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International University of Applied Sciences (IU).
Capstone Project (04/2023)
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Study program: MBA (90)

Working title: Solution for routing in Cities and Villages in India based on the creation of Map Database.

Acknowledgement

My sincere gratitude and thanks to Mr. Dorian Mora Professor, International University of Applied Sciences (IU). His guidance and suggestions enabled me to conceive and compile this thesis in proper manner along with the guidelines of the university. He also helped and shown the way for countering the technical challenges and produce an effective solution. This would be a good opportunity to thank the exam office for their support around administering thesis in a proper way in examination systems. Last but not the least my fellow students from various groups have inspired and got some ideas and tips around developing this thesis.

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GPS	The Global Positioning System
API	Application Programming Interface
UI	User Interface
JSON	JavaScript Object Notation
REST	Representational State Transfer
URL	Uniform Resource Locator
GUI	Graphical User Interface
KC	Key cloak
DB	Database
MVP	Minimum viable product
AKS	Azure Kubernetes Service
JWT	JSON Web Token
SLA	Service Level Agreement

Abstract

In this specific thesis, we are going to discuss about a widespread problem of commuting in Indian cities by cars. We need GPS or google maps to traverse through different destination. Currently the map in this system could not be able to create routes to specific address for example to the exact house address. Because there is no comprehensive data set and supporting mapping service so that a routing could be created by this system. That is why we have tried to take a technical approach to create a database of house number, postcode and so on. In this we have discussed our approach and the ways to implement this.

1. Problem Statement

The relevant question in this context whether a car driver would be able to select an address with house number, postcode, street in the Google map or GPS mapping system could be able to create a route.

1.1. What comes to mind First.

1.1.1 Is the data ready and organized.

We have already discussed that a data model which will ease the routing and point to point commuting would be easily done via GPS. But the main and the critical issue here is, do we have proper house number, street number, postcode distributed every location in Indian cities in consideration here. Is this information available with specified authority and digitized with supporting information.

1.1.2 Do the authorities got the correct map.

Along with location data like house number, street name, postcode we also need to latest satellite image. More importantly the authorities should have the data which resembles with satellite image. This is especially important question because the physical data and the image from the satellite should be mapped correctly that means for example if we have a school the longitude and latitude of the school should match with the address and data should be correct.

2. Consulting Functions

2.1. Objective and Challenges

2.1.1 Goal Envisioned

Here the goal would be to supply a hassle-free commuting experience. What do we mean by hassle free meaning seamless the way one person drive in abroad could have the same experience in India as well. We know in India also we can drive via GPS to locations which are uploaded by the user or establishment. And sometimes the data can be inappropriate and then one would route to wrong address. Also, it is worth mentioning that we would be able to also route to correct landmark in India. So, the data need to be correct, and this can only be done as we discussed before when the data of each establishment shared by a competent authority like city council. So, the main goal would be getting correct data more importantly validated data.

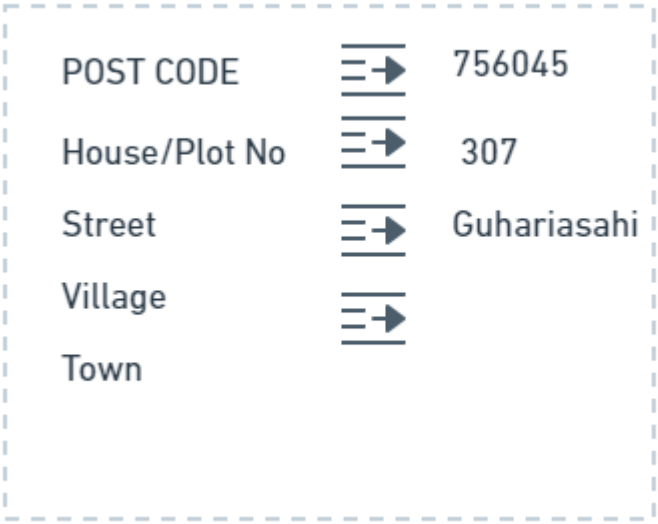


Figure 1

2.1.2 Approach to achieve the Goal.

First, the data which is critical to this project should be created in conjunction with the authority and their approval. The data should be confirmed and reconciled to get rid of any anonymity and on top of that the data again should be mapped with satellite imagery and the 2D data along with satellite image should be verified. To put it more precise way the satellite imagery should follow ground establishment. This exercise is base of the data model of the project, and we need to know what the primary data groups of our data model should be, because that would give us clear picture about the implementation and a minimum data set. We need to find out which are the minimum data one needed to get the routes from the map.

The below picture shows the database which needs to be created. The side-by-side picture will give brief overview to the audience about the implementation we are thinking here. This data model will be logical to support the existing data of Google map.

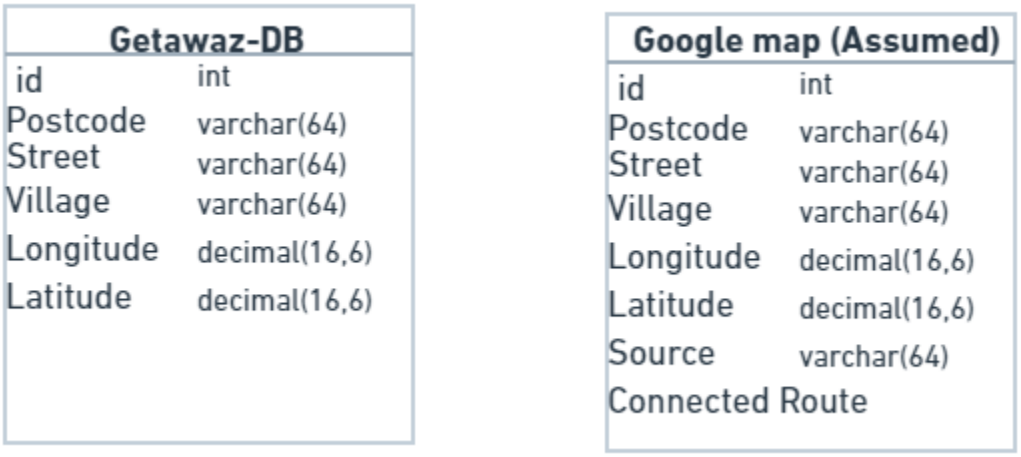


Figure 2

2.1.3 City council discussions

City council and its members are especially important to success of this project. The members need to be convinced about this project so that they can supply necessary help about the data. These government authorities should be convinced to get help from other government department like the satellite department which is in public organizations need to very meticulous in organizing meetings with city council and answering their question. They need to be found that this project would going to give them good return and they would be able to score social responsibility point and get appreciations from the city residents. The city municipality considered in this project is Soro Municipality (2022)

2.1.4 Bring consensus in city residents.

After first meetings with city council members and other government authorities who manage maps of the road and villages. The minutes of meeting are documented and discussed with a committee which is formed forming of residents of the small town. This committee involvement is especially important as they can have some impetus to the project as these people are from same area so city council would listen to them, and the consensus building would help us in getting the traction in the project in city council level.

2.1.5 Resolution needed in city council.

We had to undergo few sessions with the city council member and resident committee. Then we came to a same page to conduct around the implementation of this project The city council members assured of help needed to get the correct data. The city council will pass a resolution for this activity. The resolution will ease gathering of data from city council department.

2.1.6 Development project plan.

The three main aims being create data with establishment meaning data of the physical structure. This must happen with collaboration of the city council as discussed before. Second is to create a user interface which would ease easy uploading of land or physical data by the city council official who got smallest ICT knowledge. Third is to analyse the data from deep analysis of satellite imagery that the data uploaded is correct and having the correct information and adjoining infrastructure also updated. Once the data is ready, we will produce restful service implementation which will enable a third part access the said database.

2.2. Methods adopted.

2.2.1 Discussion by forming a resident committee.

As we mentioned before city resident committee is especially important and they should fully be aware of the project along with the solution. The city residents persuaded to hold meetings with city council to convince them about the project and how the success of the project can add to the wellbeing of the city residents. So, the development team would hold series of meetings with city residents committee for their better understanding.

2.2.2 Design thinking concept.

The city council finally given the nod to start a pilot project with a sample data. So, this is right time to wear the design thinking hat. As we know this project user input based and going to extensively used. According to design thinking method here we need focus on the user and think from the user perspective.

Design thinking also teaches us how to collaborate with other teams and stakeholders, collaboration is especially important here because of multiple teams being involved here. That is why we need to take some reference about collaboration and collective thinking Edelman and J. A. Omoyele (2018). This would be beneficial in how design thinking can be implemented in this specific scenario.

2.2.3 Challenges in Design Thinking approach

We will be surely faced by many challenges along the way of developing this project. The project here critically dependent upon data. The data is also not readily available with the authority. Another challenge would be the validation of data because end of the day we need verified data to work with. This is one of the primary design challenges. So, we need to work collaborative manner with government authority and other department and need to go out of the box. As we know the current data which is in google map database may not be correct. We need start from the scratch and collect correct data. We also need to emphatic towards the government department because they can have multiple responsibility. We must learn and few things and apply those techniques from Design Thinking techniques.

2.2.4 Summary of Design Thinking Concept.

Design thinking is the approach towards client-driven innovation. Design thinking also considered to have customer-oriented innovation. Customer or client or user's empathy is the key. As we all know the design thinking followed classically is difficult to follow because of its non-linearity. The approach would be to combine lean startup with design thinking power. While thinking about the project and during my study I also followed a course available in scrum-academy about this concept the application side of it in software development projects. The popular framework from Eric Ries goes on to enable you to garner revenue as soon as possible with a new idea.

2.2.5 Start with Prototype.

Customers are producing vague requirement which is not possible to develop. And on top of that in customer interviews one can easily see that, what they are doing not exactly what they are asking or asked to develop. So proper analysis of requirement and insight into customer's behaviour is prime prior to development of product and services. Precisely this is the point where design thinking enables to get a big picture

or complete picture of the customer. The investigation of feel along with desire in addition to feel and speak. In order get the things right from the start and to understand having a correct insight of the product, one must start building prototype of services or product. This is one of the aspects of design thinking to start with prototype or small to ease the grey area of understanding.

2.2.6 About Lean Startup.

In this specific project we have started to follow design thinking concept for the greater good. And the important thing is if you have the complete picture with respect to design thinking methodology's lean start up would be good for structuring the whole project. As we have already mentioned the said theory would lead you in correct path starting from insight to prototype. This theory would be base for your any new development hence forth. So, this build to measure-learn to cycle from Eric R, is best way to get rid off dead ends eventually to a product which is unwanted. Now the theory will enable to find solution quickly and go to market is faster so on and son forth.

2.2.7 Start small as per Design Thinking.

The training of lean starts up and design thinking would enable one to build or develop innovation, which is going to be used. Since the product we have proposed here is based on a strong feedback mechanism for the user. Secondly, we have already insighted the requirement for this product. The insights are very promising and could foresee that this is going to be a unique product in this space as there is no such product available in space currently. We talked about prototype a lot in this thesis. Even before creating the thesis, I had a smaller prototype not exactly like this one but just to understand the concept, I have created a small database of my village with 100-150 houses and their out their respective data in database. And this enabled me to understand the basics and the importance of the data in an organized way. For example, now I have a database with all plot numbers of my village along with their co-ordinate, name of the village, street name, other datapoints as well. Bottom line now I have a database or map database through which a GPS route can be created. That was my first aim which was proven by this fact.

2.2.8 Development Process and the project framework

The project would be conducted in agile way as most of the software project being undertaken now a days. The scrum team will be formed of development team along with land department or the team responsible from the government to aid the project. The project plan needs to be prepared and would be reviewed by the stakeholders. The teams here like multifunctional and interdisciplinary team. They will be having an open and innovative mindset. The team should encourage mistake to find innovative solutions.

2.2.9 More about Project Management.

Let us first understand a project, meaning what is a project. A project is based on efforts which are temporary and on that basis of temporary efforts value being created. This value may be in terms of processes, services, or unique products. There also may be instances where projects being undertaken to have a quick resolution to a problem, also there are others which have longer term goals. As we intended to work with the city council authorities or government in our case. So, for us this is project is longer term basis and requires maintenance as well. There are projects which are combinations of things be it process, product services or maintenance. Here we wanted to highlight this aspect of project management so that we can apply and adhere to these methodologies in our project. Projects are made of or based on amalgamations of deliverable along with task and activities. The task and activities need to be structured to conduct the goals of the project.

2.2.10 Project Management in Government's Project

Now a days the project management technique also being applied in government projects. The use of these techniques aids government operations to achieve tangible results. Here we need to learn the way the government follows the project management techniques also what are the main area they refer in project management when they collaborate with vendors. The government want to follow this, as this has bindings on the vendor and deadlines are part of the project plan and then once this is documented it can be followed strictly by the government. Since most of the government project are important from operational point of view, the government employee now puts more focus on project management rather than on functional management. Since in this project we will be working with the government authorities. We should take some reference from this PMI and adhere to these concepts for fulfilment of our project.

