Reimagining Urban Mobility: Analyzing the Relationship between Mode Choice and Trip Chaining Behavior in Kota City, Rajasthan India

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Introduction

- The world, including transportation, is changing fast
- Urbanization has led to a growing global population migrating to cities, resulting in more diverse households and complex trip chains. This has increased dependence on travel modes and peak travel periods in cities.
- These conditions influence travel behavior and making it too complex
- Trip chaining is the succession of trip segments all trips start and end at home with trip chains revolving around work and non-work trip segments
- Trip chaining and mode choice are two critical factors influencing a variety of patterns of urban travel demand
- The analysis of trip-chaining is essential for a better understanding of travel behavior, forecast travel demand, and identifying appropriate transportation policies
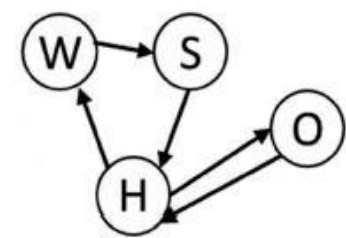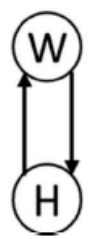
Trip Chain

Simple Chain

consists of two activities and a single destination

Complex Chain

includes all trip-chains with at least two activities

Trip chain type	Sequence
Simple work	h – w – h
Simple non-work	h – nw – h
Complex non-work	h – nw – (– nw –) – h
Complex from work	h – w (– nw/w –) – nw – h
Complex to and from work	h – nw – (– nw/w –) – w – (– nw/w –) – nw – h

1

Study Area

- Kota city is one of the smart city of India has well structured transportation system

- The city area is 221.36sqkm is located in the southeastern Rajasthan state, northwestern India, with a population density of 374 per sqkm

- Public transportation in Kota city consists of city buses

- Intermediate public transportation – auto rickshaws and Ola

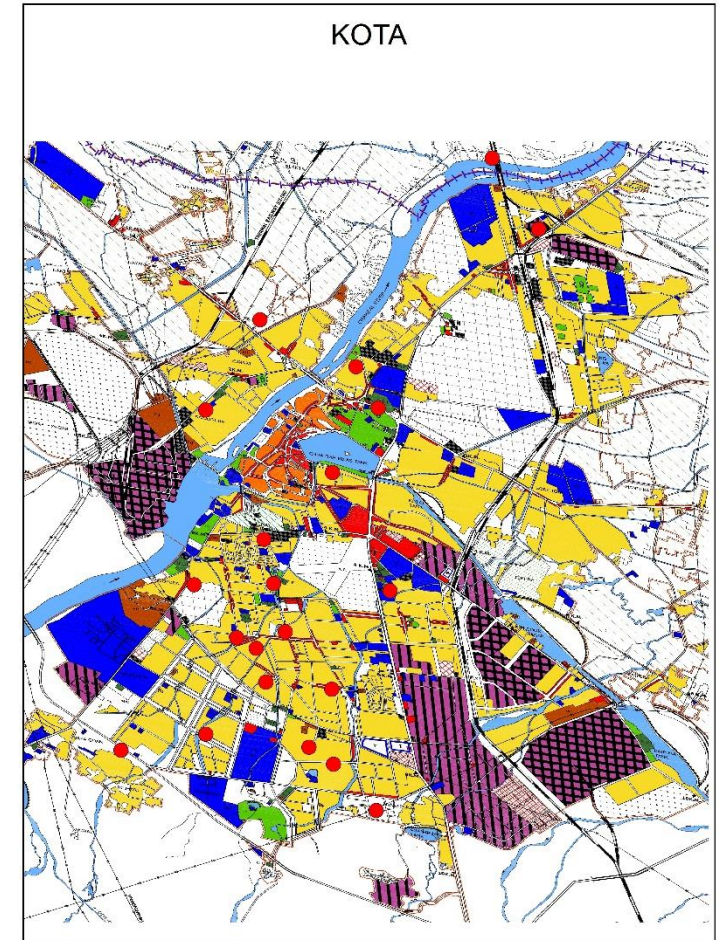- Private vehicles – two wheelers, cars, and bicycles

Fig. 1. study area contextual map showing land use pattern

Methodology

Objectives:

