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1. Shipment size and mode choice are crucial decisions exercised by shippers to minimise their total logistics cost.
2. The paper develops discrete freight choice models for the case city of Jaipur in the Indian context for urban goods distribution from wholesalers to retailers.
3. Two wholesale markets, i.e., building hardware & electronics markets, are selected for the freight mode choice model to assess the variation within and across the markets.
4. Primary data was collected from establishments and transport operators through a structured questionnaire with face to face pen and pencil survey.
5. Binary logit models comprised of non-mortised transport (NMT), 3W, 4W, LGV & HGV modes were developed for various combinations of variables/attributes like time, cost, and distance for both wholesale markets.
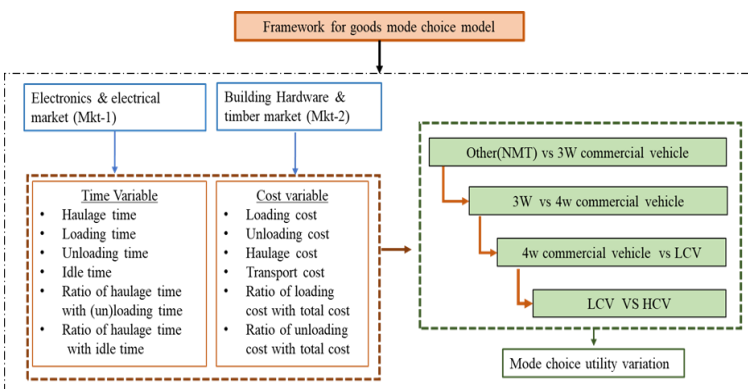
Table 1. Sample size

Mode/Shop	Electronics Market	Building Hard. Market	Total sample size
Other (NMT)	35	30	65
3W	35	31	66
4W	32	35	67
LCV	31	30	61
HCV	32	32	64
Establishment (wholesalers)	50	51	101

Table 2. Descriptive statistics of wholesalers

Indicators	Unit	Electronics Market			Building Hardware Market		
		Mean	Median	SD	Mean	Median	SD
Shop Area	Sqmt	140.2	149.5	67.7	89.1	80	62.5
Employment	/100sqm	5	4	2.1	3.1	3	1.5
Incoming frequency	weekly	4.1	4	1.4	9	9	2.7
Incoming tonnage	weekly	14.1	15	3.04	27.6	23	15.5
Outgoing trips frequency	weekly	22.1	23	4.1	14.9	15	3.2
Outgoing tonnage	weekly	11.8	12	2.04	24.8	20	13.8
Frequency handled I+O	weekly	26.3	27	3.04	23.9	24	6.02
Tonnage handled I+O	weekly	26.6	27	5.1	52.4	43	29.2

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Fig. 1. The proposed framework for urban freight choice model

$$U = (b_0 + b_1 x_{1,} i + \cdots + b_k x_k, i)$$
$$p_i = \frac{1}{1 + e^{-(b_0 + b_1, i + \cdots + b_k x_k \cdot i)}}$$

Where;
U is the utility of individual i for a particular choice.
b_0 is constant.
$b_1, b_2, \ldots b_k$ are parameters that need calibration.
$x_1 i, x_2 i, \ldots x_k i$ are variables associated with the choice set.

Table 4. The utility of freight modes

Utility of Mode	Wholesale Market	Utility equation
NMT vs 3W	Electronics Market	U = 4.83 (Travel Time) + 1.53 (Loading Cost) +9.97
	Building Hardware Market	U = -26.9 (loading time) + 0.002 (Tpt. Cost) − 1.13
3W vs 4W	Electronics Market	U = -31.3 (Travel Time) +.004 (Tpt. Cost) + 6.1
	Building Hardware Market	U = -50.9 (Travel time) +.002 (Tpt. Cost) + 4.87
4W vs LCV	Electronics Market	U = -170.1 (Travel Time) + 0.02 (Tpt. Cost) + 8.3
	Building Hardware Market	U = 101.01 (Idle time) + 0.01 (Loading cost) -24.9
LCV vs HCV	Electronics Market	U = -147.03 (Travel Time) +.014 (Tpt. Cost) + 5.19
	Building Hardware Market	U = 4.68 (Travel. time) + 2.66 (Idle time) +0.00 1 (Tpt. cost) -38.4

Table 5. Statistical results

Utility of Mode	Wholesale Market	-2 log-likelihood	Nagelkerke R square	Hosmer & L. test	Predicted %	VOT (INR)
Other vs 3W	Electronics	15.2	0.91	0.99	93%	3157
	Building Hard.	29.04	0.8	0.67	90%	13480
3W vs 4W	Electronics	23.7	0.85	0.92	96%	7825
	Building Hard.	13.71	0.92	0.98	89%	25465
4W vs LCV	Electronics	13.05	0.92	0.98	98%	8505
	Building Hard.	9.88	0.94	0.98	95%	10101
LCV vs HCV	Electronics	23.2	0.87	0.97	95%	10502
	Building Hard.	20.5	0.87	0.9	98%	7340

Table 6 sensitivity analysis

Variables	Mode	Electronics market						Building hardware market					
		-30%	-20%	-10%	10	20	30	-30%	-20%	-10%	10	20	30
Haulage cost	3w	-16%	-10%	-4%	4%	7%	10%	-11%	-6.7%	-3.2%	2.8%	5.4%	7.7%
	4w	-18%	-11%	-5%	4%	8%	11%	-11%	-6.8%	-3.2%	2.8%	5.3%	7.5%
Haulage time	3w	1.3%	0.9%	0.4%	-0.4%	-0.9%	-1.4%	0.3%	0.2%	0.1%	-0.1%	-0.2%	-0.3%
	4w	2.0%	1.3%	0.7%	-0.7%	-1.4%	-2.1%	0.4%	0.2%	0.1%	-0.1%	-0.2%	-0.4%
Idle time	4w	-12%	-7%	-3%	3%	6%	8%	-10%	-6%	-3%	3%	5%	8%
	Lcv	-14%	-8%	-4%	3%	6%	9%	-10%	-6%	-3%	2%	5%	6%
Loading cost	4w	1%	1%	0%	0%	-1%	-1%	-0.1%	-0.1%	0.0%	0.0%	0.1%	0.1%
	Lcv	2%	2%	1%	-1%	-2%	-3%	-0.1%	-0.1%	0.0%	0.0%	0.1%	0.1%

Conclusions

*The main finding of study are mode choice variables differ from one commodity to other commodity distribution.

*Mode choice variables also differ according to mode due to the difference in tonnage carrying capacities.

*Travel time and transport cost variable are essential for electronics goods intracity shipment, whereas loading cost and idle time are also crucial in building hardware shipments.

*Haulage cost is the primary determinant in selection between 3W & 4W and idle time variable in selection between 4W & LCV in both markets.

*Variables which affect the choice between a motorised and non-motorised mode in the electronics market are travel time, loading cost whereas it is loading time and transport cost in building hardware market.

*Mode choice variables for Intercity shipments are sensitive to ton TKT as compared with VKT in case of intracity shipments.