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Planning & Consolidation Strategies for Sustainable Urban Freight Jaipur City, India

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Abstract

- Urban freight transport is integral to the overall sustainable development of cities in tandem with passenger transport.
- This research paper is based on study carried out in the city of Jaipur in north India.
- This paper presents planning & consolidation freight strategies from literature and intends to come up with aggregate weightage and ranking of different strategies for sustainable freight mobility for Jaipur city.
- Analytical Hierarchical Process (AHP) and Best Worst Method (BWM) are used to assess the weights.
- Hypothesis for selecting AHP & BWM is that both methods produce similar results.
- This paper critically analyses the planning & consolidation strategies in the preview of wholesalers and local policymakers involved in urban goods distribution in case city.
- Primary data and response were collected with face to face paper-pencil survey from stakeholders in case city for selection and ranking of freight strategies.
- Response received from 48 stakeholders of Jaipur city is used for analysis.
- The policy implications based on this study demonstrates the potential utility of AHP & BWM as a decision-making tool in urban freight sector in India.

Keywords: Urban freight; Sustainability, freight strategies, AHP, BWM

Background

There are growing concerns for the impacts of urban goods distribution in urban areas for congestion, externalities, infrastructure vulnerability and consistency with land use. Sustainability of urban goods transport is the key policy objective of various countries [1]. Sustainable transportation is essential for overall sustainable development due to its contribution to externalities, economic and social issues [2]. Strategies and key performance indicators (KPI) are used for the decision-making process, travel patterns, physical impacts, environmental effects and economic impacts [3]. Decision-making, simulation and diagnosis are critical objectives of urban goods studies. Freight strategies are required and helpful for decision-makers to achieve sustainable development objectives [4]. Understanding and replicating stakeholders behaviours and attributes related to urban freight are recognised as an essential research topic. Impacts associated with freight vehicles on urban mobility and sustainability are important issues for planners on urban freight management [5]. Local authorities and policymakers have low awareness and knowledge regarding urban freight sector due to complex supply chains of urban goods and multiple stakeholders involvement. It is difficult to predict the outcomes of freight policies and strategies [6]. The relation between policies measures and stakeholders behaviours is still an area of investigation in the urban freight sector **[7].** There is a need to raise awareness for freight issues considering all relevant stakeholders [8].

The changing pace of urbanisation, coupled with economic growth, has led to increasing pressure on the sustainability of transport infrastructure in India. There has been a renewed focus on the provision of passenger transport in cities of India in recent decades owing to National Urban Transport Policy, the urban freight is sadly neglected in the policy discourse as well as transport system development plan proposals in cities [9]. Even the flagship smart cities mission programme of Government of India, which has earmarked budgetary support for 100 smart cities till date has very limited priorities for urban freight transport proposals being taken up for implementation in these cities [10]. The explicit consideration of urban goods movement has the potential to contribute towards achieving the goals of urban transport. The objective of city planning, in particular, is to enable goods movement at desired levels of efficiency of goods movement [11].

Heterogeneous nature of urban freight stakeholders and goods movement characteristics in the city poses a key challenge to policymakers to select suitable freight strategies for sustainable goods distribution. Freight strategies for sustainable urban goods distribution are not adequately addressed in India. This research paper evaluates the weights of various planning & consolidation strategies for sustainable urban goods distribution for Jaipur city (India) by the Analytical Hierarchy Process (AHP) and Best Worst Method (BWM) method. AHP & BWM are useful tools for dealing with complex decision making. AHP and BWM aid the decision-maker to make the best decisions [12][13]. The next section presents a literature review related to freight strategies used in urban goods distribution. Section 3: case city profile and wholesale commodity market selection. Section 4: research methodology. Section 5: AHP & BWM model formulation. Section 6: AHP & BWM analysis of urban goods strategies and the last part, section 7: presents conclusions and policy implications.

Literature review

Effect of urban freight transport can be quantified under the transport fleet, urban deliveries, economy, environment and safety. Each category required a different kind of freight strategies [14]. Urban freight data of 56 cities from 32 countries were compiled and analysed in-depth for various urban freight strategies implemented based on their final results. A total of 48 freight strategies under seven major group were identified for investigation. A multicriteria scoring function was used to rank & weight urban freight strategies of 56 cities [15]. Urban freight strategies under three groups i,e., last-mile, environment and trade node strategies were identified for sustainable urban goods distribution. These three group consists of 21 urban freight strategies already implemented by various cities around the globe. There is more need for research for intracity freight movements and the effectiveness of existing policies and freight measures [16][17]. Several types of traffic, building and vehicle regulations freight strategies are identified [18].