- Analyzing complex trip chain patterns in the typical Indian city

- Studying the factors influencing trip patterns and mode choice

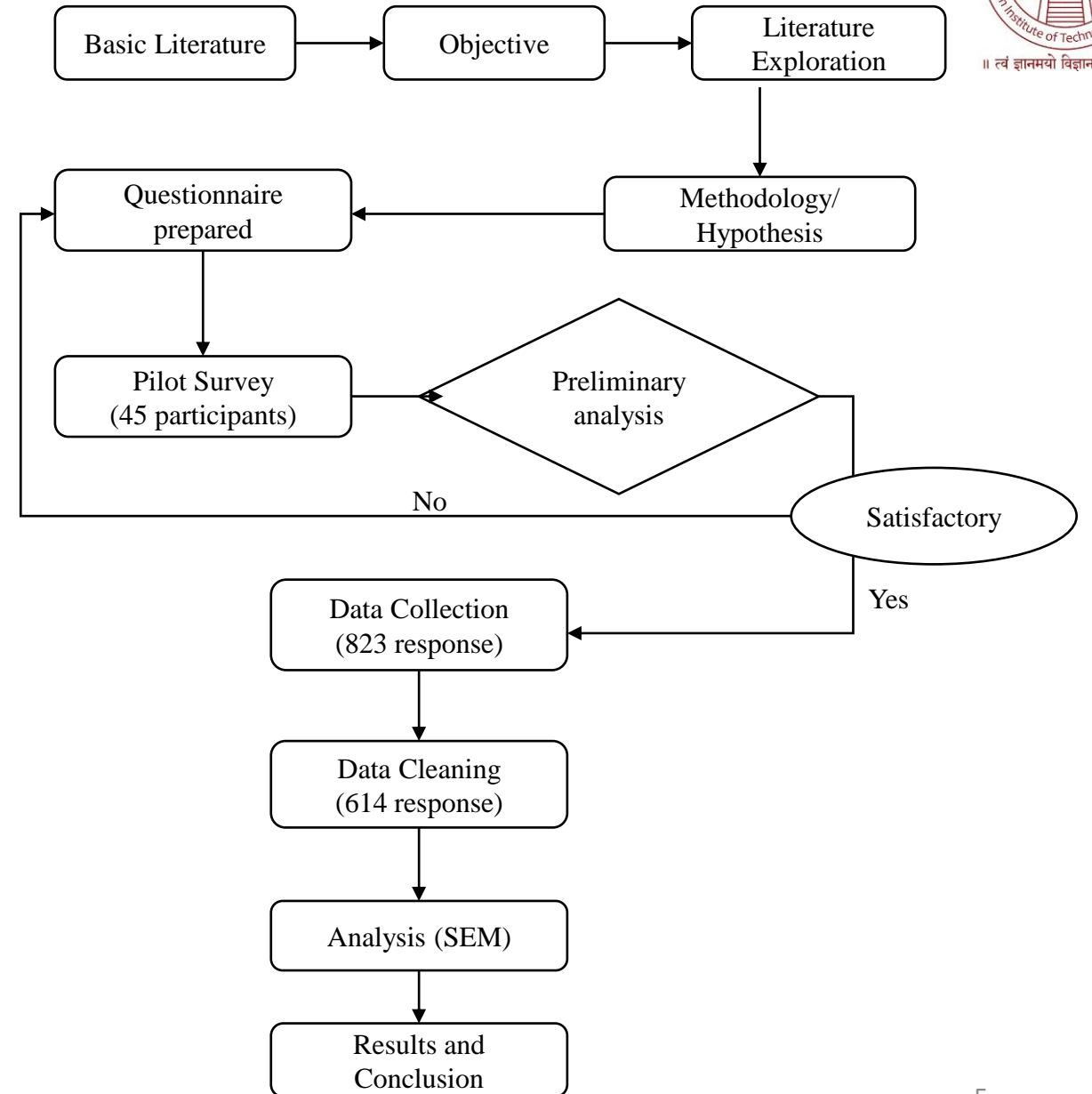- Linkage between the mode and trip chain patterns

Fig. 2. Flow chart of the methodology employed

Structural Equation Modelling (SEM)