2.2.11 Develop Project Plan

The project will be prepared taking all the development activities into consideration. Since the project is initially approved as pilot project. Here we have depicted the main task the high-level task in Gantt chart. This plan has also included the design and database integration and data collection. This project plan will be prepared with a deadline in mind. As we start the development journey, we need more help from the government authorities. We have also considered the testing and deployment of the project. Since government is involvement is primary in this project, we need to know working style of specifically Government of India, Ministry of Telecom (2013). Please follow the link as part of reference to know details of the government's style of working. There is quite common procedure of working now a days is the PPP mode. So, this may be style which will suit us because we must get database and map data from the government. With this partnership we can achieve our mission and the government, or the city council can achieve the corporate social responsibility point over here. As this project is overly ambitious and critical on data.it would be great to have partnership with the city council and go forward which will be mutually beneficial. In this PPP mode the government distributes resources and may be an investment in some cases and once project is developed and run by private management for defined years, but the private sector can not own the project and after few years of getting profit than government could implement a new revenue sharing model.

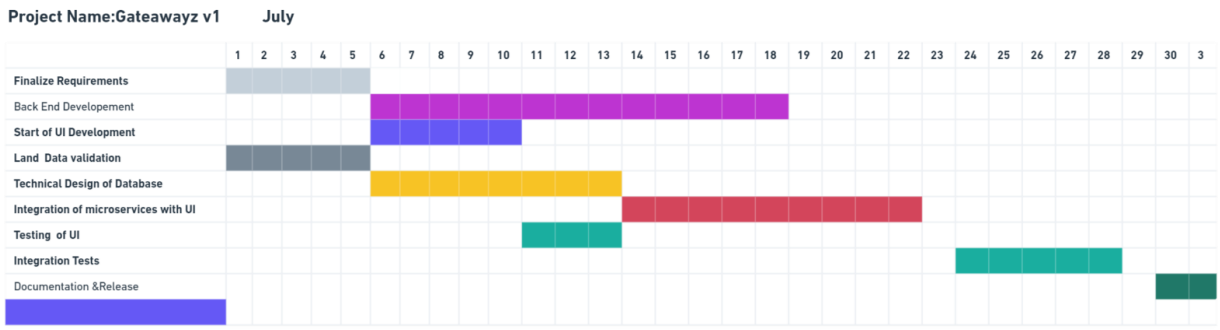


Figure 2

2.3. Analysis and Research.

2.3.1 Survey for Quantitative Data.

When we started to think about this project and future implementation of this. Since we already know about the problem from self-experience. But self-experience or experience of few will not be considered as enough. We need to have concrete data and survey needs to be done to get the data. Once we did the survey then we will come to know how desirable the solution is, which is also one of the major thought processes in design thinking approaches. We did a survey and interviewed around fifty households in the small town. We interviewed government employees who use to commute in car, at the same time also the local households.

2.3.2 Data Interpretation.

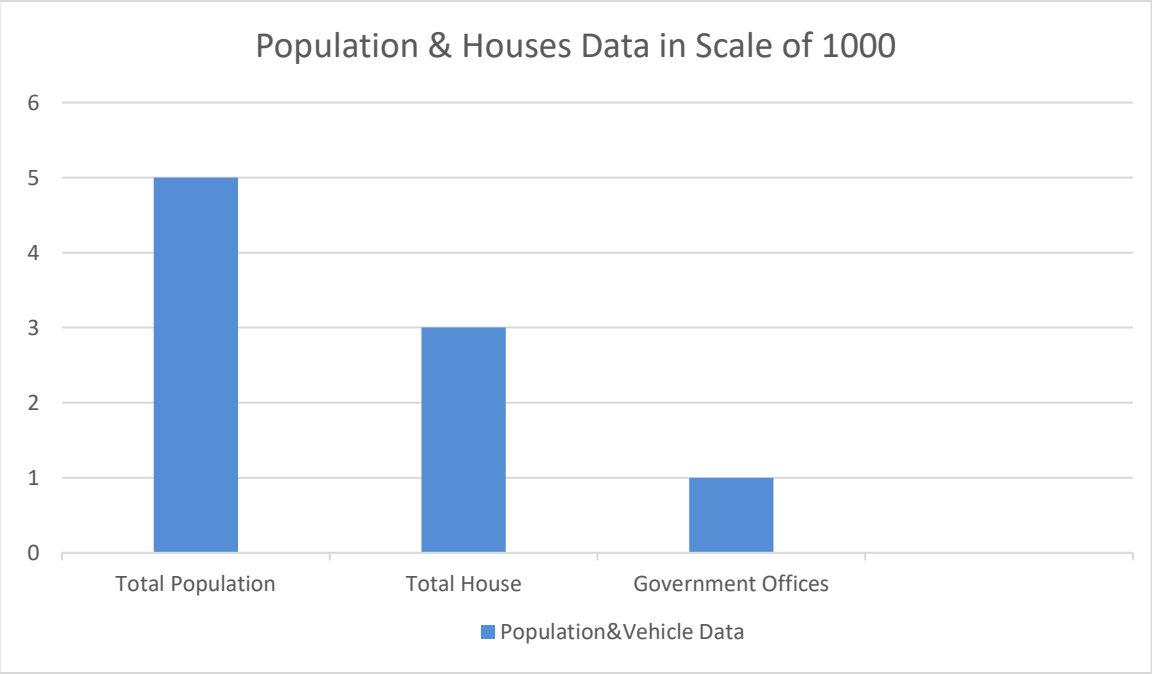
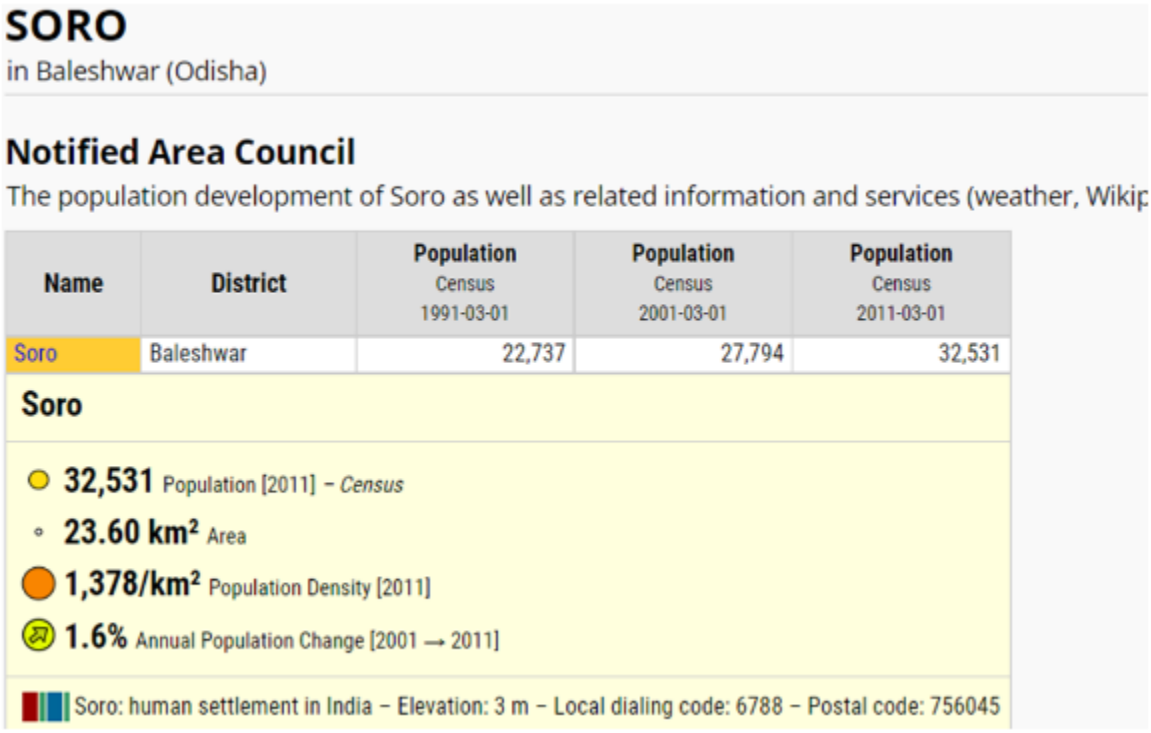

Population & Houses Data in Scale of 1000
6
5
4
3
2
1
0
Total Population
Total House
Government Offices
Population&Vehicle Data

Figure 3



SORO

in Baleshwar (Odisha)

Notified Area Council

The population development of Soro as well as related information and services (weather, Wikip

Name	District	Population Census 1991-03-01	Population Census 2001-03-01	Population Census 2011-03-01
Soro	Baleshwar	22,737	27,794	32,531

Soro

32,531 Population [2011] – *Census*

23.60 km² Area

1,378/km² Population Density [2011]

1.6% Annual Population Change [2001 → 2011]

Soro: human settlement in India – Elevation: 3 m – Local dialing code: 6788 – Postal code: 756045

Figure 4

The vehicle data below supplies important data for the development of the project. From the data below, it is quite clear about the desirability and viability of the project. In the below graph the data considered to plot a graph for ingress and egress vehicles of the locality considered in this project. The traffic data is huge considering this is a small city. This is quite possible in India because of population, and we can imagine how important this kind of project if it is considered or a bigger Indian city.

WD represents the Weekend.

WK represents a workday in the chart below.

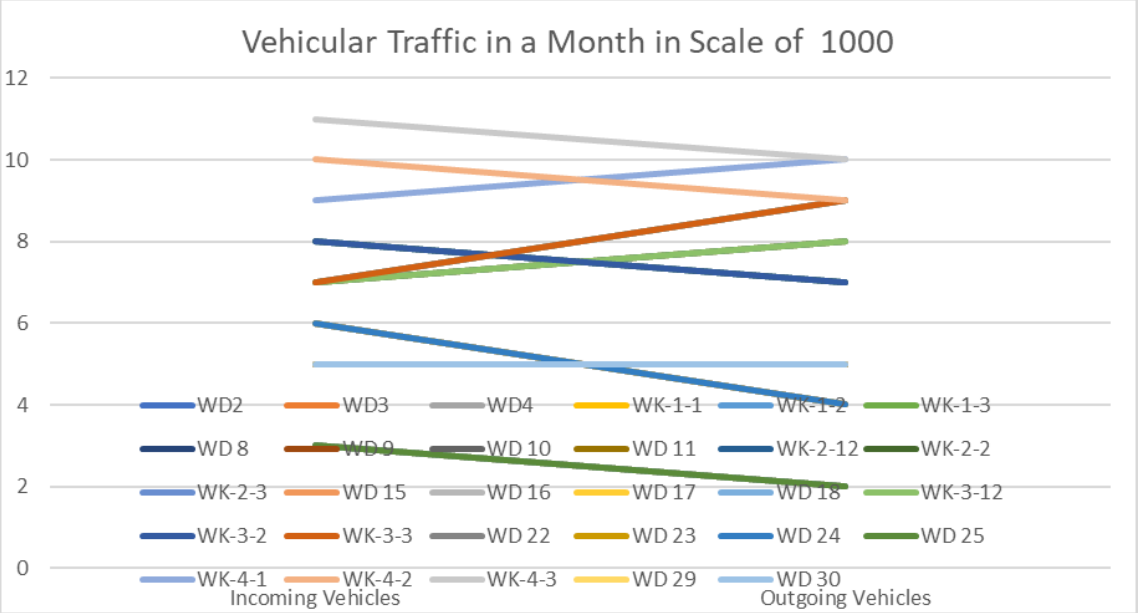


Figure 6

2.3.3 Survey Design and Data.

The main aim of the survey is to get quantitative data. This should be done on top of the interviews we did earlier with individuals the households. The questions of the survey were designed to consider and capture the true essence of the problem faced by people. At the same time in the same area. Along with the survey question and the issues, we also focused on the solution desired by the survey respondents. The surveys are a very tedious process, mainly the interviews done in the neighborhood. This required a lot of coordination requirements and convinced people for their time. Sometimes people are not keen to be part of a survey, and some want their identity to be anonymous, it requires great skill to convince people. Finally, we could align some people to part of the interview, which has provided us with remarkable results. After the survey it made us clear that how desirable the solution is. So bottom line the survey concluded in a fair way, and we are happy that we got the relevant data required to convince the required stakeholders.

