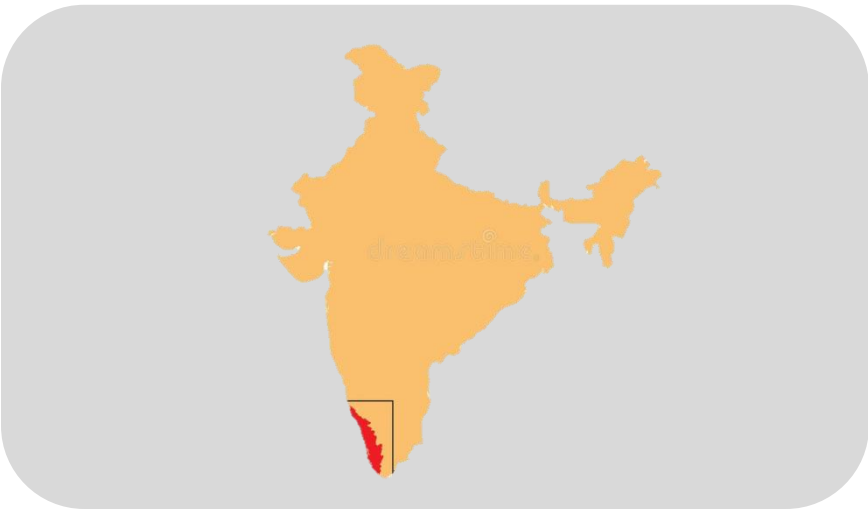


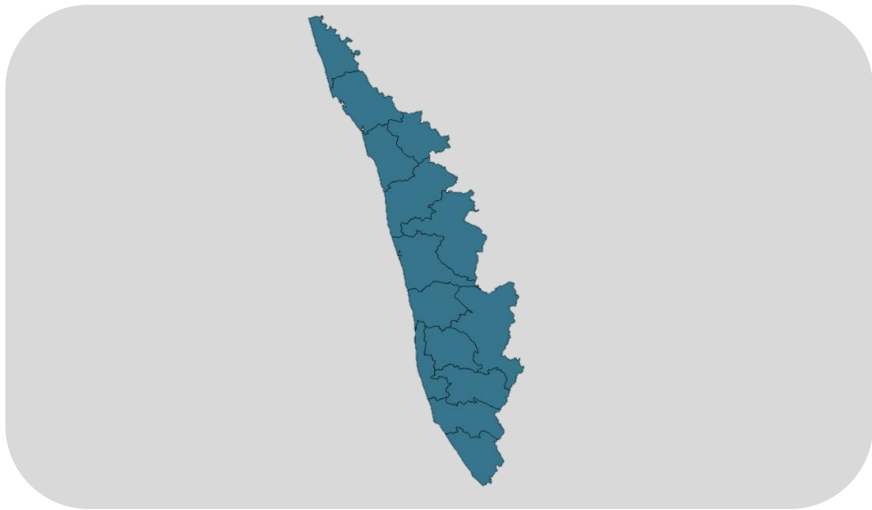
# Viability of water transport for passenger movement in Kochi

Sneha George, Naina Gupta

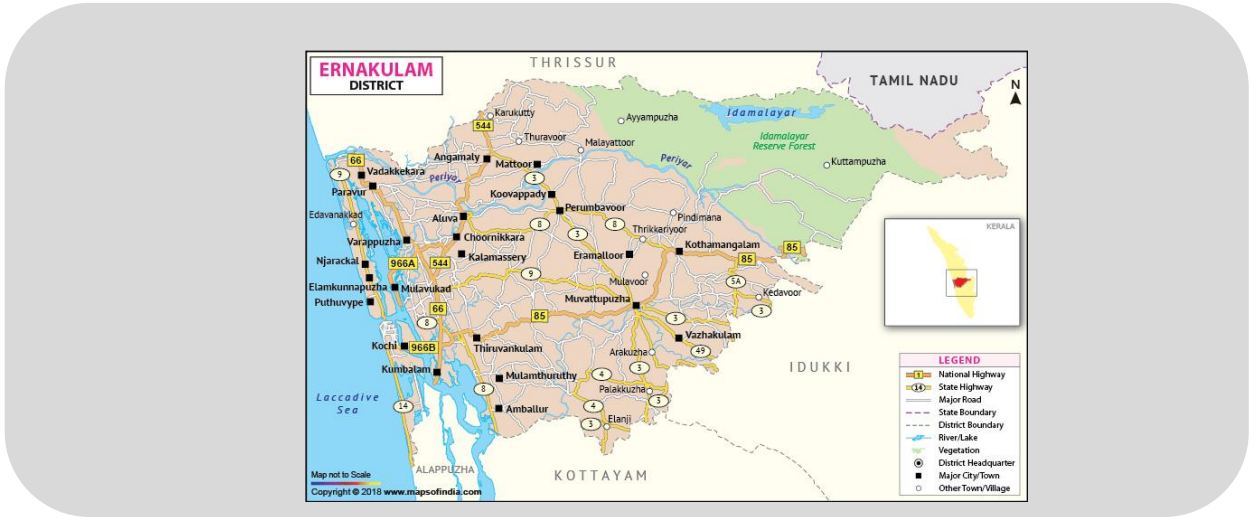
# INTRODUCTION TO STUDY AREA



INDIA



KERALA



KOCHI

Kerala is one of the very few states blessed with a **wide range of water bodies** and Kochi is one among the few cities of Kerala that has access to these water bodies and there is a proposal for **an integrated water transport system** in Kochi. So the city should take advantage of the available water bodies and use them for sustainable transportation.

## NEED FOR THE STUDY

The reasons for the **decline of water transportation** are many. The **commissioning of bridges**, most notably the Goshree bridges that opened in the 2000s has led to people choosing roadbased transportation modes over water transportation. There seems to be a preference among the citizens for door to door connectivity in this area where rains are a constant possibility. **The levels of service delivery in the ferry system have failed to keep up with the expectations of the general public.**

## GAPS IDENTIFIED

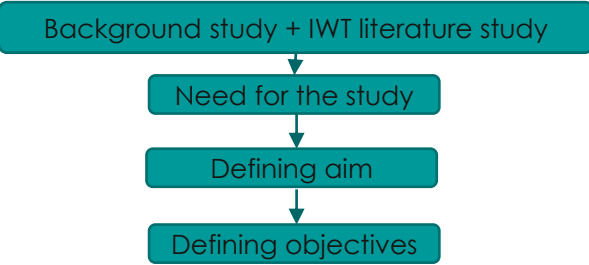
Even though water transport is highly praised by the public of kerala and even though it has **2-3 times lower travel time** compared to roads, people prefer using other modes of transport. Why is that? Very few studies have been done on water transport.