- Statistical method used to test and estimate complex relationships between latent variables and large number of endogenous variables.
- Used to study the connection between one or more independent (Exogenous) or dependent (Endogenous) variables
- Used to explore the causal relationships between various factors that influence travel behavior
- There are some complicated relationship between mode choice and trip chain that cannot be done by linear regression
- SEM handles complex and multiple relationships
- Structural equation: relationship between latent variables and exogenous variables $\qquad \eta = \beta.\eta + \Gamma.X + \varsigma$
- Measurement equation: relationship between endogenous variables and latent variables $\qquad Y = \Lambda.\eta + \varepsilon$
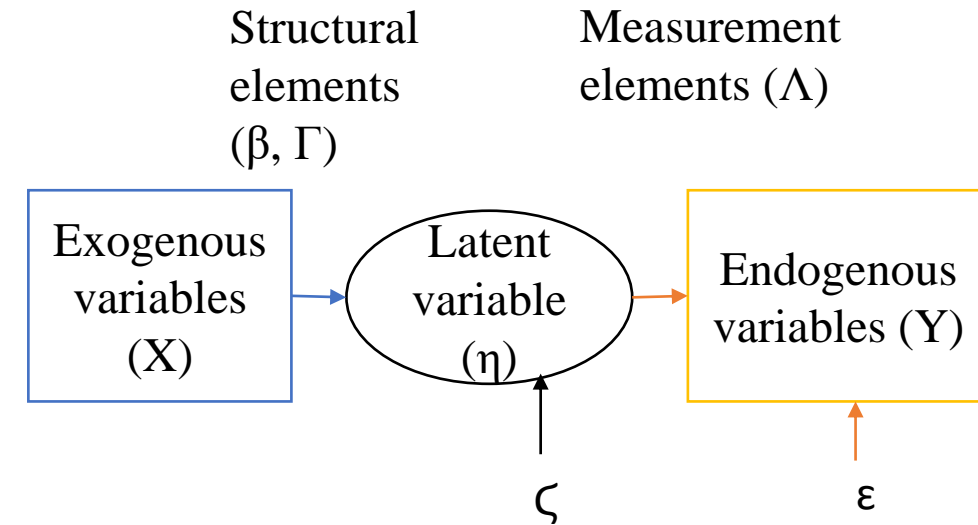
Structural elements (β, Γ)

Measurement elements (Λ)

Exogenous variables (X) → Latent variable (η) → Endogenous variables (Y)

ς

ε

Fig. 3. SEM framework

Data Collection

- **Survey design:**
  - For collecting data questionnaire form is designed
  - There were three different sets of information in the Household survey data these are socio-economic, trip-activity, and attitude-related data
  - A pilot study was conducted with 45 participants

- **Data collection:**
  - The dataset is one-month travel information that was gathered in February 2023 in the various location of the City
  - The dataset comprises 823 respondents, from which 614 were chosen following data cleaning