The study concluded Seven groups of sustainable policy measures and company actions to mitigate the negative impact of urban freight for economic vitality and quality of urban life. The study also considers the barriers and difficulties in implementing freight measures for the sustainability of urban freight transport. Policy measures are grouped at the level national, urban scale and also focused for shippers, receivers and transport operators [19]. There is a lack of interaction and understanding between administrators and other stakeholders of urban freight like transport operators and retailers in finalisation and implementation of freight strategies [20]. Preferences and characteristics of stakeholders involved in urban goods distribution are essential for the success of city logistics policies and strategies. City logistics freight strategies and measures should complement the issue related to policymakers, freight demand and supply [21].

Literature review

International best practice in sustainable urban freight strategies on the basis of their strength and weakness have been extensively compiled for local policymakers and private stakeholders. Aspects of sustainability, i.e. economic, environment and society, has been addressed in organising urban freight strategies [22]. Divergent objectives of shippers and transport act as a barrier in the implementation of urban freight initiatives, and there is a need for dialogue between urban freight stakeholders [23]. Different freight operation strategies need to be considered for collaborative and systematic examination for management and operations during transportation project design and development [24]. Urban freight strategies need to be formulated on the basis and issues faced by urban goods movement. Design standards, infrastructure design, land use zoning and truck regulation are some key issues that need to considered for freight strategies [25].

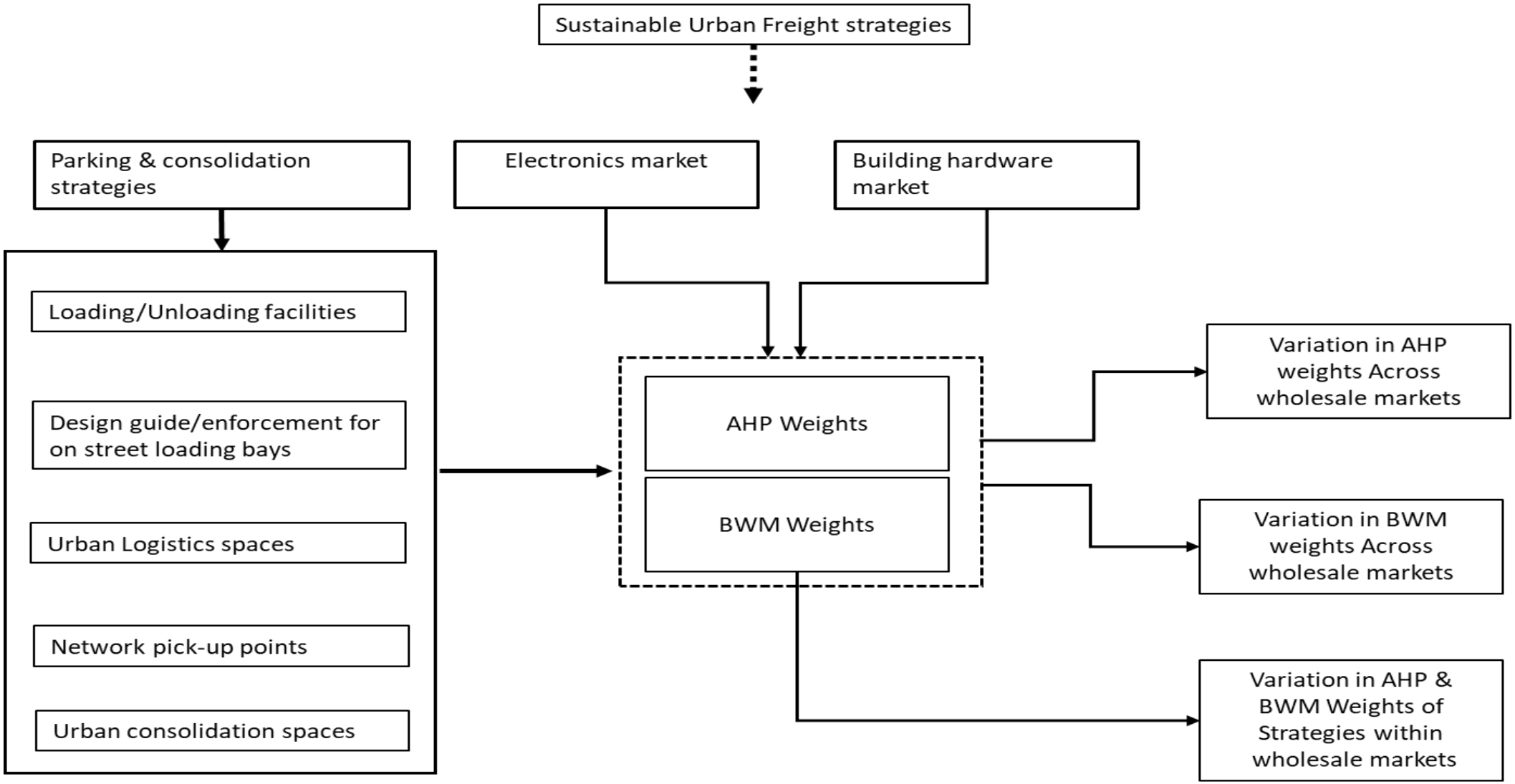
Freight strategies and their integration in land use plan enhance the sustainable goods supply and transport in urban areas. No single freight measure but a bundle of freight measures along with close cooperation between the administration and private stakeholders are required for sustainable transport in urban areas [6]. Transport management plan (TMP) strategies are often selected without comprehensive information of its potential benefits and disadvantages [26]. A small improvement in freight efficiency can provide considerable benefits due to large movements of big trucks in goods distribution [3]. Framework for identification and selection of freight strategies by incorporating stakeholders concerns is essential for sustainable freight transport. Modelling and evaluation of freight strategies are also vital in the range of available freight strategies [27].