AIM

To critically analyse the usage of water transportation as a service for Urban Passenger transport in the city of Kochi

# STUDY METHODOLOGY

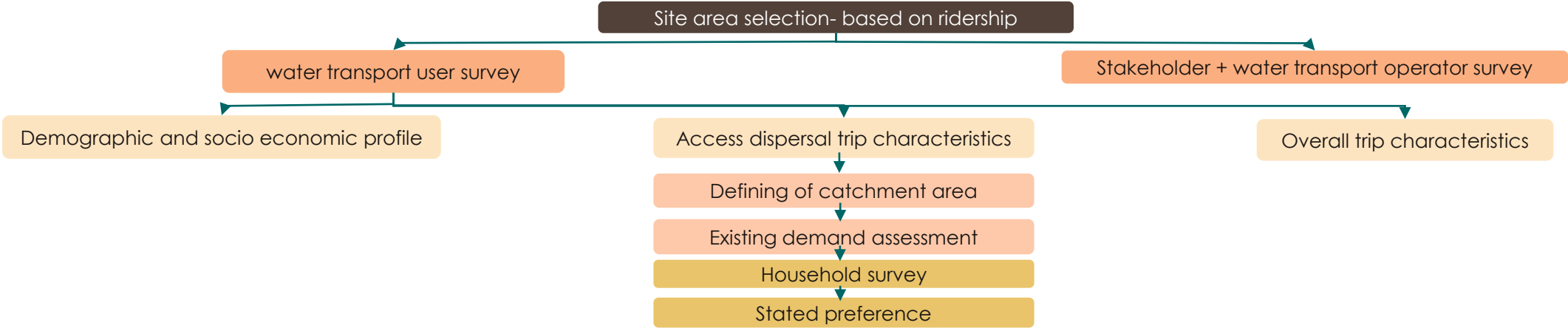
STAGE 1



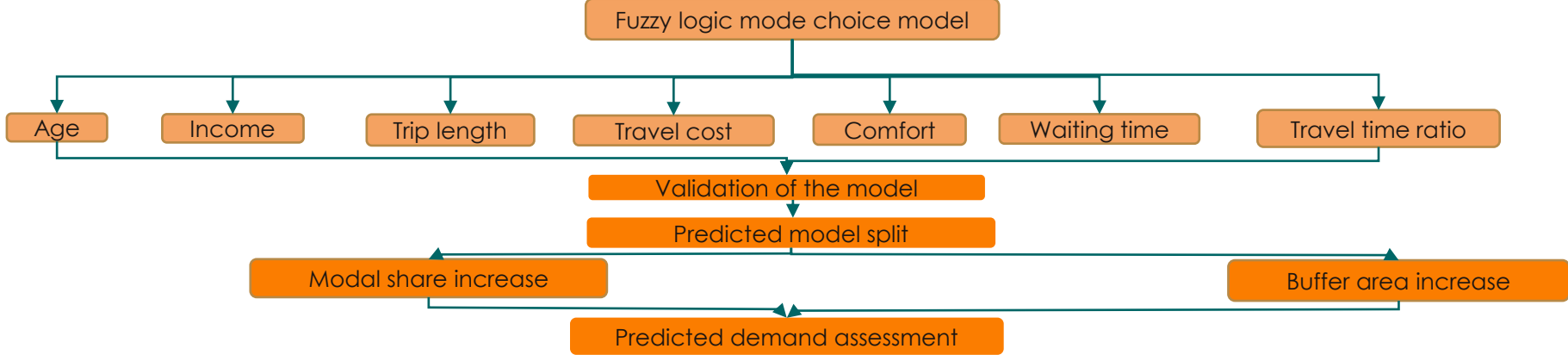
LITERATURE STUDY



DATA COLLECTION



DATA ANALYSIS



PROPOSALS



LITERATURE REVIEW

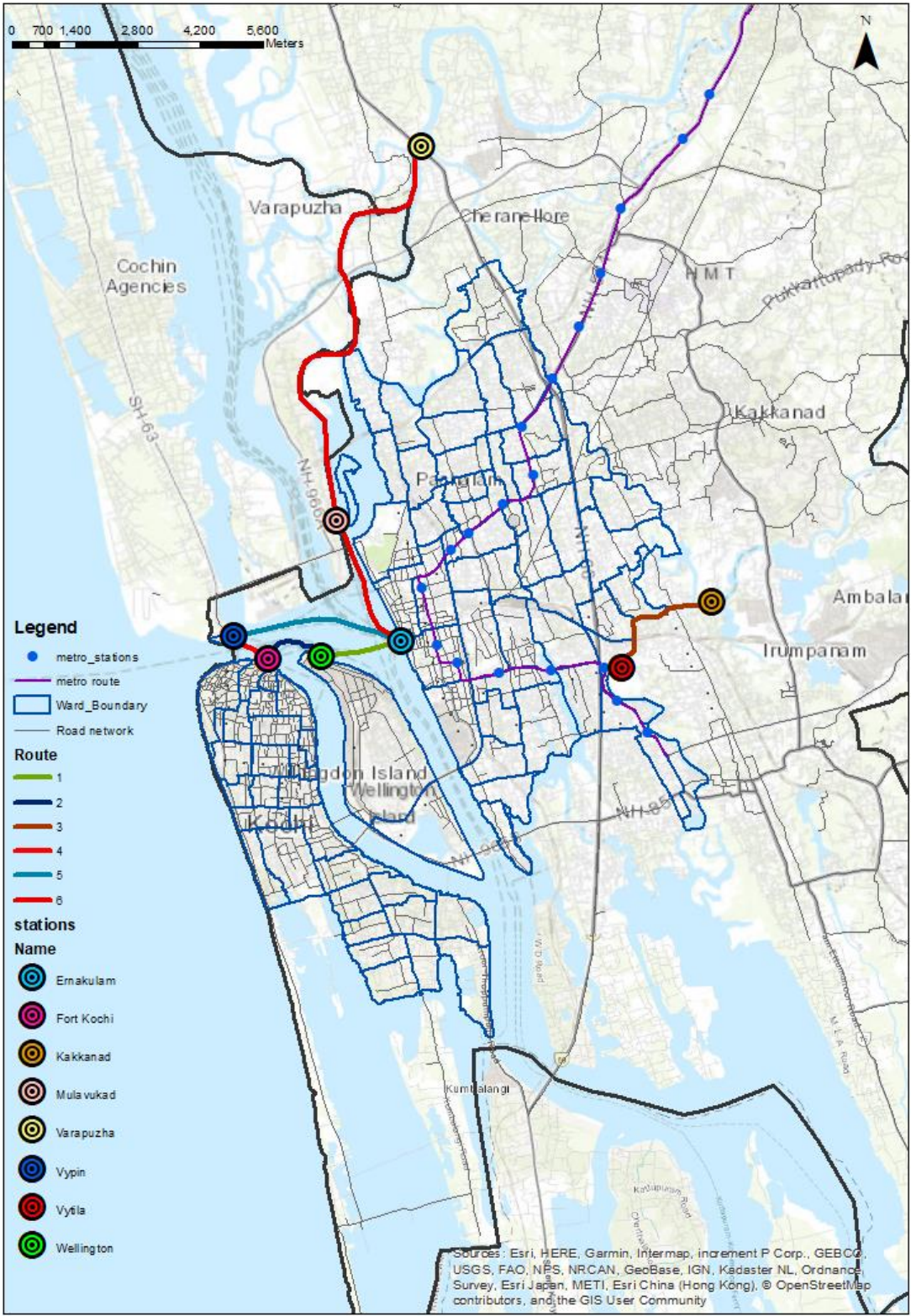
| A case study of Indian metropolitan city (Ashu Shivkumar Kedia, 2015)                                                                                                                                                                                                                                                                                                                                                                                         |                                                    |                                                                        |                                                                       |                                                                                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| Fuzzy logic approach                                                                                                                                                                                                                                                                                                                                                                                                                                          | Basic hypothesis                                   | Major constraints                                                      | Major drawbacks                                                       |                                                                                            |
| ANN model                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Inspired by Human Neural System                    | Performance depends on architecture, training, and activation function | Difficult to interpret the result in terms of natural language        | High                                                                                       |
| Mode share and choice behaviour play a vital role in boosting sustainable transportation, and while conventional logit modelling is used to analyse mode choice, fuzzy logic can better resemble human behaviour by accepting multivariate inputs in linguistic expressions. This study aims to develop a fuzzy logic based mode choice model for education trips, which make up a significant share of mandatory trips across various income groups in India |                                                    |                                                                        |                                                                       |                                                                                            |
| GEV model                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Multivariate extreme value distribution            | Independent, but not identically distributed error terms               | Perceived utility of any alternative should not exceed an upper bound | Low                                                                                        |
| The paper has done fuzzy logic mode choice model to calculate the income impact on mode choice. Similarly the effect of different parameters on modal shift can be analyzed using fuzzy logic                                                                                                                                                                                                                                                                 |                                                    |                                                                        |                                                                       |                                                                                            |
| Household income                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                    |                                                                        |                                                                       |                                                                                            |
| Trip length                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                    |                                                                        |                                                                       |                                                                                            |
| Comfort and convenience                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                    |                                                                        |                                                                       |                                                                                            |
| Travel mode                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                    |                                                                        |                                                                       |                                                                                            |
| Planning and evaluation of passenger ferry service in Hong Kong (CEDER, 2006)                                                                                                                                                                                                                                                                                                                                                                                 |                                                    |                                                                        |                                                                       |                                                                                            |
| Fuzzy set theory                                                                                                                                                                                                                                                                                                                                                                                                                                              | Based on underlying assumption of commensurability | Input values should be fuzzy                                           | ability and difficulty in deciding membership function (tuning)       | Origin<br>Destination<br>Fare for travel<br>Waiting time<br>Trip time<br>Comfort of travel |
| Designed a planning approach combined with an evaluation procedure on how to make the best use of the existing water and pier resources.                                                                                                                                                                                                                                                                                                                      |                                                    |                                                                        |                                                                       |                                                                                            |
| The process included steps starting with                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                    |                                                                        |                                                                       |                                                                                            |
| Calculate avg. Origin Destination (OD) for peak & off peak & daily periods, Calculate WT, Calculate empty seats, model Ferry travel time to determine fleet size, Cost of travel evaluation.                                                                                                                                                                                                                                                                  |                                                    |                                                                        |                                                                       |                                                                                            |
| Demand is projected for the horizon year, MNL is used to find modal split and opinion survey is conducted and put in regression model.                                                                                                                                                                                                                                                                                                                        |                                                    |                                                                        |                                                                       |                                                                                            |
| Better chairs                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                    |                                                                        |                                                                       |                                                                                            |
| More safety                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                    |                                                                        |                                                                       |                                                                                            |
| Stability                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                    |                                                                        |                                                                       |                                                                                            |
| Fleet size                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                    |                                                                        |                                                                       |                                                                                            |
| First mile mode                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                    |                                                                        |                                                                       |                                                                                            |
| Mainline mode                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                    |                                                                        |                                                                       |                                                                                            |
| Last mile mode                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                    |                                                                        |                                                                       |                                                                                            |
| Walking time to station                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                    |                                                                        |                                                                       |                                                                                            |
| Minimum frequency required in each vessel                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                    |                                                                        |                                                                       |                                                                                            |
| Minimum travel time for best PT competitor                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                    |                                                                        |                                                                       |                                                                                            |