Fig. 4. Questionnaire snapshot
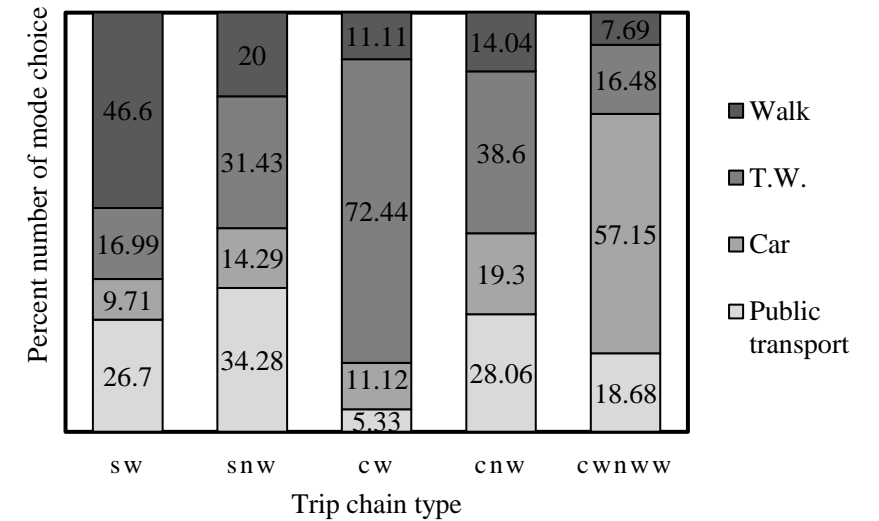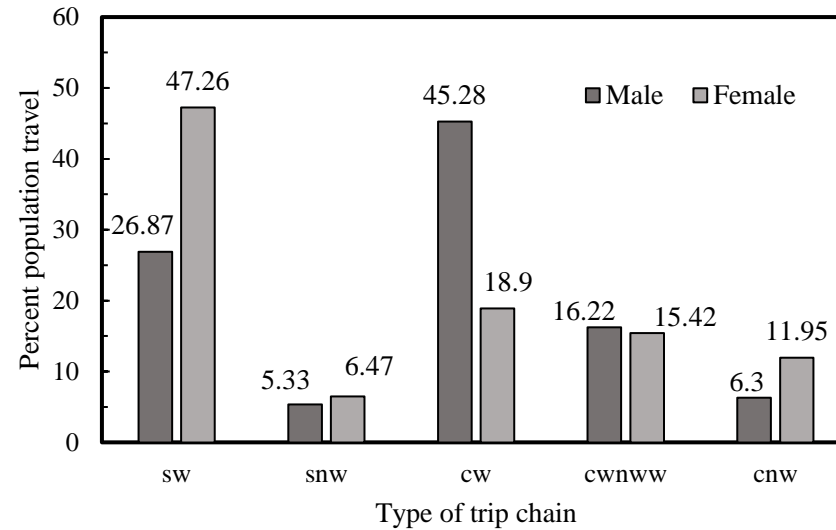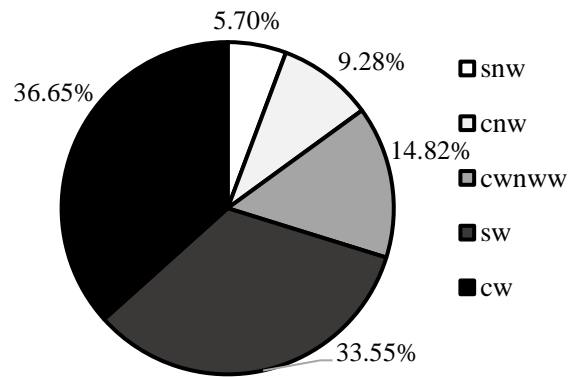
Descriptive Statistics

Fig. 5.a Distribution of typology of trip chain with percentage distribution of the types of trips based on gender

Fig. 5.b Trip chains based on mode choice

Analysis

- The model includes 13 socio-demographic factors as exogenous variables, two latent variables representing 'trip-chain utility' (η1) and 'mode choice utility' (η2) and observed variables for five types of trip chains and four mode choices as endogenous variables

- Path diagrams are then created using SPSS AMOS software based on the SPSS dataset prepared