AHP method was used to evaluate the choice of transportation alternatives in the multimodal freight transport system [28]. AHP method has a wide variety of applications like Performance type problems, resource management, corporate policy, public policy, political strategy, and planning. AHP method is easy to use, scalable, and it's not data-intensive [29]. AHP method can be applied within the context of the stakeholder-driven or institutional approach to transport project evaluation [30]. BWM method was used for evaluation and supplier selection in the context of social sustainability [31]. BWM was used to evaluate the different factors affecting the energy efficiency of buildings along with barriers to mitigate these factors. Results show that economic, governmental and technological barriers as the most prominent barriers among all [32]. BWM is preferred methods to use when deciding on weights for parameters as it easy to understand [33]. Various freight strategies are available to improve the sustainability of urban goods distribution. Impact of freight strategies can vary due to different characteristics of stakeholders involved in urban goods distribution. Assessment of freight strategies weights will be helpful for policy intervention in urban freight distribution.

Methodology

- Objectives of this research study are to assess the weights of freight strategies across and within two wholesale markets in the city of Jaipur.
- These two wholesale markets are the Electronics market and Building hardware market.
- Hypothesis for the research study is that freight strategies have the same relevance & importance across two commodity distribution for stakeholders.
- AHP & BWM methods were used to assess the weights of planning & consolidation strategies. Planning & consolidation strategies are selected based on the literature review of urban goods distribution for this research study [17].
- Planning & consolidation strategies are chosen in the purview of the city administrator, as they have an essential role in city logistics for managing freight traffic and providing freight infrastructure.
- The final weights of freight strategies are geometric means of individual responses with consistency ration less than 10%.

Methodology



Data collection

S.No.	Stakeholders	Sample size AHP	Sample size BWM
1	Wholesalers-building hardware market	10	10
2	Wholesalers-electronics market markemaarket	10	10
3	Traffic management /enforcement officials	2	2
4	Urban planners	2	2

Data collection method

- List of wholesalers was collected from the market association of both markets.
- Time and date of face to face paper-pencil surveys were fixed via telephonic conversations. Wholesalers having more than five years in business has been selected for the survey.
- List of traffic police officers having more than two years of experience in and around these two wholesale markets have been obtained from superintendent of police (Traffic) Jaipur.
- The core urban planning team of Jaipur development authority and town planning department have been consulted for a detailed interview as per their available time.
- A team of four trained enumerators were assigned to collect eight samples per day.
- Consistency of results from both methods was obtained each day for the further need of interviews on the next available day until the required sample size is collected as per Table 1.

AHP model formulation

Analytical Hierarchical Process (AHP) is a multicriteria decision-making technique that can help to express the general decision operations. It decomposes a complicated problem into a multilevel hierarchical structure of objective, criteria and alternatives. AHP can combine quantitative and qualitative factors to handle different groups of stakeholders. In the AHP method, the opinions of many experts can be mixed [35]. The relative importance of criteria and alternatives are calculated by the pairwise comparison in each level of the hierarchy. AHP method can also be used to assess the relative importance among criteria and sub-criteria. AHP is a commonly used mathematical tool, especially where subjectivity may affect the overall result of the decision-making process [36]. The relative importance of criteria or alternatives is determined on an absolute scale during a paired comparison of the hierarchy of structures.