Fuzzy logic model  
Mamdani Approach

- Advantages
- Intuitive
  - Well-suited to human input
  - More interpretable rule base
  - Have widespread acceptance



# SELECTION OF STATIONS FOR THE STUDY



| Route | Route_length(km) |
|-------|------------------|
| 1     | 1.80             |
| 2     | 1.53             |
| 3     | 3.05             |
| 4     | 0.90             |
| 5     | 3.81             |
| 6     | 13.84            |

|    | Jetty name           | Daily total boarding alighting |
|----|----------------------|--------------------------------|
| 1  | Ernakulam            | 8170                           |
| 2  | Fort kochi           | 6550                           |
| 3  | Wellington island    | 2450                           |
| 4  | Mattancherry         | 1850                           |
| 5  | Vypeen               | 1600                           |
| 6  | High court jetty     | 515                            |
| 7  | Pizhala              | 330                            |
| 8  | Vytla                | 300                            |
| 9  | Kakkanad             | 300                            |
| 10 | Chittoor             | 283                            |
| 11 | Mulavakadu panchayat | 257                            |
| 12 | Thandonithuruth      | 225                            |
| 13 | Varapuzha            | 190                            |
| 14 | Mulavakadu north     | 110                            |
| 15 | Eroor                | 100                            |
| 16 | Kadamakudy           | 80                             |
| 17 | Poonari mangalam     | 75                             |

Detailed Project Report, Kochi water metro 2015



# STATION ANALYSIS

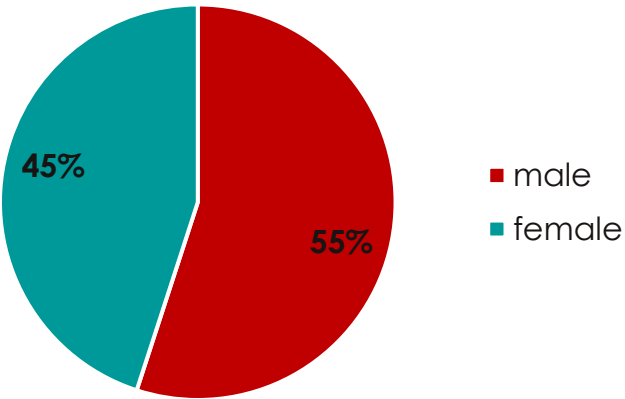
- Main station in Kochi
- Includes officers rooms
- 2 ticket counters
- Ticket fare- 6 Rs
- Luggage ticket- 6 Rs