2.3.4 Result of Survey with Data

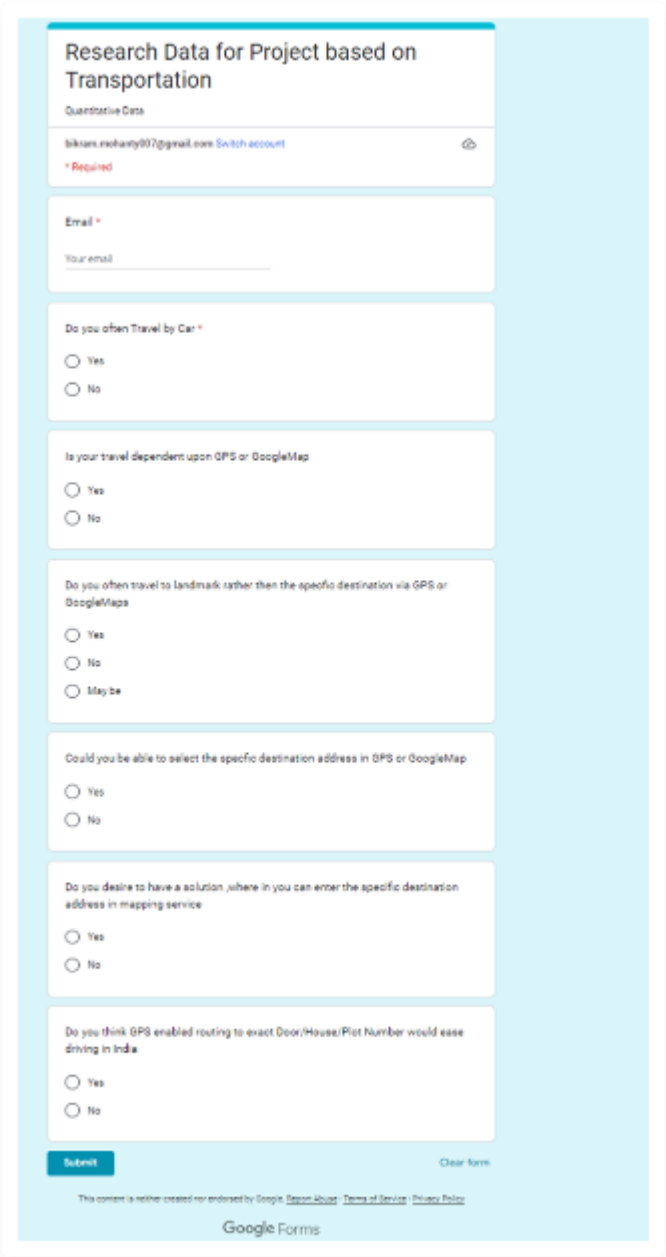


Figure 7

2.3.5 Results of survey with Specific Questions.

Survey Question #1

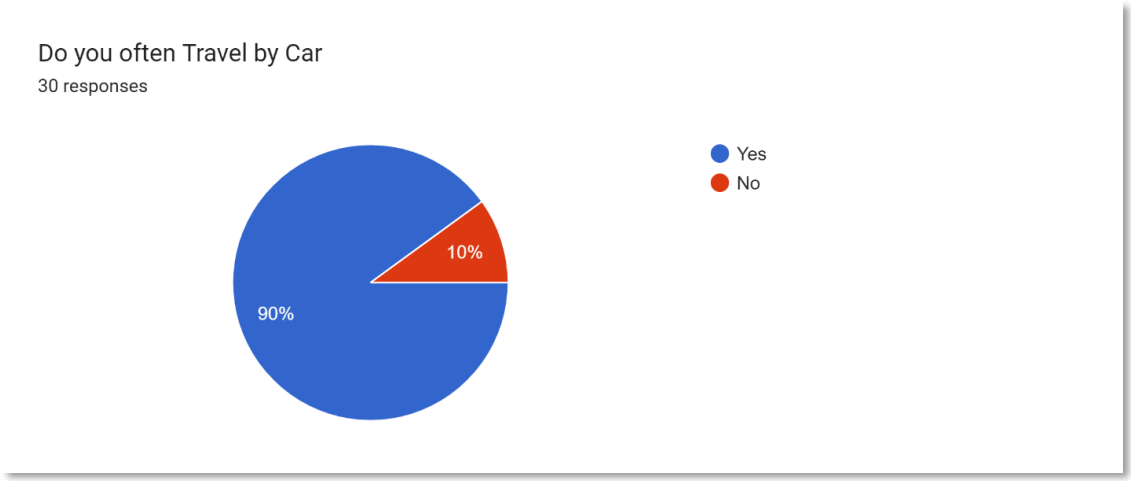


Figure 8

Survey Question #2

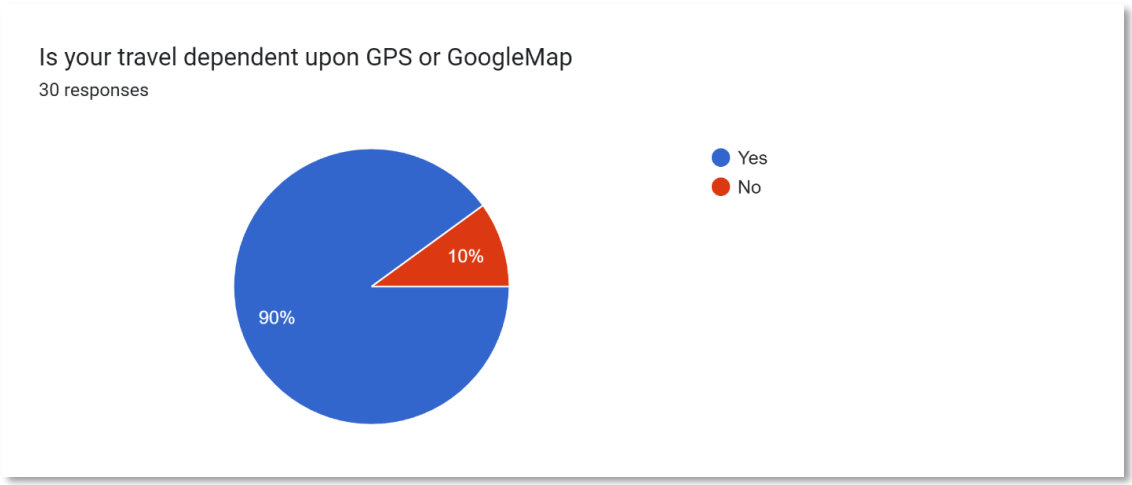


Figure 9

Survey Question #3

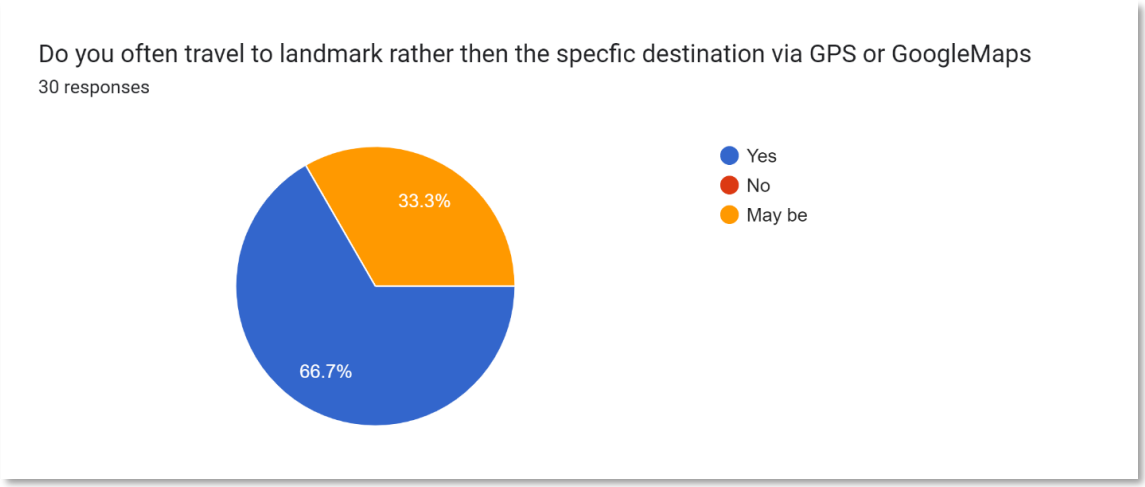


Figure 10

Survey Question #4

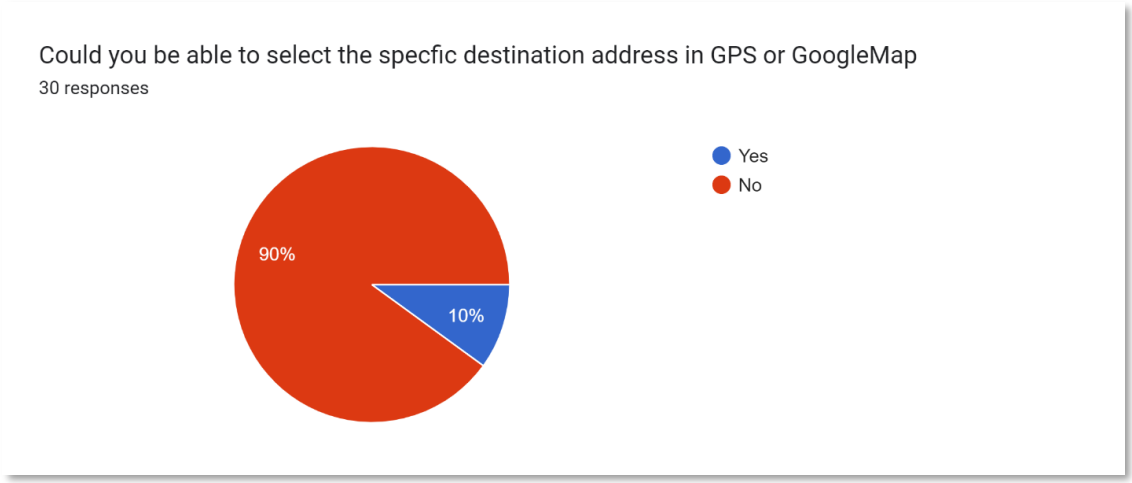


Figure 11

Survey Question #5

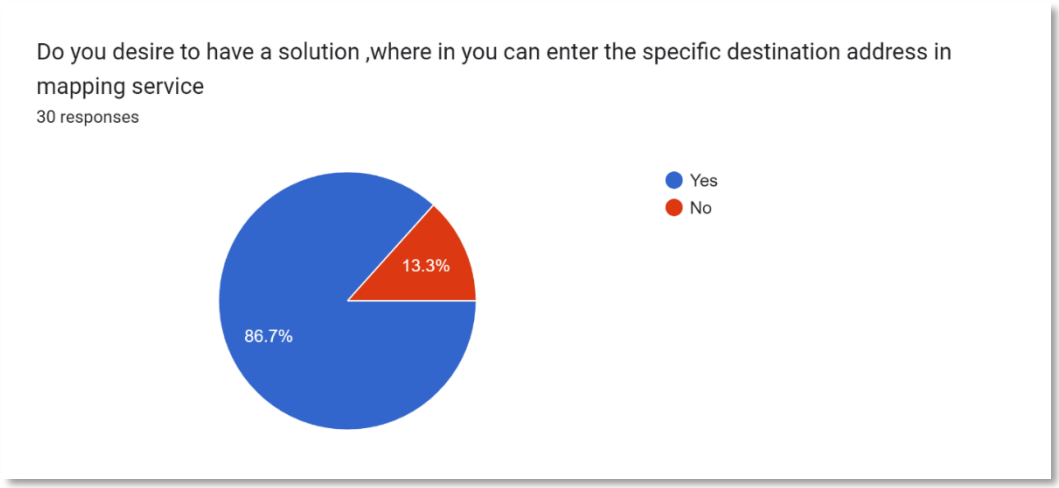


Figure 12

Survey Question #6

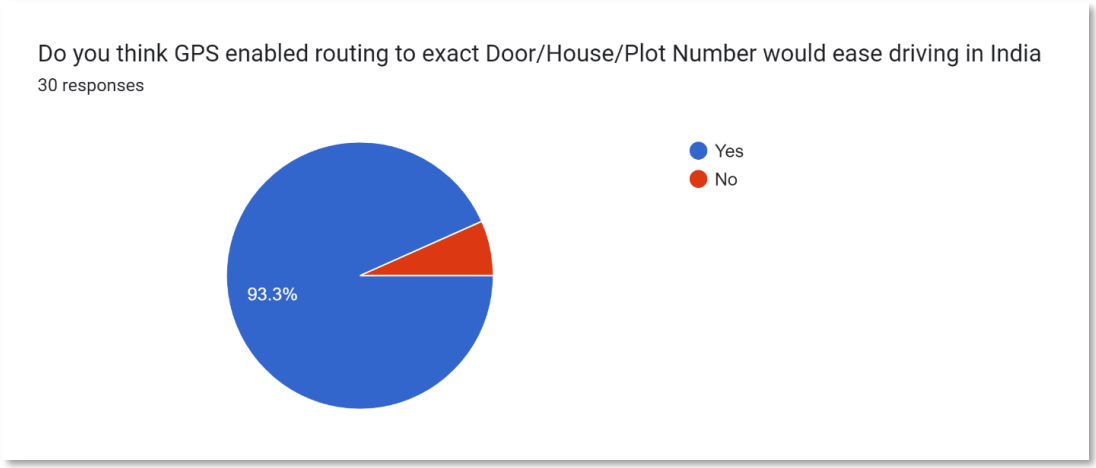


Figure 13

2.3.6 Extrapolation of survey Data.

In this specific survey we collected the data. Then we tried to extrapolate and plot with two hundred respondents participating in the survey. We required to get an estimate to understand the desirability of the solution. We did a survey for thirty users then extorted it can also be made for bigger lot as well. This is only for understanding and explanation purpose not for quoting.

