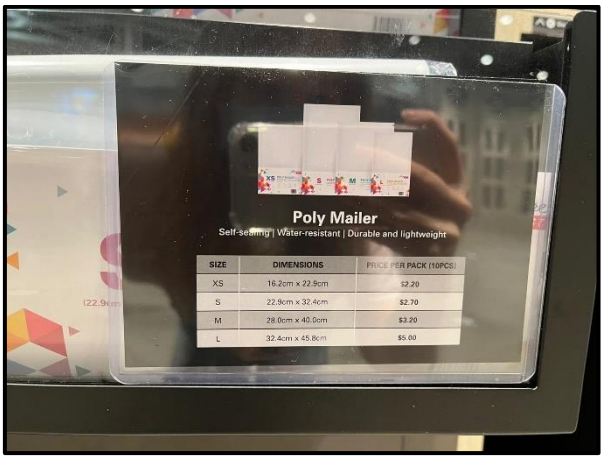
17. “SingPost -Speed Post-Send Overseas.” *Speedpost.com.sg*, 2022, www.speedpost.com.sg/sending/send-overseas.html. Accessed 3 Apr. 2022.
18. *Tracking (Web/Mobile) Delivery Speed Overview Service Guide ZONE a (Malaysia) ZONE a Delivery Time Guide*.
19. *DHL Singapore Service Guide 2019 - https://bh-estore.com/media/wysiwyg/shipping_rates/pdf/dhl_express_rates.pdf*
20. “Packaging Guide.” *Dhl.com*, 2022, www.dhl.com/discover/en-sg/how-to/packaging-guide. Accessed 3 Mar. 2022.
21. *International Shipping Services | UPS - Singapore.” Www.ups.com, www.ups.com/sg/en/shipping/international/services.page?. Accessed 3 Mar. 2022.*
22. *2022 UPS ® Domestic Rate and Service Guide Singapore Effective Daily Rates*. 2021. Accessed 3 Mar. 2022.
23. *2022 UPS ® Rate and Service Guide Singapore Effective Daily Rates*. 2021. Accessed 3 Mar. 2022.
24. Kumar, Ayush. “Flight.” *GitHub*, 4 Apr. 2022, github.com/ayush9304/Flight. Accessed 1 Mar. 2022.

14 Appendix F: Photos from SingPost Centre Observation Visit

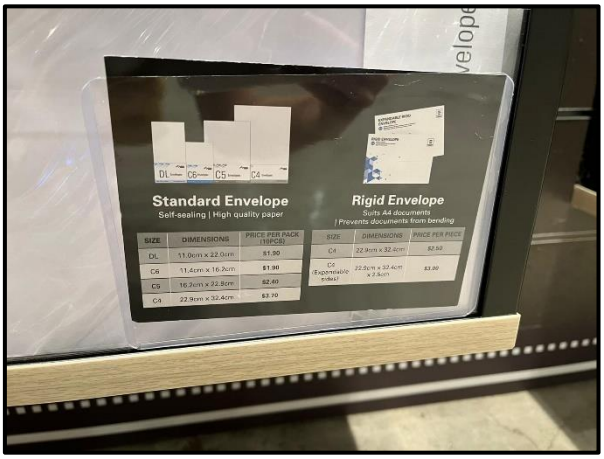



PACKAGING WITH LOCAL POSTAGE INCLUDED
QUALITY PACKING MATERIALS AND GIFTS


RE:POST
OLD UNIFORMS. NEW LIFE.
An upcycling initiative by SingPost
POLY MAILER SAMPLE
L POLY MAILER
M POLY MAILER
S POLY MAILER
XS POLY MAILER


Poly Mailer
Self-sealing | Water-resistant | Durable and lightweight
SIZE
DIMENSIONS
PRICE PER PACK (10PCS)
XS 16.2cm x 22.9cm $2.20
S 22.9cm x 32.4cm $2.70
M 28.0cm x 40.0cm $3.20
L 32.4cm x 45.8cm $5.00


22.9cm x 32.4cm
(Inner size: 20.9cm x 31.4cm)
Self-sealing | Extra protection
Fits into most letterboxes
S
Padded Envelope
Self-sealing | Extra protection
Padded Poly Mailer
Water-resistant | Extra protection


DL C6 C5 C4
Standard Envelope
Self-sealing | High quality paper
Rigid Envelope
Suits A4 documents
| Prevents documents from bending


FRAGILE
Foam Peanuts
Superior cushioning
| Lightweight and easy to use
Clear Tape
Durable and adhesive
| Ideal for sealing boxes or envelopes
Fragile Tape
Ideal for sealing parcels with fragile contents


Waterproof Paper | 89 x 120cm
$7.80
Easy-To-Fold Carton | 40 x 25 x 15cm
$5.60
Bubble Wrap (Small Bubbles) | 50 x 100cm
$7.30


BIRTHDA
ALL OCCASI

15 Appendix G: Logistics Customer Behaviour Study Survey

Survey can be accessed at https://forms.office.com/Pages/ResponsePage.aspx?id=Xu-lWwkxd06Fvc_rDTR-glPJ01lgiHpPsTzvgy-nGWRUQzhCSDU3SEw0WU4ySkRQN0NLSjZST0ZZMiQlQCN0PWcu

Logistics Customer Behaviour Study

The survey will take approximately 3-5 minutes to complete.

We would really appreciate it if you could help answer the following questions based on your previous experience. If you have friends/colleagues that don't mind helping please help forward this survey to them as well. This will be very helpful!