Embarkation + Fort Kochi

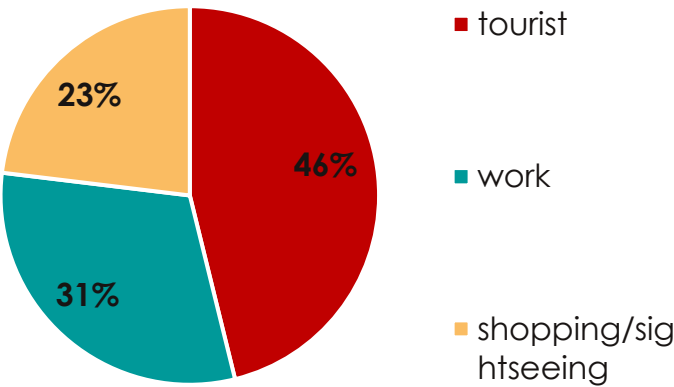
Vypin



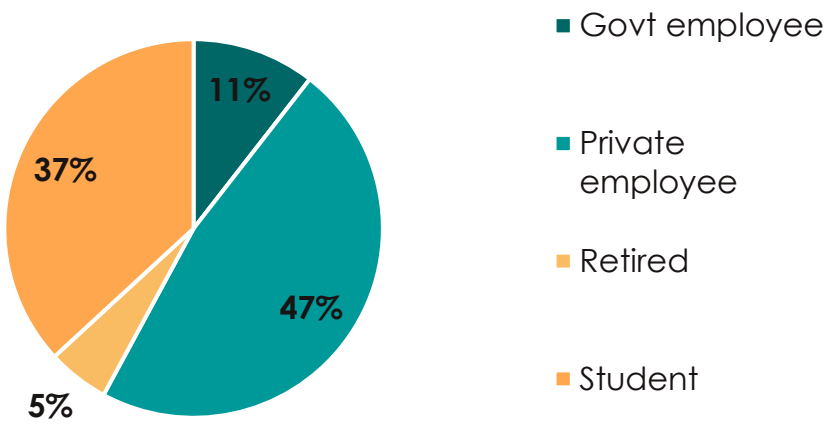
GENDER



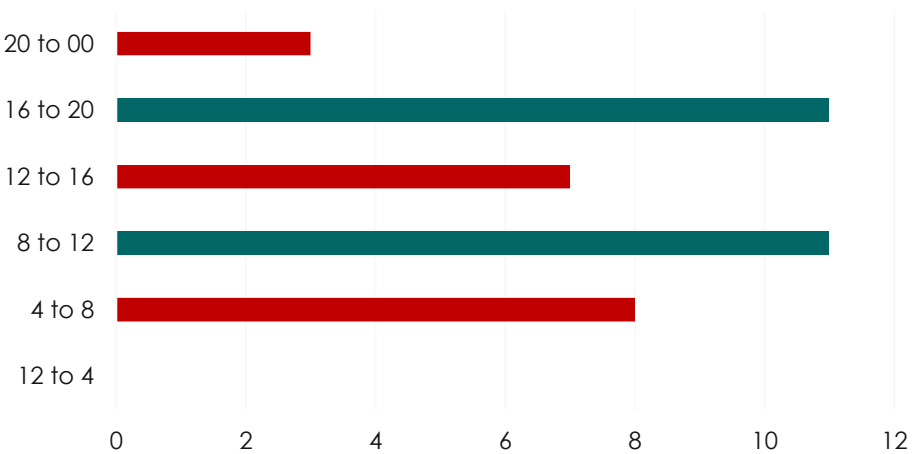
TRIP PURPOSE



OCCUPATION



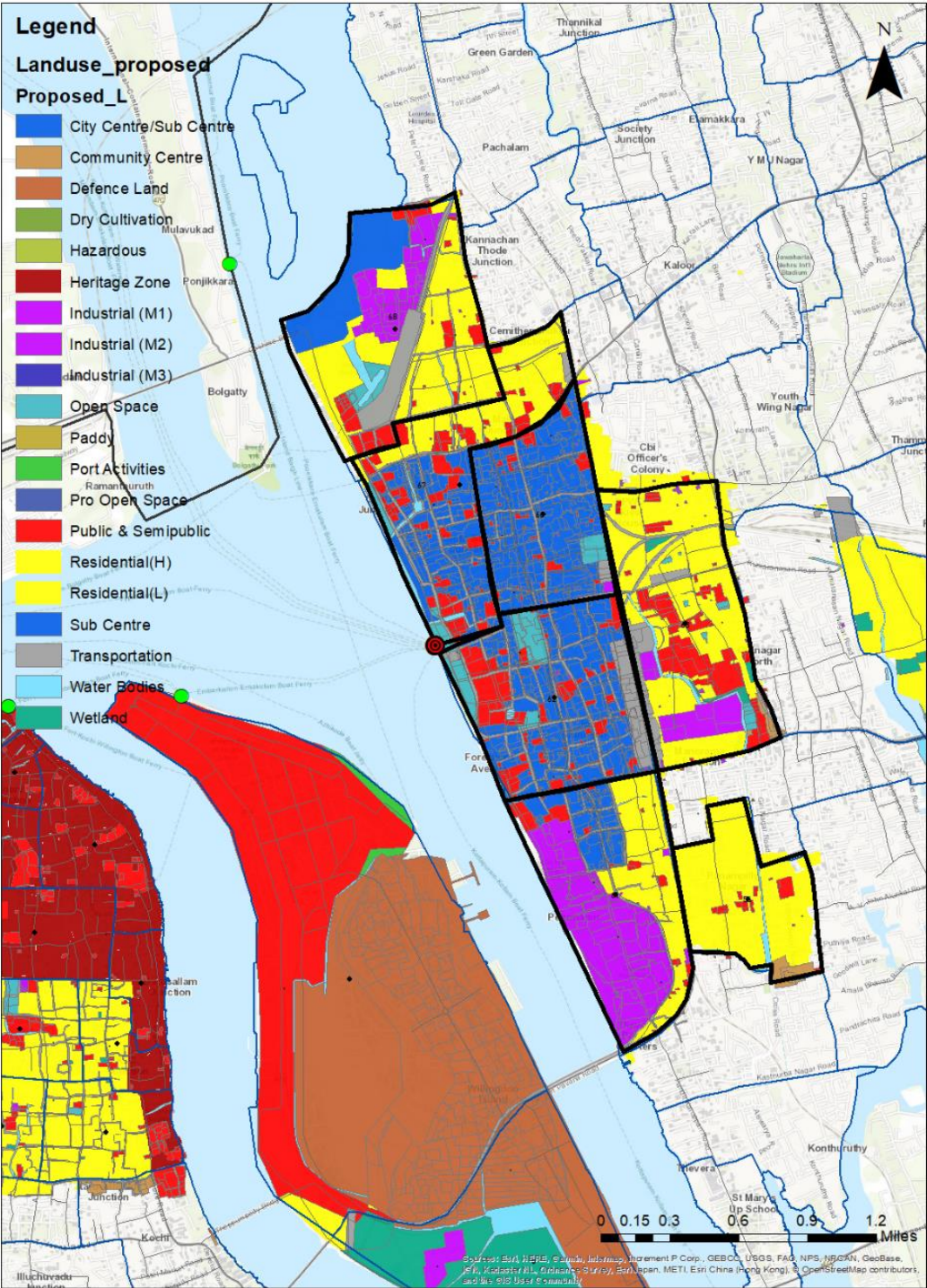
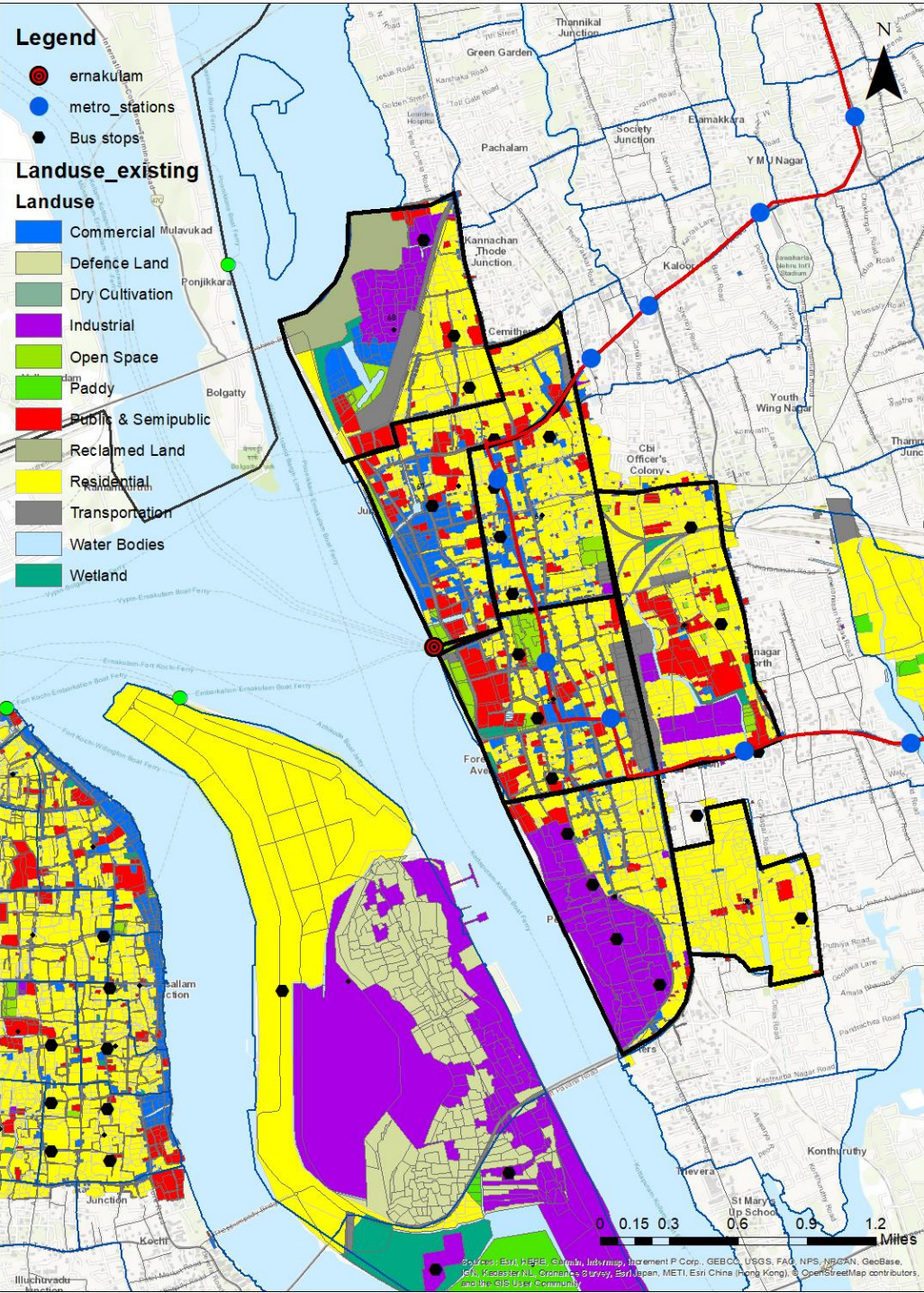
PEAK HOUR - EKM FK ROUTE