Summary of Survey Questions and their Screen shots

Figure 14

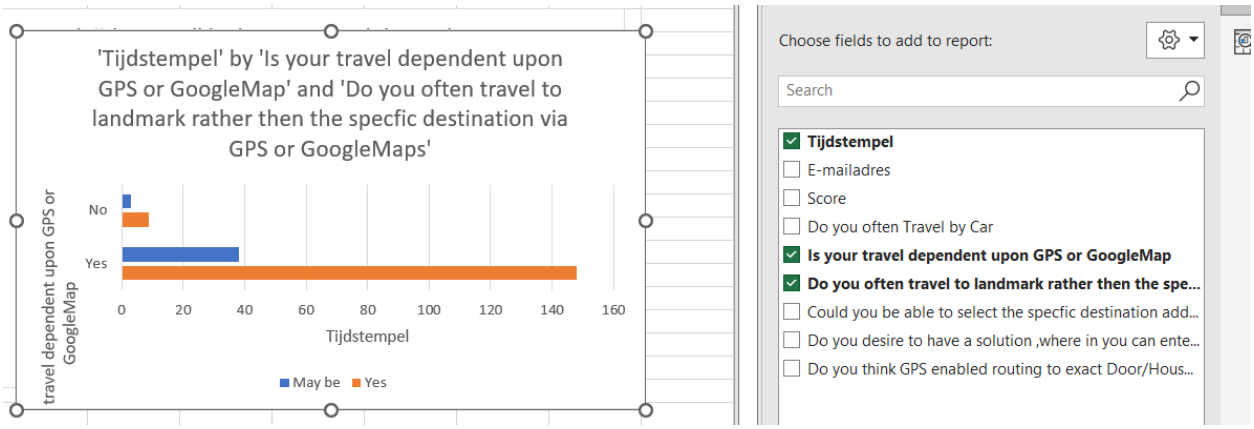
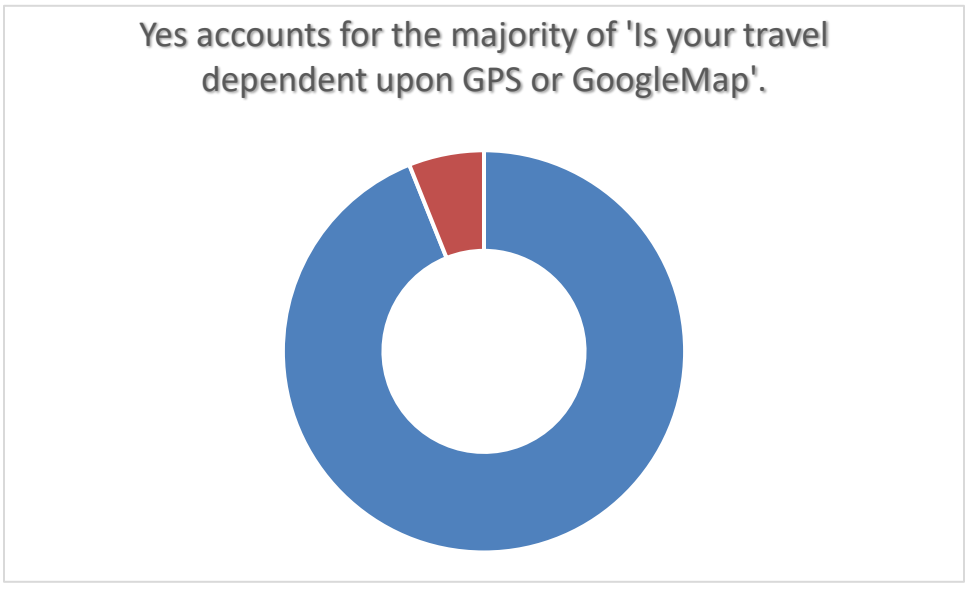


Figure 15



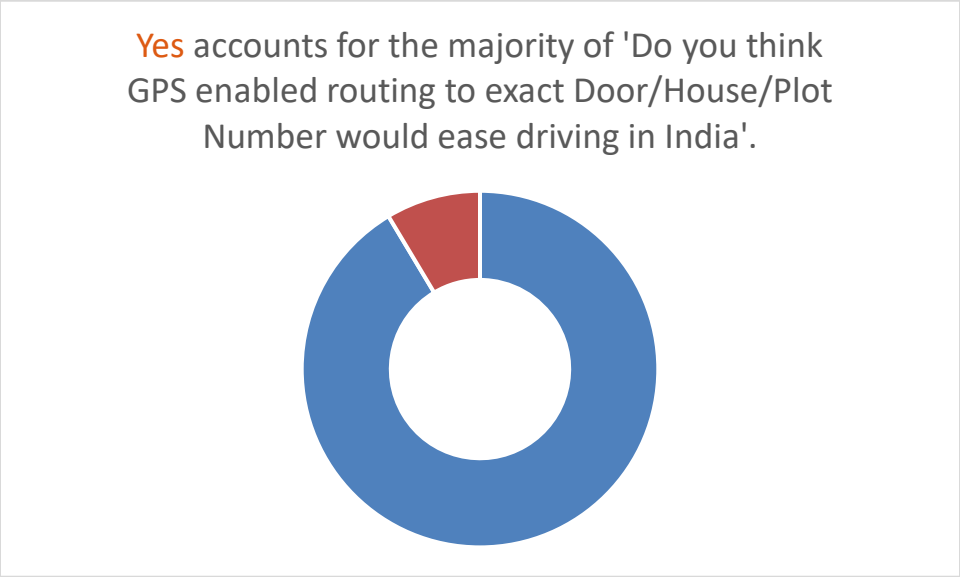


Figure 16

Do you often travel to landmark rather then the specfic destination via GPS or GoogleMaps	Count of Do you often travel to landmark rather then the specfic destination via GPS or GoogleMaps
Yes	157
May be	41
Grand Total	**198**

Figure 17

2.3.6 Analysis of Survey Results.

The survey is done and all the feedback from the respondents has been received and now it is time to build the data. The data being analysed and extrapolated to understand from a bigger population and city point of view. While extrapolating, we found that the amount of people wants the solution is staggering, most of the respondents agree that they face lot of difficulties while driving as there is not specific routes available. Since they wanted to travel between point to point most of times. Precisely that is the solution we are targeting here. We had already the result from Face-to-face interview and now the online survey data. So, combining both we will have good amount of data which can be shared with city council member, and which will give them sense of desirability of this project.

2.3.7 Risks and Contingencies.

Risk:

We all know any Software project or other Project the risks bound to be associated. This project is no exception, more over the amount and nature of data makes it riskier. So, the risks need to be considered carefully and necessary contingency plan should be derived, so that the risk if at all happens then can be mitigated. For example, the land data the of the specific location and the data belongs to the government. Below we have shown few areas of risk.

- Risks Correspnding to Data Security

The security aspect of this specific area could be mitigated by hiring security architect and discuss the loopholes, areas where the data can be hacked, or the architect would prepare a security architecture to address all the security related issue in our application and data.

- Server Availability

This is standard implementation of making the server universally available. The applications should be reachable of the server is down. As the back up is always ready and application is 99.9 % availability

- Risks (Others)

In Software development there can be many risks.

- Vulnerabilities of Systems
- Compliance Issues
- Stability Problem
- Efficiency related Weakness
- Degradation about Performance
- Flaws around Security Architecture

All risks in and around the project development and implementation. The risks evaluation process should be done diligently and documented. One of the most important points is we should follow standard

encryption algorithm when it comes access of the database. Because eventually the database would be accessible through rest calls, so it is important to consider those risk factors. When other implement our project or access part of the solution proper contractual agreement should be done to avoid future surprise.

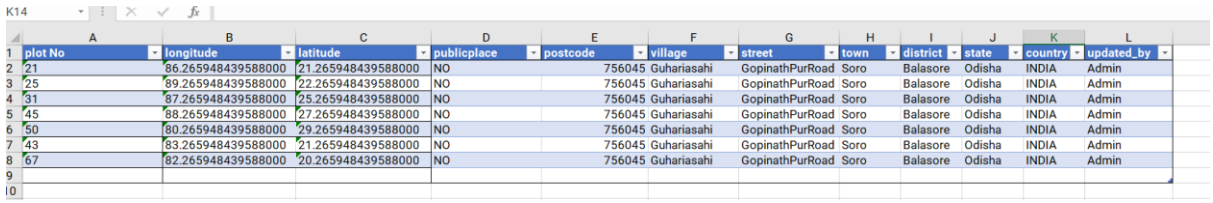
2.3.7 Recommendations

We thought of few recommendations so that project can be commercially practical. These recommendations could give the traction to the project. See below for more details.

- We should collaborate with manufacturing unit deals in vehicles.
- Can also think to collaborate with GPS and mapping system entities.
- More survey needs to be done to get more data.
- Small and influential group can be made in the city to convince city council and other stakeholders.
- Discussions with car manufacturers who are interested in an integrated GPS solution.

3. Propose a Solution

In this project we will be having a solution a database. The database which will cater to need of the mapping service. This database would have the physical address like house number, street, village etc. Along with coordinates (longitude & latitude). The high-level data model is mentioned below.



plot No	longitude	latitude	publicplace	postcode	village	street	town	district	state	country	updated_by
21	86.265948439588000	21.265948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
25	89.265948439588000	22.265948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
31	87.265948439588000	25.265948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
45	88.265948439588000	27.265948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
50	80.265948439588000	29.265948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
43	83.265948439588000	21.265948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
67	82.265948439588000	20.265948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin

Figure 18

The data model shown here is extract of spreadsheet. Because when it will upload to the database through the user interface.it should be easy and simple so that the data can be uploaded easily without the hassle, so the user interface is being developed.

3.1. Details about Software Solution.

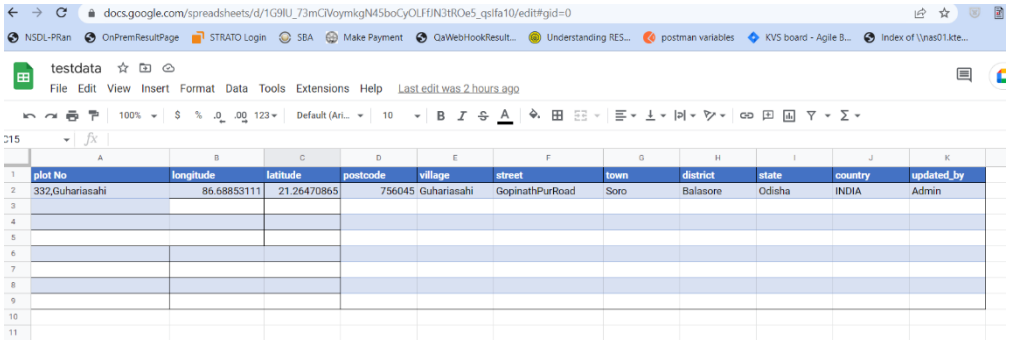
The technology here is ASP .net core and on top of that we have used .net core blazer for html rendering. mudblazorframework for ui components and entity framework as an in-memory data base. Having said that we could use another database as well like PostgreSQL and MongoDB. All these services will be deployed in cloud as of now we did in aks cluster Standard_D2s_v4.

3.1.1.Deployment Procedure

The code once developed needs to be deployed. Here we have deployed the code Azure through azure dev ops. This is deployed in Azure as app-service, please find the documentation here MSappservicedocu.

3.2. Evaluate the Database with Popular mapping service.

As we know the project here is data critical and once the data is prepared it needs to be evaluated. Once we the data is prepared and confirmed the next step is to know whether the data is correct. And then if the data can be used to create routes which is the primary goal of this project. To do that we have taken help of my map from google which is application from google. We will use this application and inject our data to understand, if the data we injected could be able to create good routes. Below is data file screenshot shot of the data which we have applied in mampalons we get this data in my map and create few routes and validate them, we know that we are good here.



plot No	longitude	latitude	postcode	village	street	town	district	state	country	updated_by
332,Guhariasahi	86.68853111	21.26470865	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin

Figure 19

The data sheet is prepared with above data as mentioned. My map is launched, and the map is created as mentioned below.