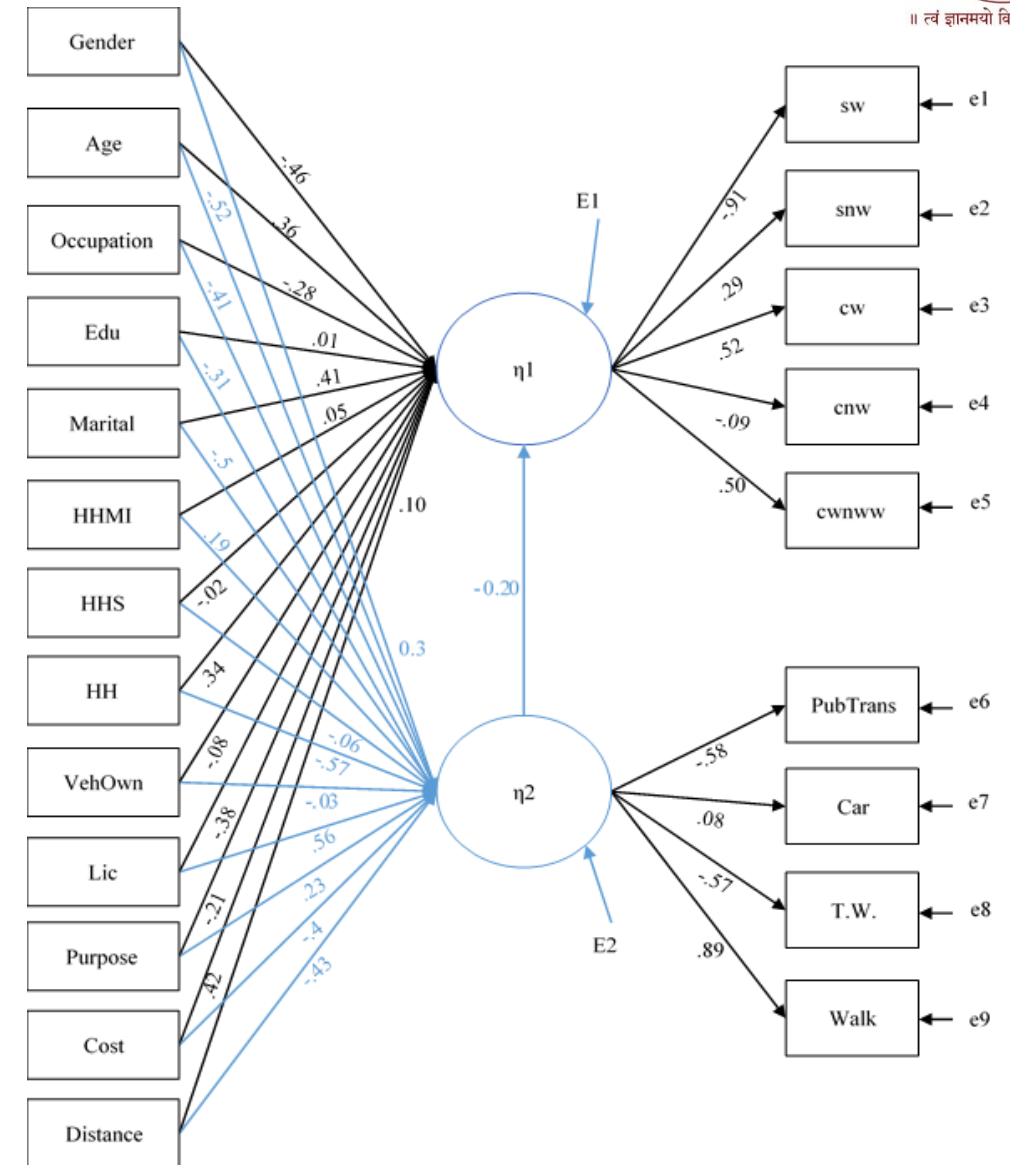| Fit Indices	
Goodness of Fit Index (GFI)	0.922
Adjusted Goodness of Fit Index (AGFI)	0.903
Comparative Fit Index (CFI)	0.931
Tucker-Lewis Index (TLI)	0.924
Root Mean Square Error of Approximation (RMSEA)	0.072

Fig. 6. SEM model 3 mode on trip chain analysis

Results and Conclusion

- Significant covariance between the latent variables η_2 and η_1

- Factors age, household type, household monthly income, distance, and cost significantly and positively influence trip chaining. As these factors increase, the trip chaining also increases.

- Variables car ownership, gender, education level, occupation, household monthly income, license, and trip purpose positively and significantly impact mode choice, implying that as these factors increase, the mode choice also increases.

- However, some variables do not significantly affect trip chaining and mode choice as their p-values are higher than 0.001, indicating a weak connection between them.

- Public transportation is less popular than private vehicle hence, the concerned authorities should allocate more resources for the development of public transportation

- Overall, the study highlights the factors influencing trip chains, including mode choice, providing valuable insights for transportation planning and policy considerations.

Future work

- Data collection can be collected using GPS enabled apps

- Collecting data at different times of the year and incorporating attitudes, perceptions, and state choice data can further improve model outcomes.

- Extended analysis to a large scale data will be useful for further identifying various factors in trip chaining behavior

- The attitudes, perception and state choice data can boost the outcome of the models

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Thank You