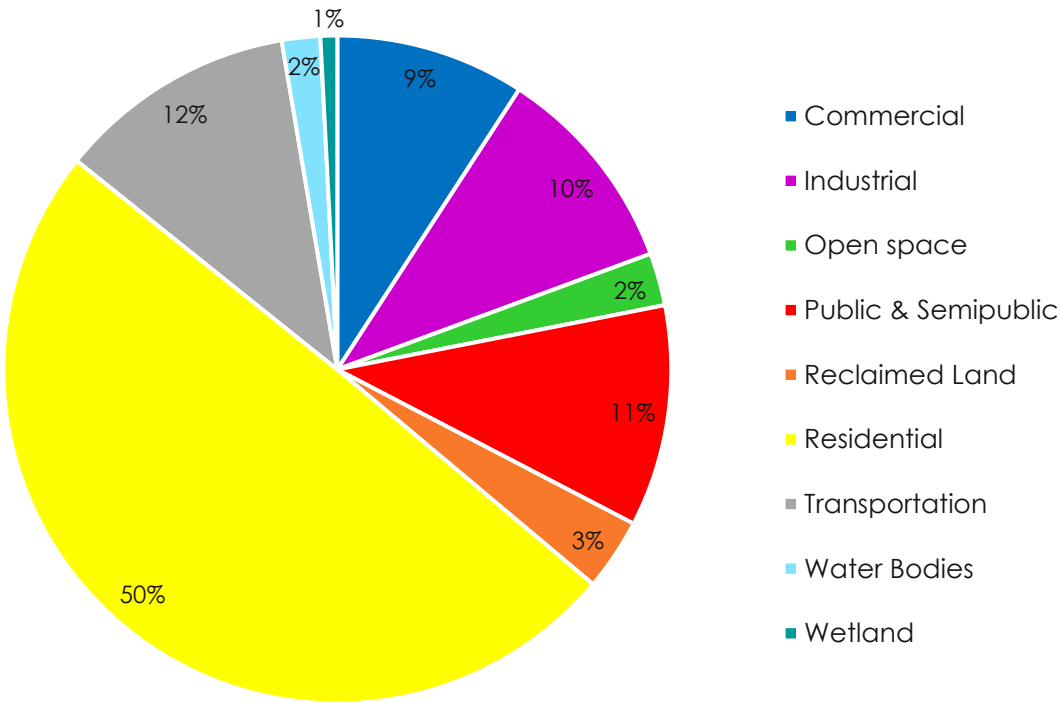
- Ticket counter in dilapidated condition, fungus growth on walls
- Not enough lighting at the station making it difficult for passengers night movement and security
- Overall infrastructure of the building is really poor with no maintenance at all



