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PLANNING FOR URBAN FREIGHT DISTRIBUTION OF AGRICULTURAL PRODUCES – CASE STUDY OF GURGAON-MANESAR

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Abstract - *The understanding of freight issues and their possible solutions in developed countries much remains to be desired in cities of developing countries like India possibly owing to a lack of empirical evidence from such countries. It also aims to facilitate decision-makers in assessing the importance of urban freight in making rational and informed policy decisions for transport infrastructure related to freight activity. The freight sector also faces several challenges such as congestion, parking for deliveries and reverse logistics (e.g., recycling and garbage collection), the lack of awareness, understanding and overall vision to urban goods movement. In addition, lack of information about the flow of urban goods movement, fragmentation in nature of stakeholders and gaps in skills and knowledge are also contributory factors leading to neglect of urban freight sector where freight logistics aspects related to supply chain linkages, storage, handling, distribution aspects including the modes used not given enough importance. The agriculture supply chain is rather unorganized and inefficient which is not very effective either and there is a lot of wastage during storage, lead times are high and security issues are not considered. (Dr. Sanjay Gupta, 2017). In the study, methods like Multicriteria Decision Making (MCDM) i.e., AHP and Supply Chain Operational Reference (SCOR) model will be used for assessing and increasing the efficiency of agricultural produces. Various scenarios will be created after evaluating the parameters affecting agricultural freight transport by developing scenarios based on the truck tour commodity-based modelling for efficient urban freight deliveries to agricultural mandi's.*

Key Words: Urban freight, Logistics, Agri-supply chain, SCOR model, truck tour, traffic analysis zone etc.

1.INTRODUCTION

Expanding globalization with fluctuating monetary turn of events, prompts move in patterns of creation and use across various locales. The item piece likewise shifts impressively, as more cargo is being moved over longer separations. Since 2000, the worldwide street organize has extended by around 12 million path km to advance the transportation of merchandise and individuals and during that time China and India represented in excess of 50 percent of cleared path km augmentations. Non-OECD districts are anticipated to represent just about 90 percent of the worldwide development in movement throughout the following four decades and most of this foundation is anticipated to be inherent and around the territory. By and large coordinations activity represent about 7% of all out GHG outflows, and inside the coordinations business, cargo transport represents around 90% of complete GHG emanations and 35% to 60% of coordinations costs. Inside coordinations, urban cargo is one of the costliest and outflow serious portions of the gracefully chain incorporates mechanical cargo. Urban cargo establishes just a little portion of complete vehicle possession, regularly under 10 percent in many creating urban communities, urban cargo comprises a critical portion of urban vehicle externalities, and is typically the most dirtying connection of the whole gracefully fasten where just 15 to 25 percent of the urban vehicle km voyaged (four-wheel or more) can be credited to business vehicles, it is evaluated that they involve around 20 to 40 percent of mechanized street space, and cause 20 to 40 percent of urban vehicle CO2 outflows. Business vehicles additionally represent around 30 to 50 percent of air contamination, (for example, particulate issue (PM) and nitrogen oxides (NOx), in urban areas in industrialized economies, and in excess of 50 percent for urban areas in creating nations.

1.1 Need and Importance of Urban Freight in Agri-Supply Chain

Since cities are the center of economic and social life, transporting products inside urban areas is necessary. The survival of cities cannot be looked at without taking into account the position of goods transport. There is an absence of a comprehensiveness understanding of freight management and their linkages with Agri supply chain in an urban area not only among the public but also among city planners and decision-makers resulting in transport-related policies and facilities being planned merely from the passenger's transport perspective, without adequate considerations to the needs of freight transport (Dr. Sanjay Gupta, 2017).No markets in urban areas could exist without a massive, sustained and reliable flow of goods to from, and within it' (Goyal, 2016).