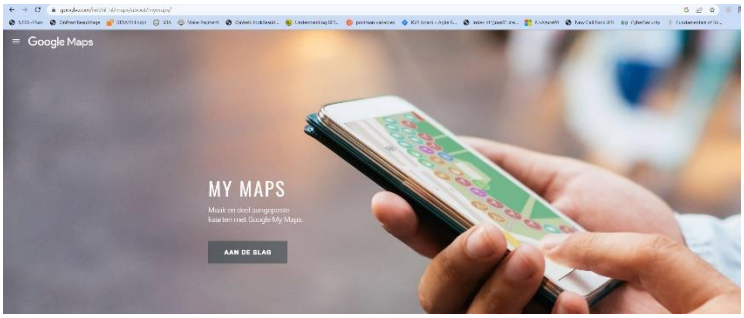


Figure 20

Then the map is created by importing the file as shown below.

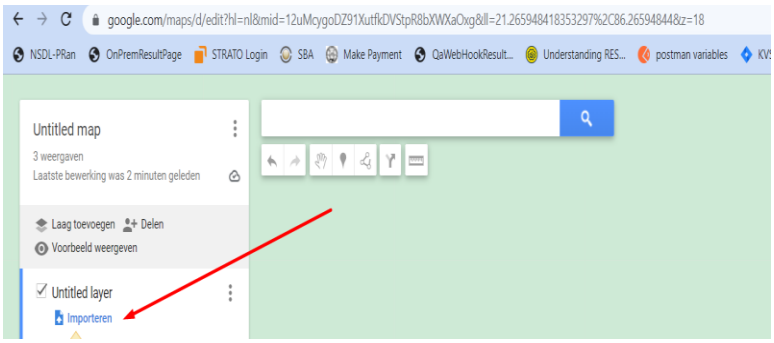


Figure 21

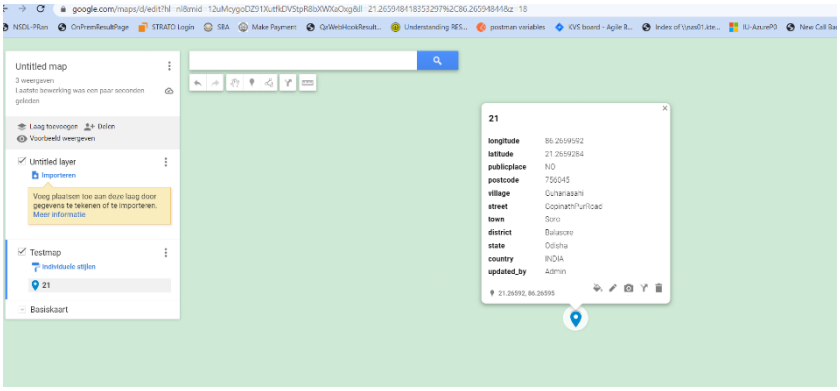


Figure 22

Then uploaded the sheet developed with data in above step. While being uploaded in my map, the application would need some validations according to data. For instance, what would be the location and data in primary. The data will be seen uploaded and map with a layer gets created which is mentioned below via screen shot. Once the data is there it can be used to create routes and other map functions in my map and that route can be used to drive.

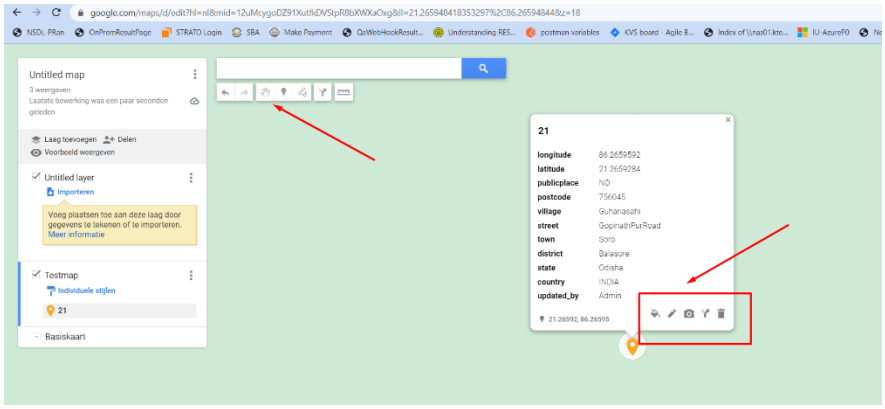


Figure 23

We wanted to evaluate our data more and how it gets integrated with my map. So, what we did here is after uploading the data according to our data model. We then went ahead create driving direction or routing from our uploaded data with the existing data in google map. To make sure the data which we uploaded works well google map's existing data. The result is quite good as routes are created nicely and with accuracy. Please find the screen shots below where the route is found or created for our data (destination in this case)

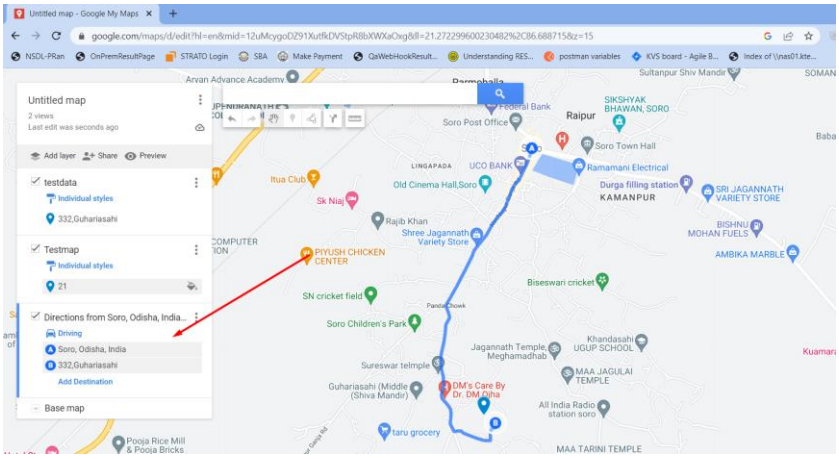
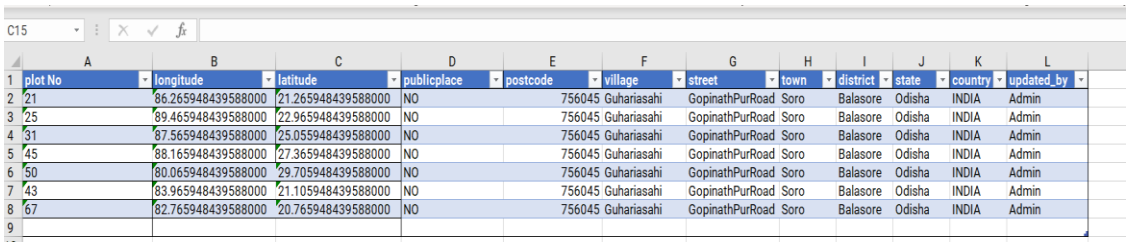


Figure 24

3.3. Development of Prototype (User Interface)

We need a user interface to ease easy upload of data. We need an interface through which xlsx sheet can be uploaded, the xlsx sheet should be created as per a data model. This user interface would give a platform the official of government authority who got less knowledge in computer and software. The UI would be very interactive and simple so that anyone can use. The data which needs to be uploaded a sample has been mentioned below for more understanding.



plot No	longitude	latitude	publicplace	postcode	village	street	town	district	state	country	updated_by
21	86.265948439588000	21.265948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
25	89.465948439588000	22.965948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
31	87.565948439588000	25.055948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
45	88.165948439588000	27.365948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
50	80.065948439588000	29.705948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
43	83.965948439588000	21.105948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin
67	82.765948439588000	20.765948439588000	NO	756045	Guhariasahi	GopinathPurRoad	Soro	Balasore	Odisha	INDIA	Admin

Figure 25

3.4. Testing of UI and Acceptance Criteria

Now we have developed the prototype and as per the first step we need to upload the data. As we know the data can be xlsx sheet according to the expected data model. Once the data precisely the physical location data uploaded in UI, the data should reflect in the designated database as discussed before. Please find the screen shots below to observe and understand how the UI launched and data uploaded. Here testing is especially important and the way the data is presented. The database always follows a specific structure without the whole UI could be useless. So, the data should be according to the data model. If any user wants to upload the data without adhering to the data model, then data would be updated as required and there can be incompatibility. Please follow the below steps carefully and this is going to be increasingly stringent once we go ahead with this project. The structure of the columns of the database should be according to the data model suggested before.

1.Launch the UI GetWayz.

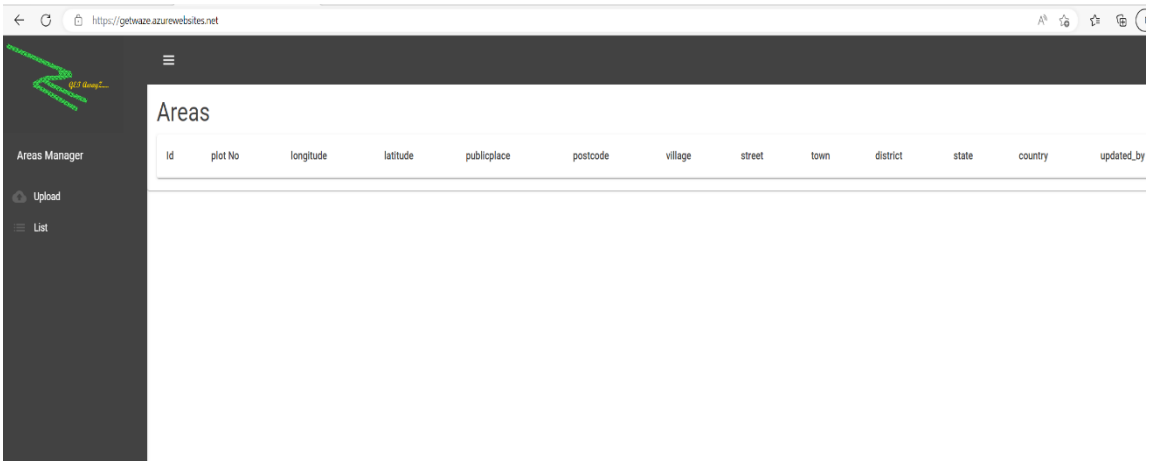


Figure 26

2. Click Upload.

Once you click Upload in the UI. now you can upload the data file.

In the right frame of UI, the user would be able drag/drop or upload a file.

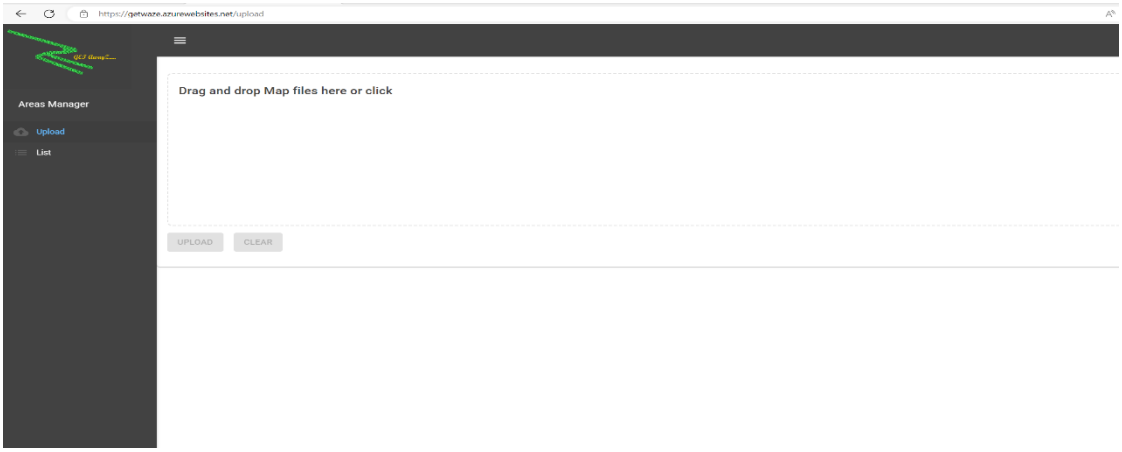


Figure 27

3.Data model file to upload.