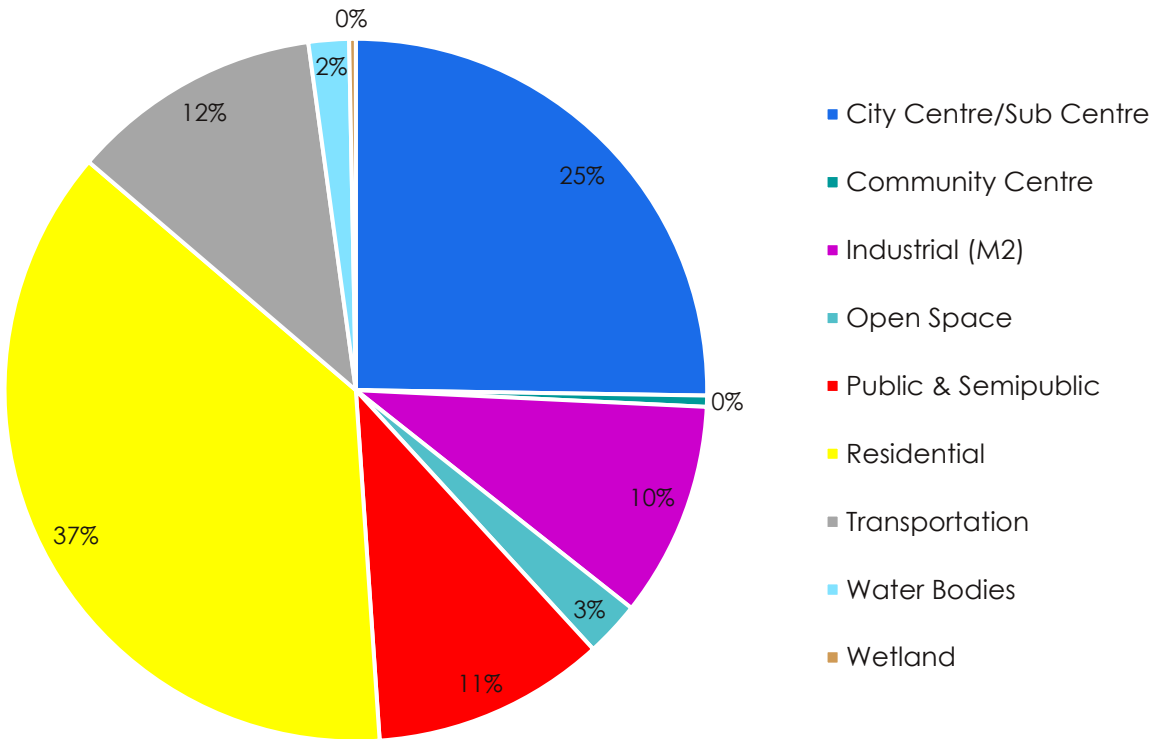
# CATCHMENT AREA



EXISTING LAND USE OF BUFFER ZONE AT EKM STATION



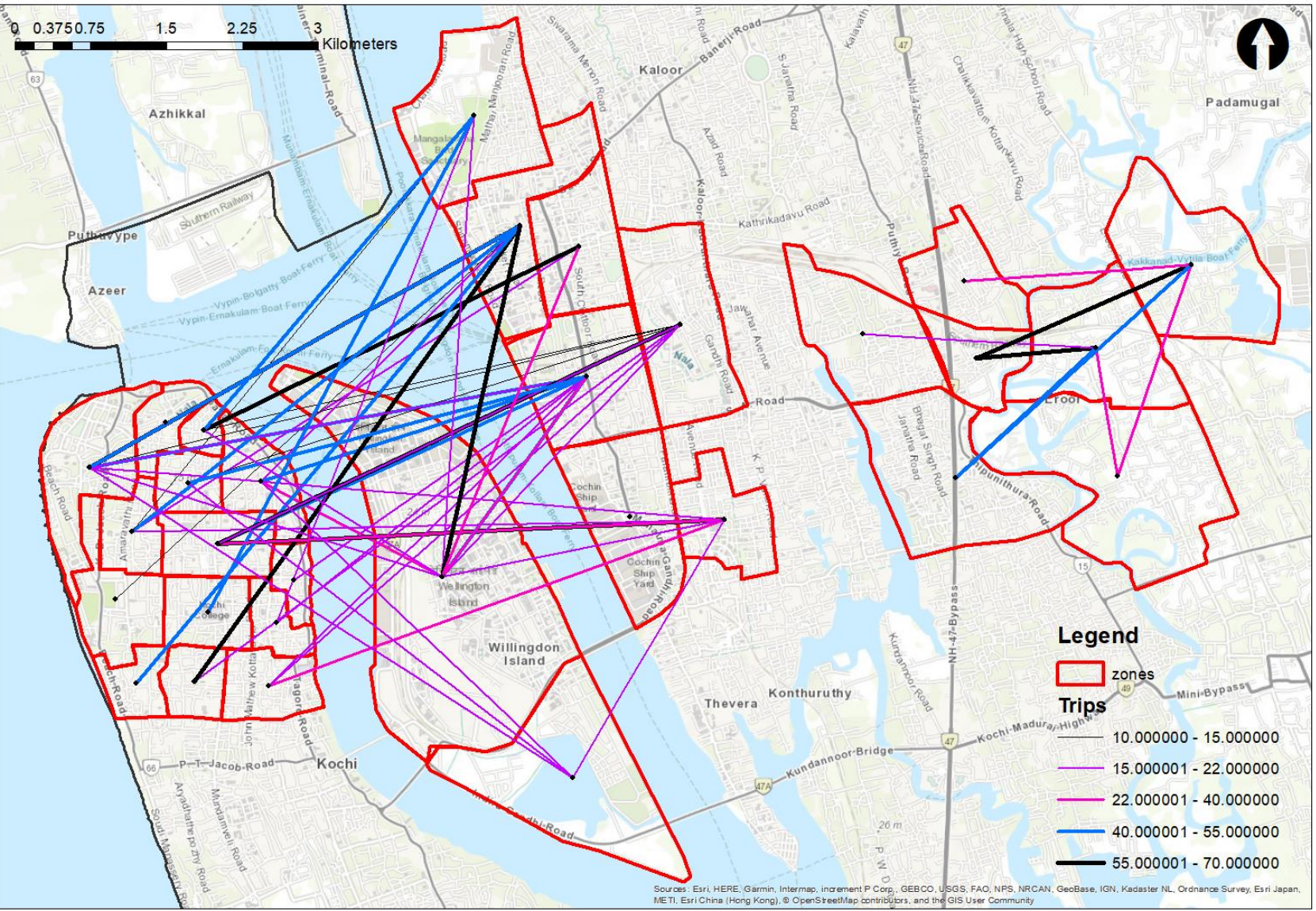
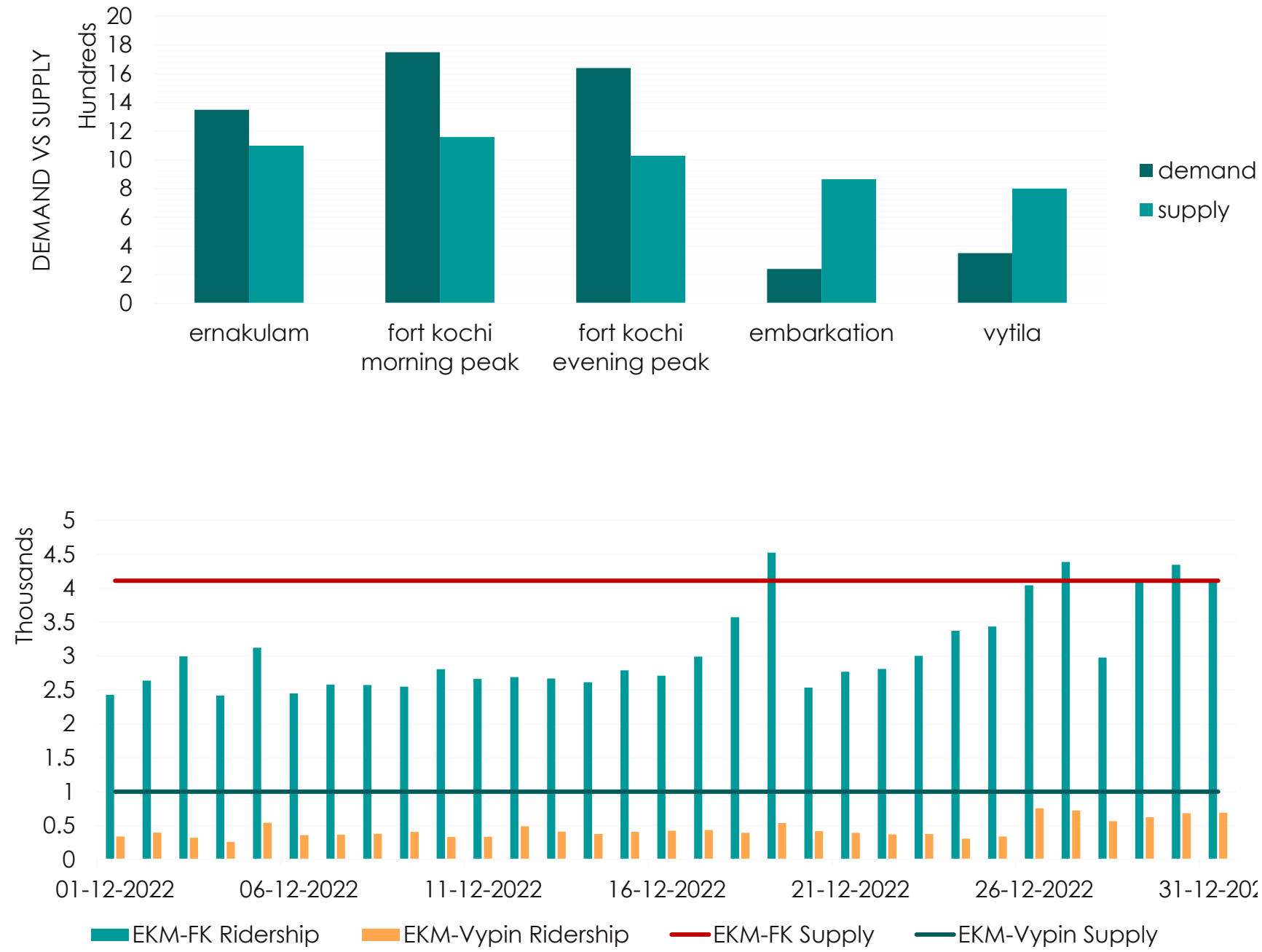
PROPOSED LAND USE OF BUFFER ZONE AT EKM STATION