The nine-point scale is used for paired comparison. Each point of this scale is assigned according to the intensity of importance among alternatives. Point 1 on the scale reflects that both alternatives (A&B) during comparison are equally important. Point 3 when later alternative (B) is slightly favourable than the former alternative. Point 5 when later alternative (B) is strongly favourable than the former alternative. Point 7 when the later choice (B) is strongly favoured due to its demonstrated dominance. Point 9 on the scale when later option (B) affirmed on the highest possible order. Even scales (2, 4,6 8) are used when there is a compromise between successive odd scales (1,3,5,7,9). If the former alternative (A) is more important than the latter alternative (B), then a reverse scale to be used (1/3, 1/5, 1/7, 1/9) [37].
In the last step of AHP, the comparison matrix is normalised to get relative weights. The right eigenvector gives the relative weights of criteria (w) corresponding to the largest eigenvalue (λ max) as equation (2),

AHP results from the output are related to the consistency of the pairwise comparison judgments. The Consistency Index (CI) of judgments is calculated by equation (3)[39].
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BMW modal formulation

The Best-worst method (BWM) is a vector-based, multicriteria decision-making method. BWM also characterised by pairwise comparison of alternatives like AHP. For BWM analysis, a set of decision criteria needs to be determined for comparison, secondly the selection of best and worst criteria without any comparison by selection maker. Then the comparison of other criteria with the best criteria. Similarly, comparison of other criteria with the worst criteria. In the last step, the optimal weights of criteria are computed. Comparison of alternatives is conducted by using a scale between 1 to 9, where 1 = equal preference and a 9 = 9x times more important. Higher consistency ratio results in less reliable comparisons. BWM requires fewer comparison data (alternatives) and leads to a more consistent comparison and reliable results. BWM can be combined with other MCDM methods. BWM is a more comfortable alternative of multicriteria decision-making methods [13][36].

Case city profile

Jaipur is the capital city for the state of Rajasthan in India. The city is a major attractor of tourists and major hub for handicrafts, gems, jewellery, die printing (textile) and stone crafting. Jaipur city is located in the north-eastern part of Rajasthan state, 280 Km from Delhi. Jaipur extends to an area of 2939 sq.km in which walled city (old area) constitute 17 Sq.km, 281 sq.km city area under Jaipur municipal corporation and rest is 2650 sq.km under Jaipur development authority. The total population of Jaipur city is 30.5 lacs (yr. 2011). Residential land use of city constitutes 44.8% (13825 ha), commercial 6.7% (2064 ha), industrial 6% (1862 ha), governmental 2% (602 ha), mixed land use 3.3% (1034 ha), public & semi-public 10.5% (3241 ha), recreational 11.3% (3461 ha) and circulation 15.4 % (4741 ha). In Jaipur city, there are 11 major wholesale markets. Electronics, handicrafts and pharmaceutical markets are situated in the walled city area. Fruits and the vegetable wholesale market at *Muhana* and *Lal Kothi* area. Food grain markets at *Surajpole* and *Kukasheda* area. Dairy and meat products at *Malviya Nagar* and NH11 bypass. Construction material market at *Aatish Nagar* and *Chandpole* area. Furniture market at *Sitapura* area. Chemical and fertilisers market in *Durgapaura* area. Industrial products at *Viskarma* industrial area [34].

Building Hardware market and Electronic market were selected for the assessment of planning & consolidation strategies. The building Hardware market is planned market recently developed by Jaipur development authority, whereas the electronics market is situated in the old city (walled city) area. Goods distribution in building hardware market is weigh based, whereas it is number and item-based in the Electronics market.

Modal results

Strategies	Electronics market		Building Hardware market	
	AHP weights %	BWM weights %	AHP weights %	BWM weights %
Loading/unloading facilities	20%	21%	22%	24%
Design guide/enforcement for on-street loading bays	13%	11%	13%	10%
Urban logistics spaces	25%	29%	32%	35%
Network pick-up points	18%	17%	14%	15%
Urban consolidation spaces	21%	22%	19%	16%

There is a variation in weights of strategies by both AHP & BWM methods, but there is a consistency in the ranking of strategies by both methods