* Required

1. What type of packages (in terms of size, volume, and maybe typical common content) do you usually send? *

- [ ] Documents
- [ ] Clothing
- [ ] Electronics (iPad, phone, laptop, etc)
- [ ] Lifestyle Essentials
- [ ] Home Needs
- [ ] Toilteries and Personal care
- [ ] Kitchen Essentials
- [ ] Food
- [ ] Health and Fitness
- [ ] Entertainment
- [ ] Medicine
- [ ] Surgical mask
- [ ] Other

2. How do you usually choose logistics company when sending your parcels? *

- [ ] Recommendation from friend/colleague/family members
- [ ] Search Online via Google/IE
- [ ] Near your home/company
- [ ] You are the member of certain company
- [ ] Other

3. Which factor is most important to you when you choose a company? *

- ◯ Delivery days
- ◯ Price
- ◯ Includeing insurance or not
- ◯ Home Delivery
- ◯ Other

4. Do you pack your own parcels in most cases? Or do you expect counter staff to pack them? *

- ◯ Yes, I pack myself
- ◯ Yes, I prefer counter staff pack for me
- ◯ Other

5. Do you need to measure the size/dimension/weight of your parcel yourself? *

- ◯ Always
- ◯ Sometimes
- ◯ Seldom
- ◯ No need at all
- ◯ Other

6. If Yes for above question, what tool do you usually use to get the size/dimensions/weight?

- [ ] Linen tape
- [ ] Ruler
- [ ] Search online
- [ ] Weighing scale
- [ ]

Other

7. Which logistics company you normally use in below list? *

- [ ] UPS
- [ ] Fedex
- [ ] Singpost
- [ ] DHL
- [ ] DB SCHENKER
- [ ] BLUE DART
- [ ] uParcel
- [ ] Aramex
- [ ] SF Express
- [ ]

Other

8. Are you satisfied with the logistics company services for the companies in Singapore? *

- ◯ Excellent
- ◯ Good
- ◯ Just so so
- ◯ Unsatisfied
- ◯

Other

9. What aspect of logistics services in Singapore do you think needs improvement? *

- [ ] The best service, nothing to improve
- [ ] Wait for too long
- [ ] Item broken/damaged during the delivery
- [ ] Too expensive
- [ ] Other

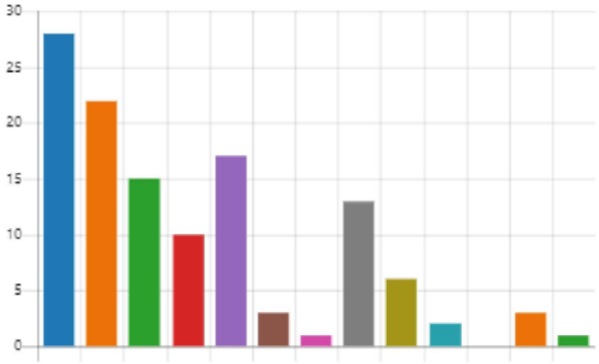
16 Appendix H: Logistics Customer Behaviour Study Survey Results Summary

Logistics Customer Behaviour Study

68	02:31	Active
Responses	Average time to complete	Status

1. What type of packages (in terms of size, volume, and maybe typical common content) do you usually send?

Documents	28
Clothing	22
Electronics (iPad, phone, lapto...	15
Lifestyle Essentials	10
Home Needs	17
Toilteries and Personal care	3
Kitchen Essentials	1
Food	13
Health and Fitness	6
Entertainment	2
Medicine	0
Surgical mask	3
Other	1



2. How do you usually choose logistics company when sending your parcels?

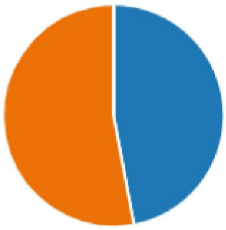
Recommendation from friend/...	38
Search Online via Google/IE	17
Near your home/company	23
You are the member of certain...	6
Other	1

3. Which factor is most important to you when you choose a company?

Delivery days	24
Price	37
Includeing insurance or not	5
Home Delivery	2
Other	0

4. Do you pack your own parcels in most cases? Or do you expect counter staff to pack them?

Yes, I pack myself	32
Yes, I prefer counter staff pack...	36
Other	0



5. Do you need to measure the size/dimension/weight of your parcel yourself?

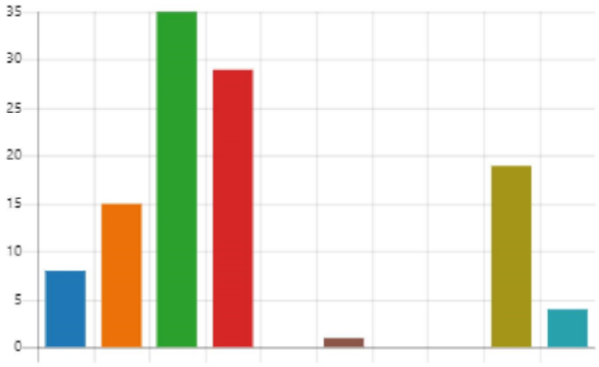
Always	12
Sometimes	21
Seldom	15
No need at all	20
Other	0

6. If Yes for above question, what tool do you usually use to get the size/dimensions/weight?

Linen tape	18
Ruler	24
Search online	9
Weighing scale	24
Other	4

7. Which logistics company you normally use in below list?

UPS	8
Fedex	15
Singpost	35
DHL	29
DB SCHENKER	0
BLUE DART	1
uParcel	0
Aramex	0
SF Express	19
Other	4



8. Are you satisfied with the logistics company services for the companies in Singapore?

Excellent	7
Good	30
Just so so	26
Unsatisfied	4
Other	1

9. What aspect of logistics services in Singapore do you think needs improvement?

The best service, nothing to i...	13
Wait for too long	45
Item broken/damaged during ...	6
Too expensive	25
Other	1