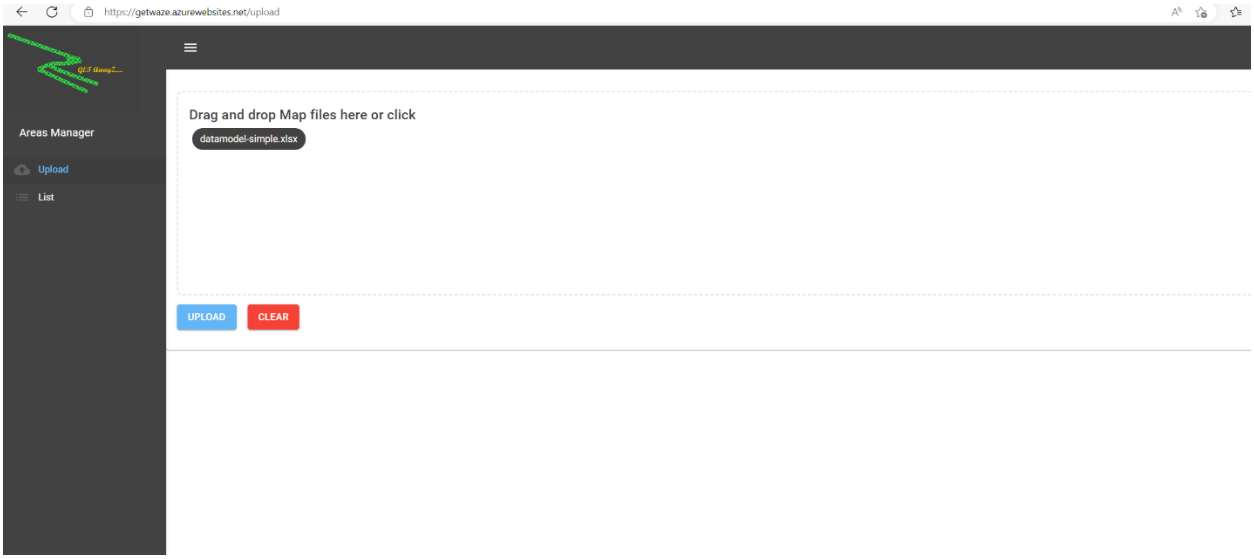


Figure 28

To upload a file, click on “Drag and drop Map files here” a window’s dialogue box will be opened to select the file. Once the file is selected the data will be uploaded to the database. The same data also seen as part of list on the UI. The xlsx file should be as per the data model. Find the sample data file for reference.

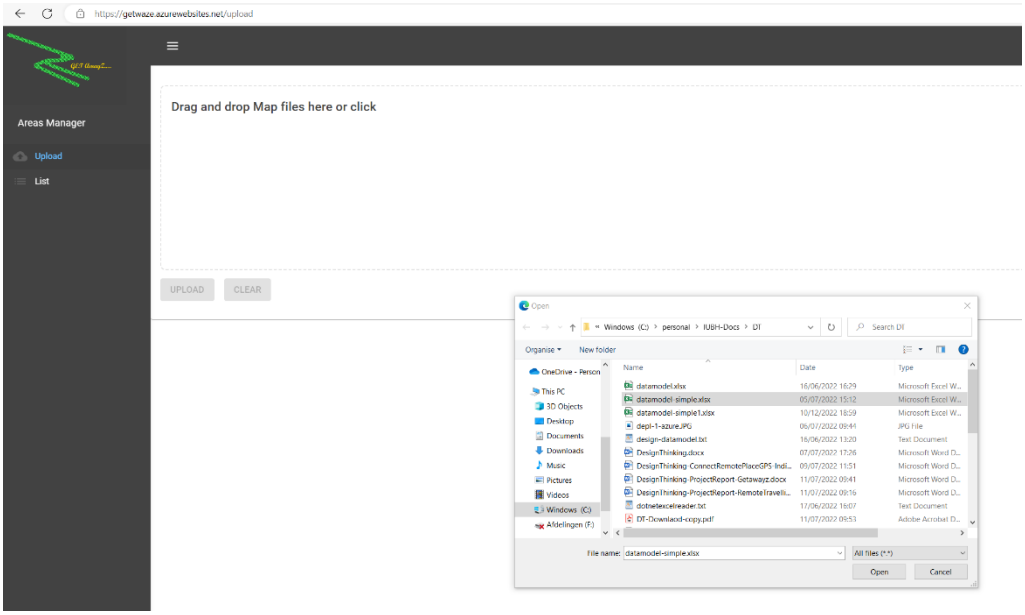


Figure 29

4.The upload button in the ui meant to upload the spread sheet.

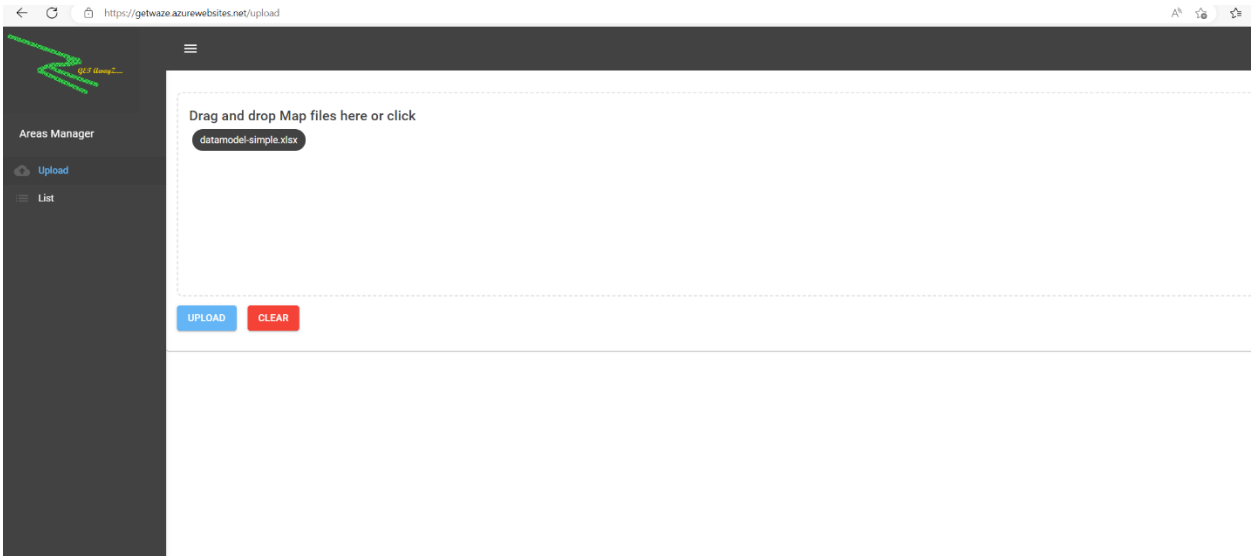


Figure 30

5. Click on list on the UI to get the data which uploaded in the previous step.
   The list would display the way we uploaded the data same as the data model designed.

As we mentioned before we have tried to make the ui as interactive as possible. Since this ui must also be used by non-it personnel. Once the data being uploaded. We have made a point to show the data in proper distinction so that functionality of the data can be visualized. For example, now when one list the data can easily understand that this data is meant for map or routing etc.

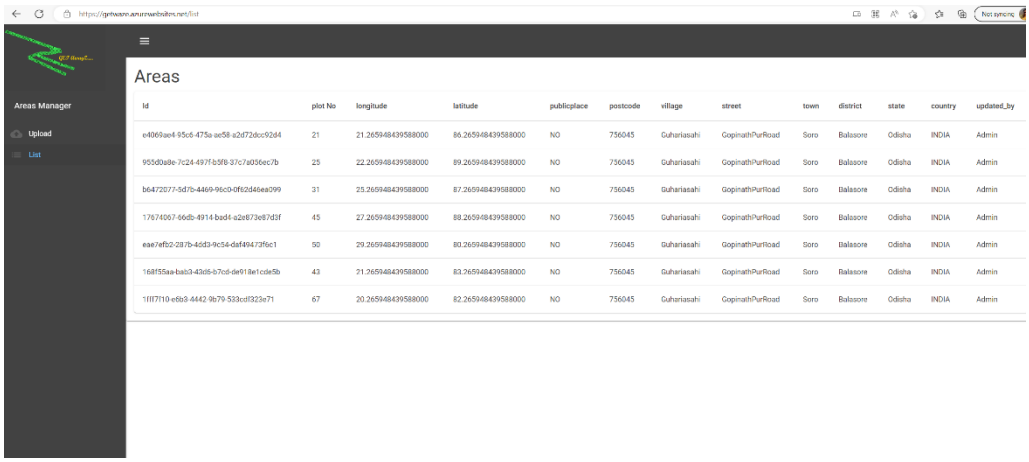


Figure 31

3.5. Future Enhancements

Since the structure is ready along with the ui prototype. The data can be uploaded at the same time the data can be stored as well. According to the data model the data being stored in the database one would use in this project. The main point is data model is modelled as per future consumption. As we know the end user like GPS system or google map would be interested in accessing the data to create route and direction. So, we thought of implementing restful service so that the database can be accessed by api calls or rest calls. These calls will be as per industry standard and easily consumed and developed as per requirement from the third-party mapping application. From api security perspective we will follow Oauth2 mechanism. Each api call is designed to make the data accessible. We have mentioned the api call below along with screen shots of the rest calls.

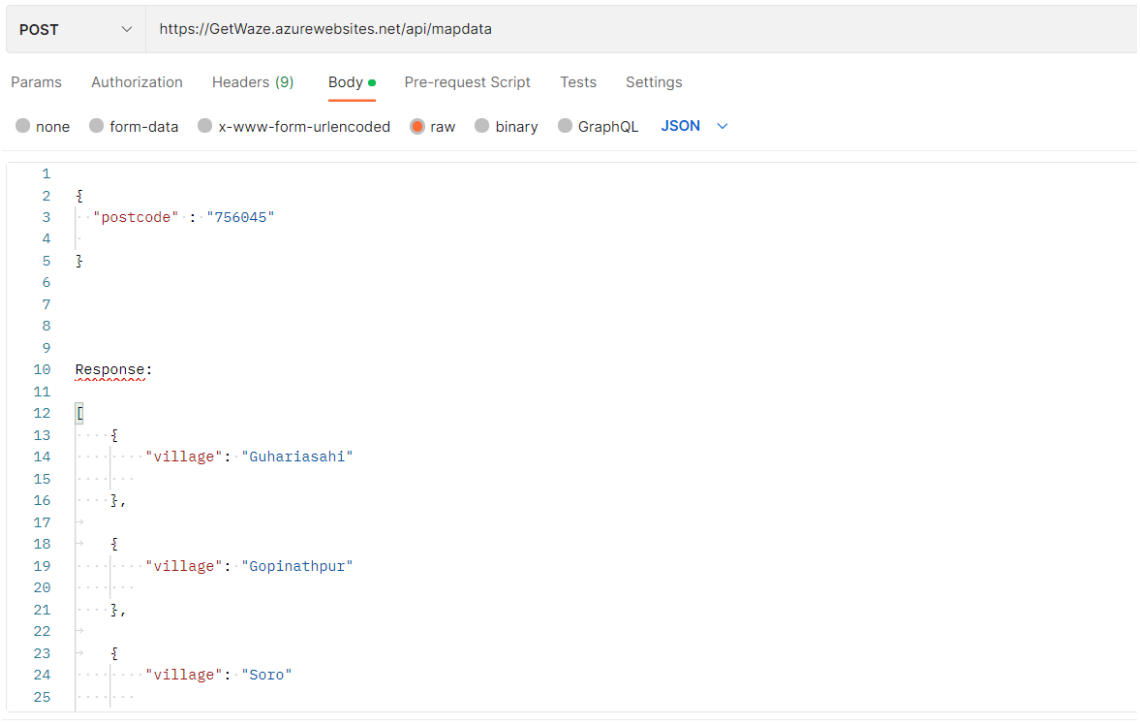


Figure 32

First, we have rest calls to get all villages corresponding to the postcode as part of the post method. As shown above the post call will retrieve all villages.

