**Modeling Social Welfare by Different Public Transport Modes in Dhaka city**

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| Variable Name | Definition / Purpose | Type / Unit | How to Obtain | Used In Models |
| Mode\_Used | Transport mode used by the passenger (MRT, Bus, Leguna, etc.) | Categorical | Passenger survey | All models (defines mode m) |
| Origin\_TAZ | Trip starting location | Categorical (zone code) | Passenger survey | All models (defines OD pair s) |
| Destination\_TAZ | Trip destination location | Categorical (zone code) | Passenger survey | All models (defines OD pair t) |
| Travel\_Time | Total time spent traveling from origin to destination | Continuous (minutes) | Passenger survey | All (affects U\_{stm}) |
| Fare\_Paid | Current fare paid for the trip | Continuous (BDT) | Passenger survey | All (input to utility, revenue) |
| Wait\_Time | Time waited before boarding | Continuous (minutes) | Passenger survey | Max-B, Max-S (convenience factor) |
| Comfort\_Level | Perceived comfort of the ride | Ordinal (1–5 scale) | Passenger survey | Max-B, Max-S (part of C) |
| Trip\_Purpose | Reason for trip (Work, School, Leisure) | Categorical | Passenger survey | Max-D, Max-S (user segmentation) |
| Frequency\_of\_Use | How often passenger uses this mode | Categorical (Daily, Weekly) | Passenger survey | Max-D, Max-B |
| Income\_Bracket | Approximate monthly income of the respondent | Ordinal (Low, Mid, High) | Passenger survey (optional) | Max-S (equity), Max-B |
| WTP\_Lower\_Fare | Willingness to use more if fare is reduced | Binary (Yes/No) | Passenger survey | Max-D, Max-S (elasticity input) |
| WTP\_Higher\_Comfort | Willingness to pay more for better comfort | Binary (Yes/No) | Passenger survey | Max-B, Max-S |
| WTP | Maximum fare respondent is willing to pay for current mode | Continuous (BDT) | Contingent valuation in survey | Max-B, Max-S (social welfare) |
| d\_{stm} | Estimated demand for mode m from OD pair (s,t) | Continuous (passengers/day) | Calculated from survey & logit model | All models |
| p\_m | Fare of mode m | Decision variable (BDT) | Optimization output / policy input | All models |
| c\_m | Cost per trip for mode m (fuel, labor, maintenance) | Continuous (BDT) | Secondary data, operator interviews | Max-P, Max-S |
| Capacity\_m | Vehicle or mode carrying capacity | Integer (passengers/vehicle) | Operator data or known specs | Max-D, Max-S |
| Congestion\_Cost | Time-based external cost of congestion | BDT/hr delay | Literature / Government reports | Max-S |
| Emissions\_m | CO₂ emissions per km or per passenger-km for each mode | kg CO₂/passenger-km | Secondary data (AQI, reports) | Max-S |
| λ (lambda) | Weighting factor for externalities (monetization of congestion/emissions) | BDT/unit | Assumed from literature (e.g. BDT 50/kg CO₂) | Max-S |
| Subsidy\_Limit | Max monthly government subsidy to operators or users | BDT | Policy assumption / government plan | Max-P, Max-S |
| Revenue | Total fare collected per mode | BDT/day | Calculated: p\_m \* d\_{stm} | Max-R, Max-P, Max-S |
| Profit | Revenue minus cost per mode | BDT/day | p\_m \* d\_{stm} - c\_m \* d\_{stm} | Max-P, Max-S |
| UserBenefit | Total benefit: WTP – Fare paid | BDT/day | ∑(WTP - p\_m) \* d\_{stm} | Max-B, Max-S |
| SocialWelfare (SW) | Combined user + operator – externalities | BDT/day | Full objective of Max-S | Max-S |
| Population\_TAZ | Population living in each Traffic Analysis Zone (TAZ) | Integer (persons) | Census data, government statistics | Demand estimation, equity analysis, segmentation |