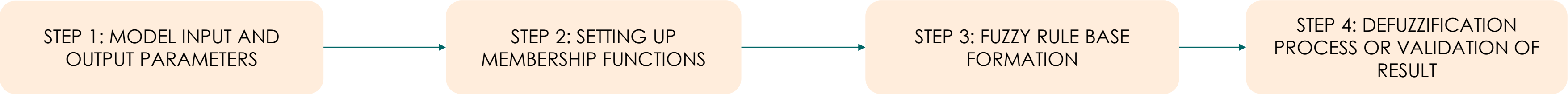
# DEMAND SUPPLY GAP

PEAK HOUR DEMAND SUPPLY GAP





# MODE CHOICE MODELLING



| Age         |                     |
|-------------|---------------------|
| <18         | [0 0 18]            |
| 18-30       | [16 23 32]          |
| 30-45       | [29 37 47]          |
| >45         | [39 65 65]          |
| Income      |                     |
| <10         | [0 0 12000]         |
| 10-20       | [7500 14000 22000]  |
| 20-30       | [18000 26000 35000] |
| 30-50       | [31000 41000 53000] |
| >50         | [47000 70000 70000] |
| Trip length |                     |
| Very Low    | [0 0 1.5]           |
| Low         | [0.5 2 4]           |
| Medium      | [3.5 8 ]            |
| High        | [6 8 10]            |
| Very High   | [9 15 15]           |
| Travel cost |                     |
| Very Low    | [0 0 15]            |
| Medium      | [12 20 30]          |
| High        | [45 60 80]          |
| Very high   | [60 150 150]        |
| Comfort     |                     |
| Low         | [0 0 3]             |
| Medium      | [2 4 6]             |
| High        | [5.5 10 10]         |

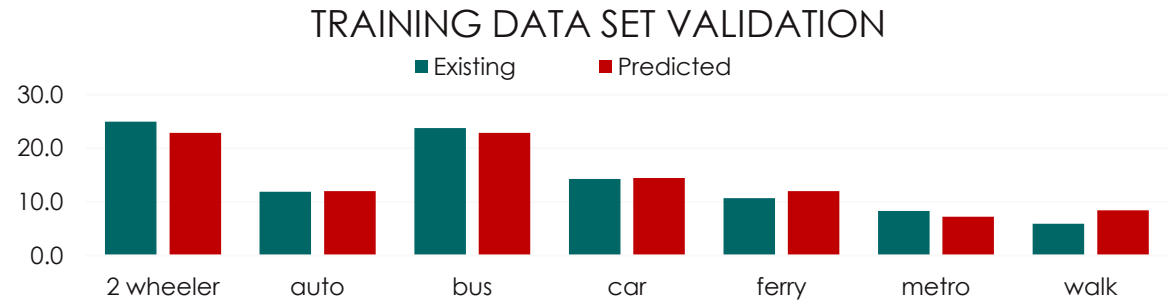
| Waiting Time      |                 |
|-------------------|-----------------|
| Very Low          | [0 0 4]         |
| Low               | [2.5 4.56.5]    |
| Medium            | [5.5 7.5 9.5]   |
| High              | [8.5 10.5 12.5] |
| Very High         | [11.5 25 25]    |
| Travel Time Ratio |                 |
| Low               | [0 0 0.6]       |
| Medium            | [0.5 0.75 1]    |
| High              | [0.9 3 3]       |
| Output-Mode       |                 |
| Walk              | [0 0 1.5]       |
| 3 wheeler         | [1 1.5 2 ]      |
| 2 wheeler         | [1.5 2.5 3.5]   |
| Ferry             | [2.5 3.5 4.5]   |
| Metro             | [3.5 4.5 5.5]   |
| Bus               | [4.5 5.5 6.5]   |
| Car               | [5.5 7.5 7.5]   |

37 rules defined

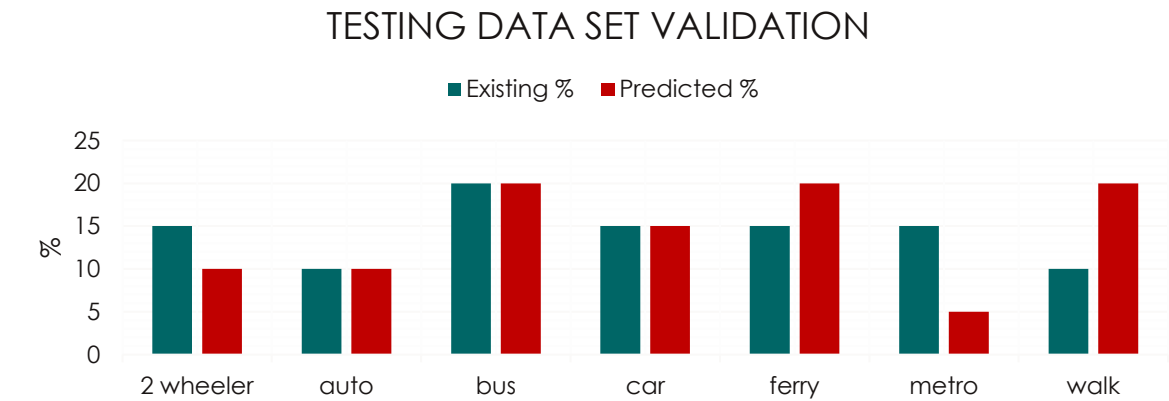
1. If (Age is 1) and (income is <10) and (Trip length is Very low) and (Travel cost is Very low) and (Comfort is Low) and (Waiting time is Very low) then (Mode is Walk) (1)
2. If (Age is <18) and (income is <10) and (Trip length is Medium) and (Travel cost is Low) and (Comfort is Low) and (Waiting time is Low) and (Travel time ratio is Low) then (Mode is Bus) (1)
3. If (Age is <18) and (income is <10) and (Trip length in High) and (Travel cost is High) and (Comfort is Medium) and (Waiting time is High) then (Mode is Metro) (1)
4. If (Age is 30-45) and (Income is 30-50) and (Trip length is Medium)d (Travel cost is Very high) and (Comfort is High) and (Waiting time is Very low) and (Travel time ratio is Medium) then (Mode is Car) (1)
5. If (Age is 18-30) and (income is 30-50) and (Trip length is Low) and (Travel cost is Very high) and (Comfort is High) and (Waiting time is Very low) and (Travel time ratio is Medium) then (Mode is Car) (1)
6. If (Income is 10-20) and (Trip length is Medium) and (Travel cost is Very low) and (Comfort is Low) and (Waiting time is Medium) and (Travel time ratio is High) then (Mode is Ferry) (1)