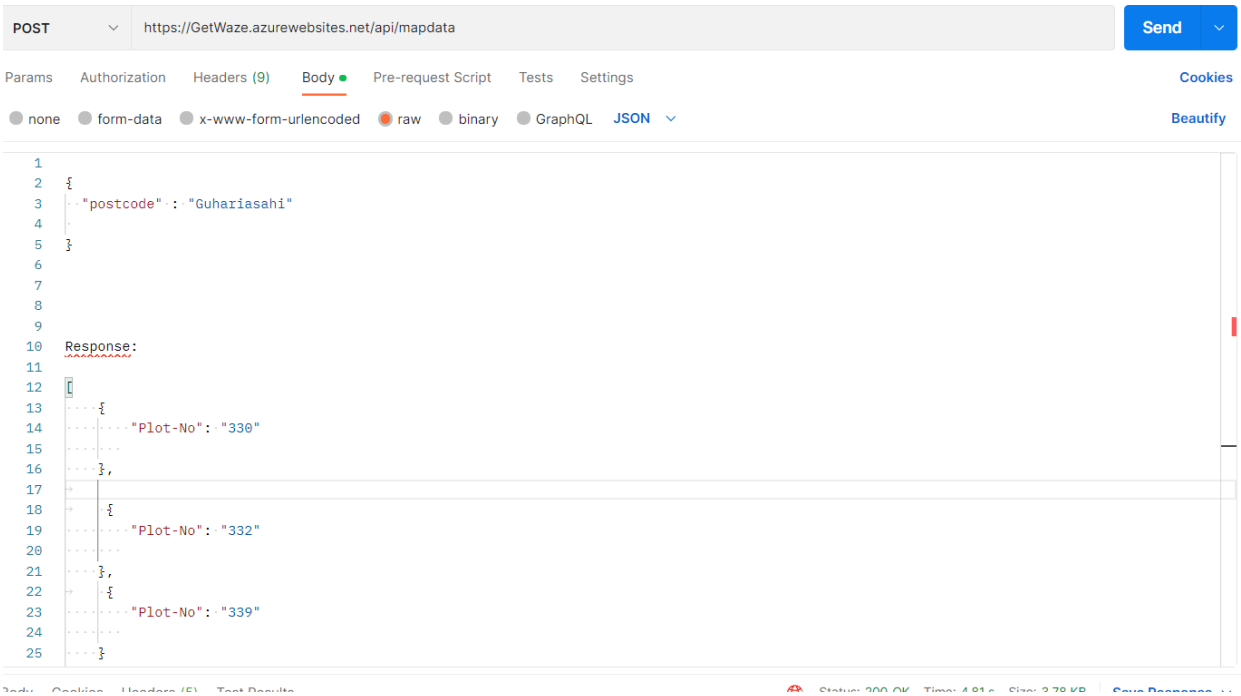


Figure 33

The later api call on a specific village would retrieve all plot numbers and so on.

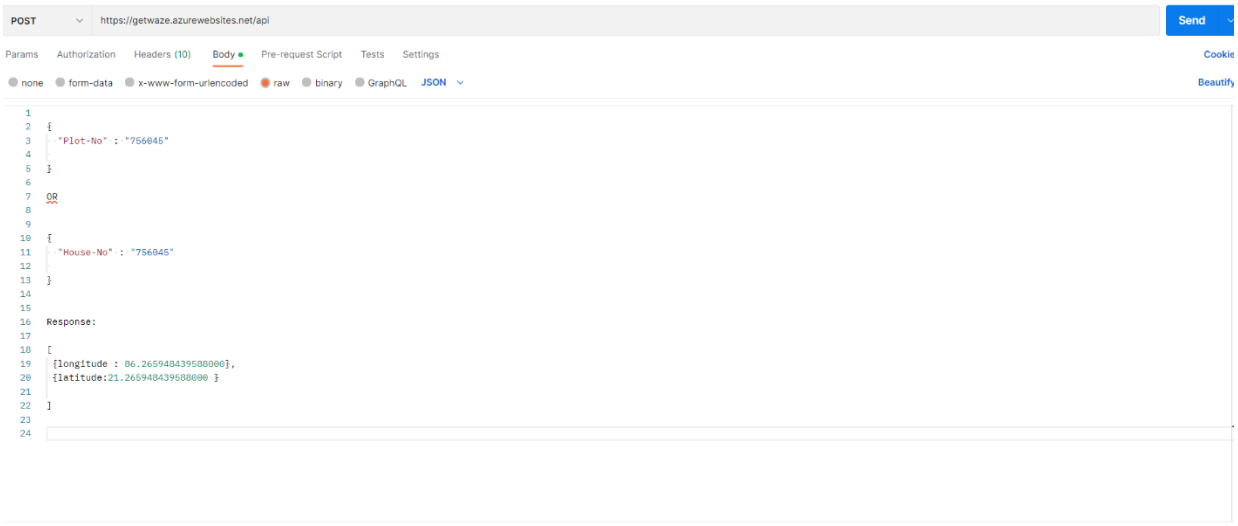


Figure 34

The restful implementation would cater to the need of the mapping service who needs to use the data to be precise the location data. The data should be accessible via parametrized calls. For example, when a mapping service wants to use the data, they should be able access it easily. When they want to access any data, for instance village, street, house number, they should be able to do it. We have all the implementation available, and we can do more specific implementation as the code is json based and follows industry standard. The data model was evaluated with google my map, which paved the way for restful development. The above testing also gives a few insights to develop restful calls. The API development is made after a lot of research. We have applied standard Microsoft technologies to build our API for testing. We have used some of the tools used by developers.

3.6. Restful API Implementation.

We have already discussed about the api restful implementation above. The main goal is to develop restful service for the database. The data model is designed to ease the data upload, now the api will be there so the data can be accessed easily as and when needed. The technology here is asp .net core. Below we have mentioned api controller architecture from Microsoft. We have taken reference from the standard implementation and applied changes according to our project. Please find the link here MSAPITutorials

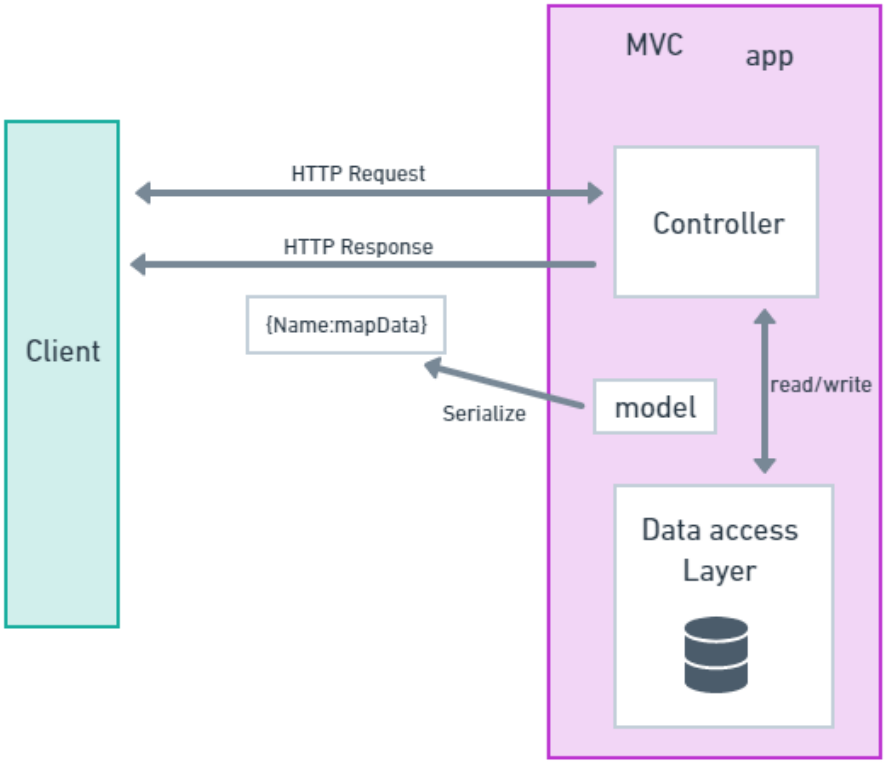


Figure 35

3.7. Technical steps in high level and Details.

Create project in Visual Studio 2022.

Create project having template **ASP.NET Core Web API.**

Confirm the framework is .NET 7.0 (or later).

Add a model having a class mentioned below.

3.7.1 Restful API Code Structure.

The code structure of the restful service of this project mentioned in the appendix A of this document. The appendix would hold the screen shot representation of the tool we have used. When the code structure would be same when it is downloaded by any standard coding application. For more details, the GitHub repo could be shared and discussed.

3.8. Deployment of restful api and Swagger

Let us understand how to deploy the restful service here. This is very straight forward implementation. The solution built in ASP .net and can be deployed in windows docker. Once deployed, we can evaluate this though swagger. Swagger is api testing tool which is already integrated in solution to make development test easy and straightforward. The api being designed via standard technologies and here we have applied some of the Microsoft standard implementation. All details are mentioned as links in the relevant sections. The api design very robust as of now so that we can easily scale it according to the usage and demand. We can use any tool to evaluate it, we have already used Postman of the api evaluating this tool has supplied us most of the functionality required to be part of api testing. This tool also incredibly good to run load testing and running automated tests. The Postman tool helped us in quick fixing of issue and in turn the deployment is faster due to easy automated testing.

How to Run:

Download code from GitHub and follow standard process.
Build and run the code according to tool being used for development.
We have used Visual Studio 2022 as development tool here.
If visual studio is used after build is successful.
To run we need to Ctrl+F5 and then swagger will be automatically launched.
And from swagger we can do testing api to verify their functionality.

System Requirement:

The project or solution can be run in windows as above from Visual Studio 2022

Docker in Windows:

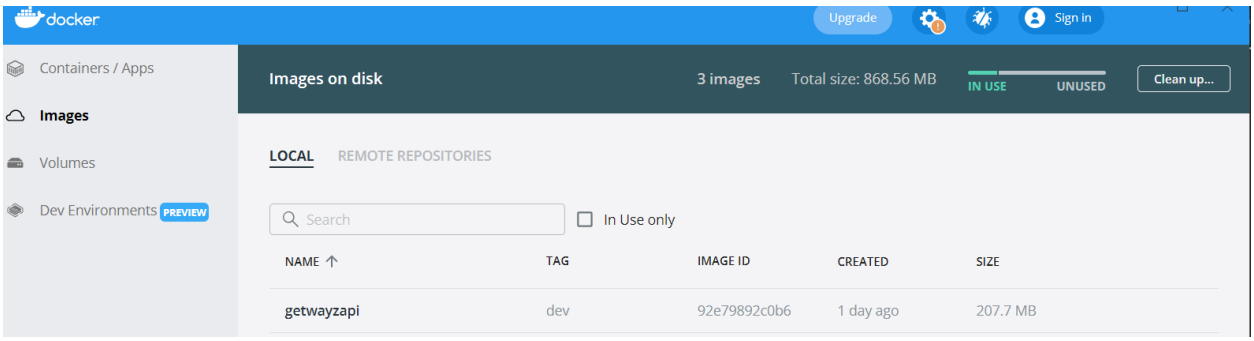


Figure 36

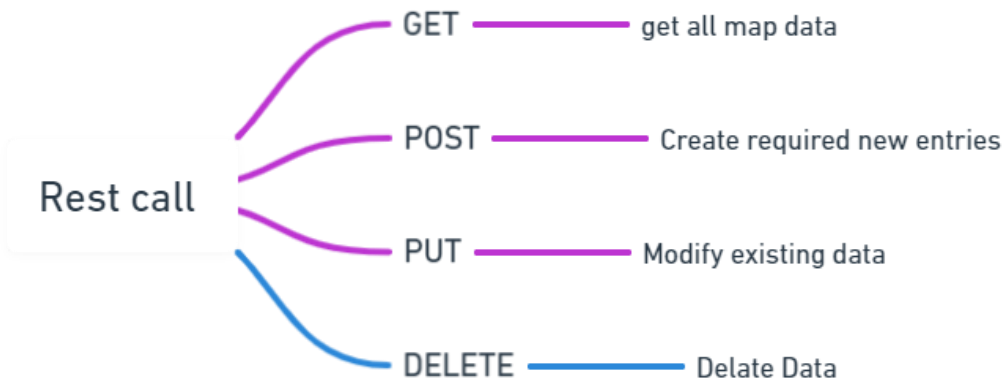


Figure 37

Swagger details:

Swagger is api testing tool and which comes as integrated in solution level. Once a use certain architecture with that swagger can be easily used. Swagger comes with all standard implementation of restful service. In our case we have CRUD operations implemented. Now if we deploy the solution then swagger will be launched so that we can test all out-rest calls. Above an example of rest call being mentioned as well.