Results discussions -1

. Urban logistics spaces are the most preferred strategy in the electronics market with the highest weight by both methods. Loading-unloading facilities and urban consolidation spaces have almost similar weights and are equally important in the electronics market. Electronics market in Jaipur is not a planned market. This wholesale market is situated in the walled city (old city) area with high density, where parking and logistics facilities are very limited. This is the reason for the higher preference (25%-29%) for urban logistics spaces followed by urban consolidation spaces and loading-unloading facilities. Network pick-up points strategy (18%-17%) is second to least preferred for wholesalers in the electronic market. Wholesalers in the market receive their incoming shipments at late night or in the morning at the periphery of the walled city. Wholesalers use their small vehicles to place their goods in their respective warehouses. Network pick-up points are there but not in the form of formally designated places by concerned authorities. Maximum variation of weights (4%) is observed for urban logistics space strategy, whereas minimum (1%) in Loading/unloading facilities, network pick-up points, loading-unloading facilities and 2% variation for Design guide/enforcement for on-street loading bays between AHP & BWM methods.

Variation in weights of strategies is also observed in building hardware market by AHP & BWM methods same like the electronics market. Urban logistics space strategy has the highest weight (32%-35%) followed by loading/unloading facilities strategy (22%-24%) and urban consolidation spaces (19%-16%) among all other strategies. The building hardware market is a planned market recently developed by local authorities. There is a mixed variety of goods from like sanitary, floor items, timber, electrical item, plumbing, iron, paints, etc., are handled in this market. All of these goods have their own supply-chain and space requirements. This building hardware market also acts as a regional distribution centre for nearby small towns apart from intracity distribution. Shops in the market are designed in standard sizes irrespective of commodity type requirements.

Results discussions -2

Parking is there for freight vehicle, but the loading-unloading facility is not dedicated. Design guide/enforcement for on-street loading bay strategy is least preferred (13%-10%). Parking, loading-unloading is not a problem as ample parking is provided for freight vehicle in the market area. As far as goods distribution and delivery is concerned, there is no policy direction from local authorities apart from time restrictions on freight vehicle. Even at commercial areas there is not dedicated freight parking demarcation with respect to time and space for the loading-unloading purpose. This is the reason for the least priority for design guide/enforcement for on-street loading bay strategy. Network pick-up points strategy is the second least preferred (14%-15%). Network pick-up point strategy is only relevant to the walled city area where there is a severe space crunch for delivering goods. The walled (old) city area is fully developed and heritage zone where no new construction is allowed. Also, the walled city constitutes 6% in area under the local municipal corporation and 0.6% under local development authority. The maximum variation (3%) in weights of strategies by AHP & BWM methods is observed for urban logistics spaces, urban consolidation spaces and design guide/enforcement for on-street loading bays strategies. A 2% variation is observed for loading-unloading facilities and 1% variation for network pick-up points strategy.

Across comparison of strategies among both wholesale markets reveals that urban logistics space strategies are the most preferred strategy, but building hardware market has higher weights attached to it in comparison to the electronics market. Design guide/enforcement for on-street loading bay strategy is least preferred in both wholesale markets. Loading-unloading facilities strategy is slightly more preferred in building hardware market compared with electronics markets. Network pick-up points and urban consolidation spaces strategies have higher weights and preference in the electronics market compare to building hardware market.

Conclusion

Sustainable urban goods distribution is vital for the overall sustainable development of cities. This research paper presents how weights of planning & consolidation freight strategies vary for different goods distribution in the city due to their supply chains and the inherent nature of the commodity, which needs to be incorporated in sustainable urban freight transport policy.

The study results confirm that there are variation and similarity in weights of planning & consolidation freight strategies across markets by both methods AHP & BWM. Design guide/enforcement for on-street loading bays strategy is least preferred, and urban logistics space strategy is most preferred in both markets. There is variation in weights and preference attached to planning & consolidation freight strategies across and within wholesale markets. Within the individual wholesale markets, both AHP & BWM methods have consistency in the ranking of strategies but with different weights. The sustainable urban freight policy initiatives shall take care of strategies which can have a similar impact on different commodity distribution and strategies for specific commodity distribution in within a city.

BWM method is more comfortable then AHP method in the context of surveying as it has a lesser and more straightforward comparison of alternatives than AHP method, especially when the number of paired comparison is large. BWM weighing scales are easy to explain to the stakeholders compared with AHP method.

This paper demonstrates the potential utility of AHP & BWM as a decision-making tool for policymakers in the urban freight sector. More urban commodities and industrial products need to be explored to assess the overall weights of planning & consolidation freight strategies within and across cities of varying sizes in the purview of sustainable city development in India.

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- Jaipur city traffic police

- Market association

- Jaipur development authority

- Jaipur municipal corporation