# DATASET VALIDATION

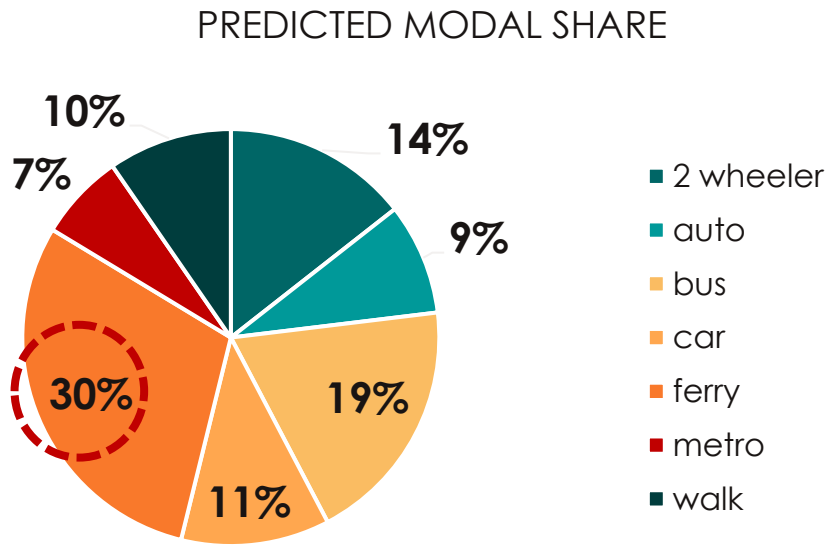
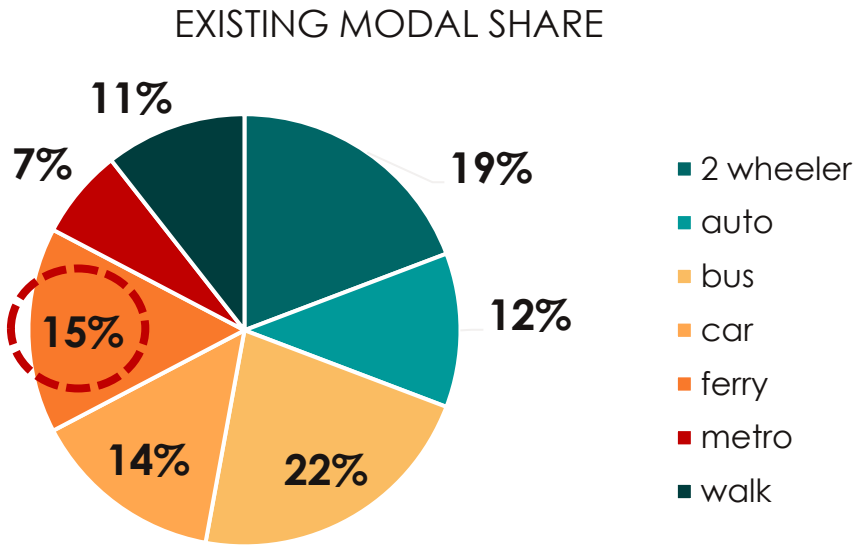
| TRAINING DATA SET- 91 SAMPLES                   |           |      |     |     |       |       |      |
|-------------------------------------------------|-----------|------|-----|-----|-------|-------|------|
|                                                 | 2 wheeler | auto | bus | car | ferry | metro | walk |
| 2 wheeler                                       | 19        |      |     | 1   | 2     |       |      |
| auto                                            |           | 10   |     |     |       |       |      |
| bus                                             |           |      | 19  | 1   |       |       | 2    |
| car                                             |           |      |     | 12  | 1     |       |      |
| ferry                                           |           |      |     |     | 10    |       |      |
| metro                                           |           |      | 1   |     |       | 6     |      |
| walk                                            |           |      |     |     |       |       | 7    |
| ACCURACY= (19+10+19+12+10+6+7)/91= <b>91.2%</b> |           |      |     |     |       |       |      |



| TESTING DATA SET- 20 SAMPLES               |           |      |     |     |       |       |      |
|--------------------------------------------|-----------|------|-----|-----|-------|-------|------|
|                                            | 2 wheeler | auto | bus | car | ferry | metro | walk |
| 2 wheeler                                  | 2         |      |     |     |       |       | 1    |
| auto                                       |           | 2    |     |     |       |       |      |
| bus                                        |           |      | 3   |     |       |       | 1    |
| car                                        |           |      |     | 3   |       |       |      |
| ferry                                      |           |      |     |     | 3     |       |      |
| metro                                      |           |      | 1   |     | 1     | 1     |      |
| walk                                       |           |      |     |     |       |       | 2    |
| ACCURACY= (2+2+3+3+3+3+1+2)/20= <b>80%</b> |           |      |     |     |       |       |      |



| PARAMETER    | EXISTING CONDITION | SCENARIO 1 | SCENARIO 2 | SCENARIO 3 | SCENARIO 4 |
|--------------|--------------------|------------|------------|------------|------------|
| WAITING TIME | 20                 | 20         | 15         | 15         | 12         |
| COMFORT      | LOW                | MEDIUM     | MEDIUM     | HIGH       | HIGH       |
| FARE         | 6                  | 8          | 10         | 12         | 15         |





- Public usage of water transport is highly dependent on the multimodal connectivity
- As there is a great amount of travel time saved using the water transport instead of by road all different mode users are interested to shift but accessibility to the station is found to be the major problem in second with the infrastructure
- Major shift as observed are the 2 wheeler passengers followed by the auto and bus users.
- High likelihood of increased ridership if the infrastructure is enhanced and waiting times are minimized
- In existing public transport services itself interconnectivity showed increase in the modal share of the service stressing on the fact that this is one of the most important factors leading to increased PT ridership. This interconnectivity when designed further has the potential to further boost ridership and make water transport a preferred mode of travel.

THANK YOU