3.9. The Architecture

The architecture below is a testimony what needs to be done in this project. This is a high-level architecture as there are still few things yet to be completed. As we know the user interface being developed, this ui will supply the platform for the user to upload data and so in. It is an easy and interactive interface and built on standard technology. Then we come to the database or the hot data which we have shown in the browser after upload. This database and population on the ui are based upon the Microsoft entity framework. Having said that we would like mention that we can also use other database like PostgreSQL and mongo. We have used the entity framework as it is easy to integrate with .net application here. So, one can

easily integrate other database system with our ui and api components. Since rest api is integrated part of this project and securing the API access is important. To do that we have implemented oauth2. The external parties when access api they need to implement the same authorization mechanism to access our api and it will be done with proper credentials. Here we use open source identity and access management toll that is Key cloak .This is very easy and interactive interface where client can be configured with proper permissions .So the client which needs to access the api need to do that by sending access token .when the client sends us request from credentials following oauth2 mechanism .we send a access token in response which the client can use the api for which they are allowed. In the architecture we have also shown user desired gps system which is connected to the back end api and data base so that once can visualize easily. We did not intend to get it deep into the architecture in this document. Since this is a thesis, we have tried give the overview of the architectures which touches all important part as needed. More importantly there could be some development in the future which could also change the architecture or the technology. Having said since we follow the standard concept hopefully, we do not have to change much. One of the important while developing this thesis is about having clear understanding and creating good diagrams and pictures. Because diagrams supply the understanding of the overall flow. At the same time, it is basis of understanding for the audience. While conceiving this thesis we realised that there is a need to show a valuable tool to draw technical diagram. There are so many tools, but we need a tool which is easy one eyes and at the same time all the other main goals like the technical goals are achieved. we have selected a tool whimsical, which is powerful yet user friendly. This is a browser based one can open the link in browser and start drawing and create many technical and architectural drawings. This has supplied me great confidence while developing this thesis.

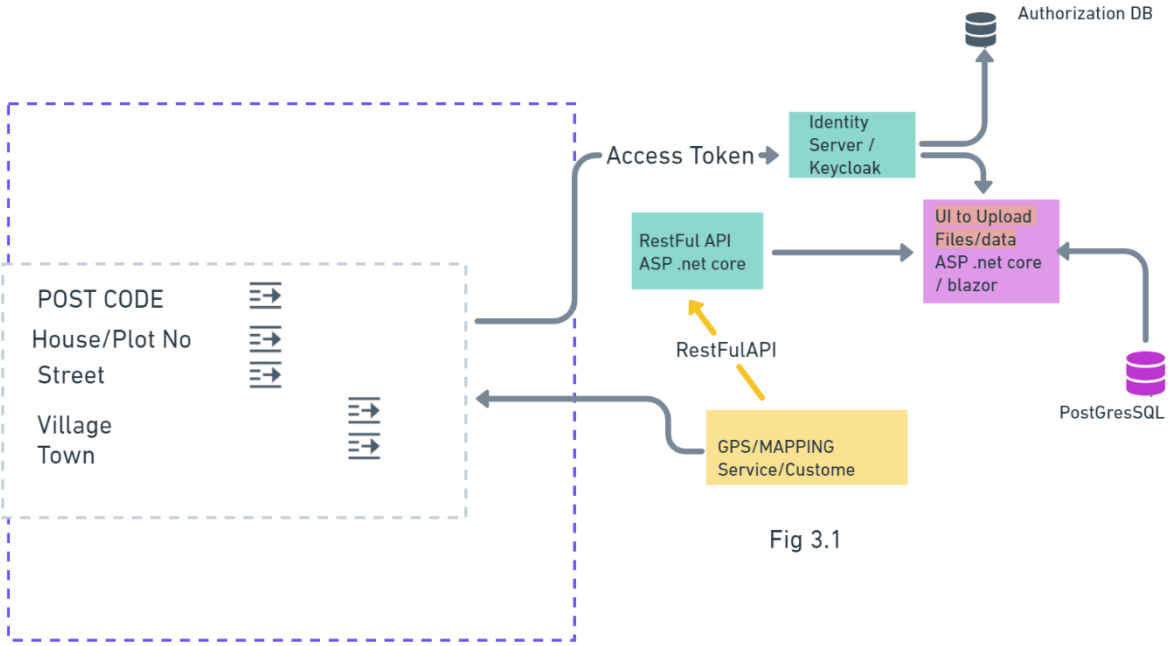


Figure 38

3.10. Mapping interface envisioned by a User.

As we have discussed about the goal so many times in this subject. The below section which got a schematic representation of the same. How a commuter or driver would like to travel across point to point in Indian cities and villages. Moreover, what are the smallest things one would need so that a route can be created. We have taken example of a house back in India to make it more precise. The location here is created by (Google map). This user display thing has been created to give a context to this thesis so that one can relate to this initiative. We all know about GPS and how it looks like but for us with the map database we wanted to mention this explicitly for better understanding.

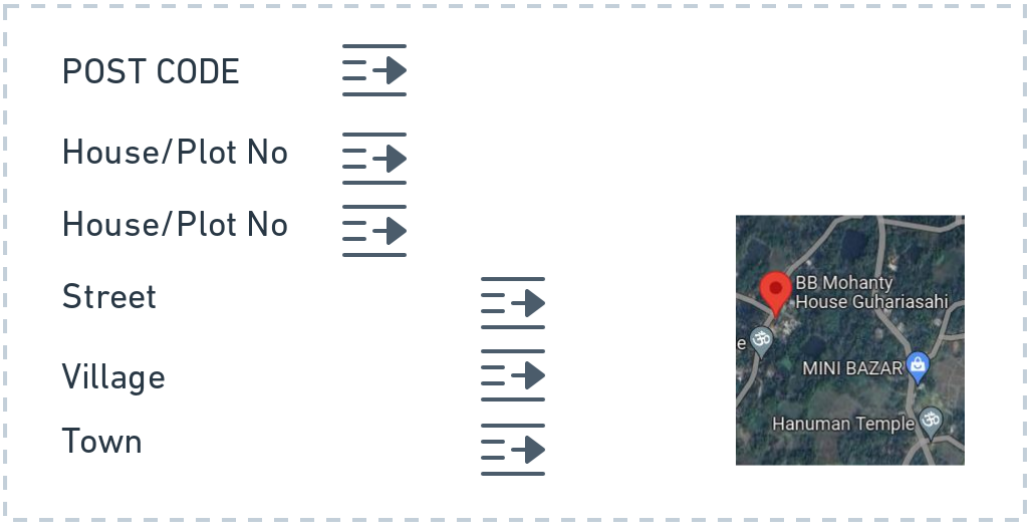


Figure 39

4. Conclusions

To conclude here we would like to focus on few areas. Most important being the ui development and the testing of ui. We have completed the ui development and evaluated the ui and uploaded the data as expected. The developed ui are being used by some user for necessary improvements. The data uploaded via the ui also persisted in the database and displayed as hot data in the browser. One can also store data and persist it using another database system as we mentioned before. Once we have ui and database ready then we thought of developing a restful service. The restful service would supply us different api to access the data from the data base. For example, if a mapping service want to retrieve the villages in a specific postcode to create route, then our rest service can provide that. Another example may be, if the service wants to cross check between longitude and latitude of requested location that also can be retrieved and compared as needed. In nutshell rest service would give necessary mechanism for the developer community to work with the data. All details of api calls with this link. The restful services being evaluated by swagger. We

have tried to create incremental product following the industry standard. Now a days software project developed by implementing agile framework. So that we can get necessary feedback after each cycle. After each cycle we would be able to deliver something tangible. The tools being used here for project management are Jira. We also got some tools for test management Xray. All these tools will ensure the process are followed to get good result. The restful service is cloud based and for that we have AzureDevops.The. AzureDevops.The ensure quick and standard deployment. The testing would be easy and can be easily scaled up as per requirement. All our code is part of AzureDevops.The approach taken by us or though we have here to implement this solution may not be adequate. There is possibility that lack of knowledge or understanding. But we have an honest approach to solve the problem and thought of doing in this way. This may not be proper solution, but this will pave the way for others to create a solution to solve the problem.

4.1. Improvements Envisioned.

We did so many assumptions in this project. So, there will be improvements in future which will be done facts rather than assumptions. Risk analysis has not been done as expected as well. Here we deal with location data so security of this is also one of the areas where we need to improve. There could be a unique way to solve this problem may be more effective way to address this real time issue. We have already assessed our solution with Google's My map. We need to do more testing around the solution with more real-time data. One more implementation comes to mind based on this solution is Geo tagging. In the below article we have discussed more about Geo Tagging. The process needs to be improved to get accurate data. Since accuracy is especially important for our project the validation of data needs to be stricter and more defined. As part of the improvement, we should create processes which will enable us to deal with precise data.

4.2. Accurate Geo Tagging Implementation can be done with the map Database.

Once the map data base is created it can also be used in specific geo tagging. For examples businesses running in specific area or neighbourhoods can be benefited by that process. As in India mobile use is very

dominant in last 5 years thanks to the less mobile subscription charges for internet. The massive use of mobile also done to find restaurants, businesses, activities etc. With this map database being available, we can use this data to geo tag more specific other than longitude and latitude we can also share address like street name etc. Which will make geo tagging more specific and users or customers will get benefited with this along with the businesses. We are talking about Geolocation app. The questions stay is how it would help the average person or the businesses. In the below sections we are going to discuss few things about geo location app and how our map database can be used for doing this more specifically.

4.3. Geo location app development and Emergency tracking with our map Database

Once we have the database and specific address of the household and establishment available this can be used by technology to supply whole lot of information around the address and these data can be used for Information, Social, Communication and marketing purpose. If we compare current scenario, then from the mobile one can get the coordinates but the not exact address of the house or establishment.
If someone agrees to share his house address which can be more specific than the coordinates it is not possible in current scenario. Another reason could be some people could be easy on their address rather than sharing the coordinates or location. Another example could be in case of emergency or medical scenario the specific address can be reached, and action can be designed accordingly. Bottomline the map database which is being developed not only help us in GPS routing also could help us for other social and commercial purpose. Please find this link to be more contextual CareXM.

4.4. A specific Indian Context in Case of Emergency

Since there is no map data base and no routing available. Let us have a situation where there is an emergency in an Indian household, and they wanted an immediate help and wanted to pass the information to the authorities. With the map database now and routing available one can easily pass the address. Since the address in the database and routes available it would be easy for the authorities to take decisions and help and aid can be reached very quickly and precisely. One can always argue we can share the location

or coordinates etc. But it is not extremely hard to imagine that a specific address location is way better then location from mobile.

5. References

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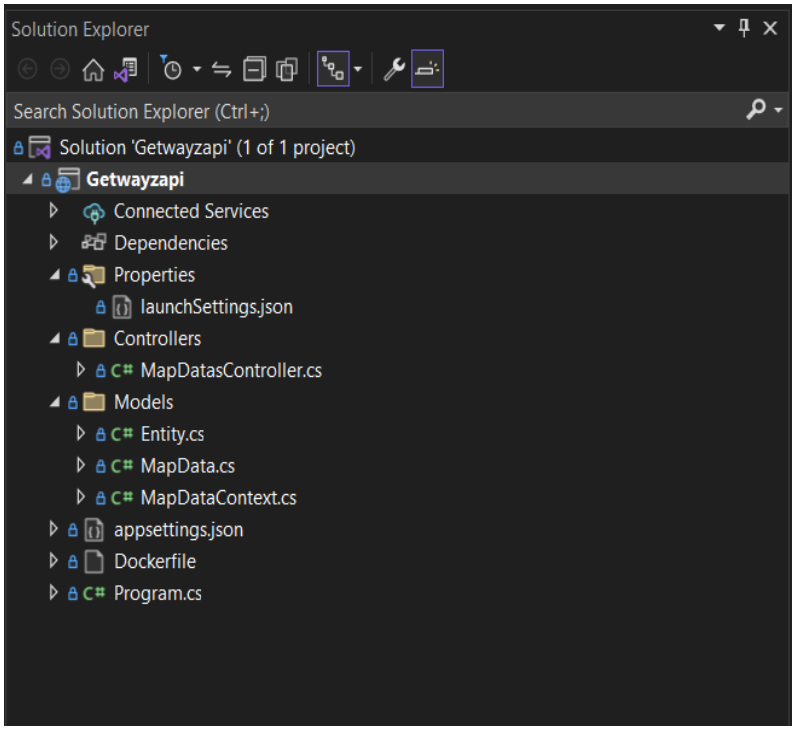
6. Appendix A

Here the code structure and different components of the rest api can be found here. This capture is from specific tool visual studio tool, but the folder structure stays the same despite the applications used for coding and building. This structure and part are all about REST API implementation details. Please find the solution explorer view below. The below representation of the code structure is symbolic and only for understanding perspective.



The class with the [ApiController] attribute. This attribute shows that the controller responds to API requests. Applies DI to inject the database context (MapDataContext.cs) into the controller. The database context must be used in each of the CRUD methods in controller. Once the controller is created the api can be accessed and required parameter could be retrieved as per requirement, we also got swagger integrated here to support the testing part so that user can test all our api, for example if one must make get all map data this api can be performed as part once the api are deployed.

7. Appendix B

7.1. Declaration of Authenticity

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Declaration of Authenticity

I hereby declare that I have completed this Bachelors/ Master's thesis on my own and without any additional external assistance. I have made use of only those sources and aids specified and I have listed all the sources from which I have extracted text and content. This thesis or parts thereof have never been presented to another examination board. I agree to a plagiarism check of my thesis via a plagiarism detection service.

AMSTERDAM, 17-APR-2023

Place, Date

Student signature