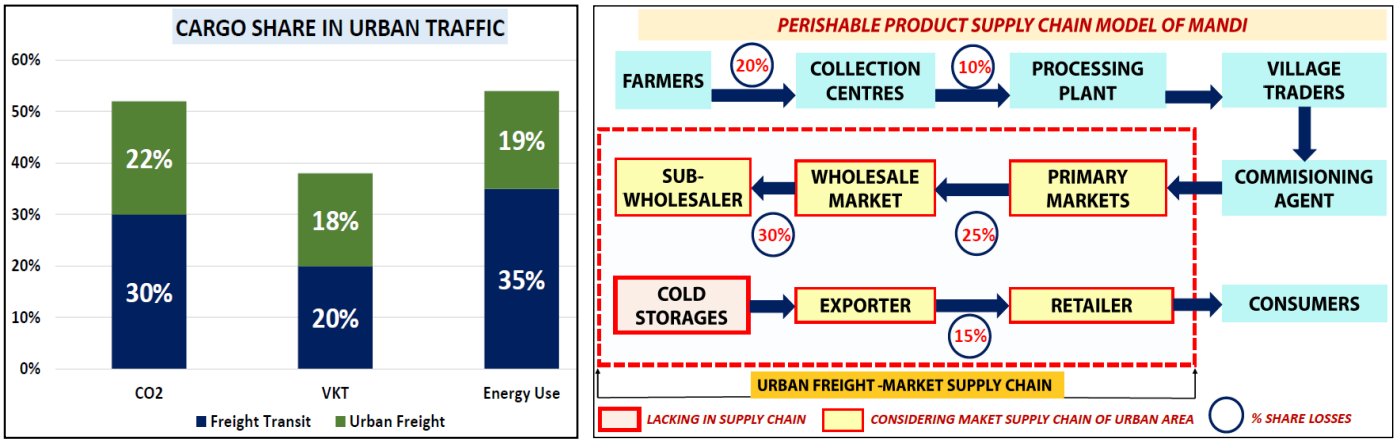


Figure 1:Cargo Share in Urban Traffic & Post handling losses in perishable product Supply Chain of Mandi during transit – CIPHET 2015

The farm to fork model of Mandi from procurement to distribution in the supply chain of agricultural produces affects the overall efficiency and effectiveness of supply chain due to lack of efficient market linkages, lack of logistics infrastructure for perishable goods, cold chain systems that link the perishable produce with existing ready markets are becoming the major bottlenecks in tapping the potential, On-time delivery, high customer satisfaction and dissemination of technology, capital, knowledge among the chain partner, lack of suitable clusters of operations to support market-to-consumer links, losses during transit, lack of reefer vehicles, handling mechanism and packaging standards for moving the commodities where maximum losses account in the transit losses around almost 70% in the urban area. The Agri-supply chain not only supports the private sector but also generates spin-offs that promote sustainable natural, social and economic growth in the area (employment generation, value-added services and reducing commodity losses during transit).

This research work studies in detail the supply-chain and urban freight models used in the Agri logistics and contracts with their transporters. Primary data were analyzed to identify the bottlenecks, infrastructure challenges and potential areas where we can reduce the distribution time and provide the shortest path, serviceable area and location-allocation of perishable goods from wholesale markets to retailers by optimizing their transportation model. Keeping in mind the limited resources and constraints of the wholesaler markets to retailers spread across geographies, model is proposed to improve truck utilization. This report also mentions the key areas where the transporters can focus in future to save time and cost.

The paper is divided into four sections. First, a literature review summarizes the published research on logistics and supply chain efficiency with its best practices and freight performance indicators. Second section explains the methodology adopted to analyze the data and draws the inferences/findings. The third section outlines the assessment and evaluation of urban freight (truck-tour based model) and supply chain operational reference model (SCOR) for creating alternate scenarios. Last section presents the results & conclusion with recommendation and strategies for the study to be done in consequent phase.

2. Literature Review

In 1991, the International Logistics Management Council (ICLM) described logistics as the method of preparing, arranging, conducting, storing and managing the secure and effective movement and inventory of perishable products or services and associated data from link to destination with a view to fulfilling customer's demand. Logistics where the method of systematically controlling the movement of products, sourcing, value added service and finished product across the company and its distribution networks for the cost-effective delivery of the customer's orders (Blackburn and Scudder, 2009)Agribusiness is a complex system which not only produces from the farm as a producers/manufacturer and distributor it also handles the transportation inventory costs of the perishable products in the supply chain which depends on the various segments of the freight involved in the process of collection, storage, procurement, value-added service and also the players involves in the freight and agribusiness movement of perishable goods (Browne Marzena Piotrowska Allan Woodburn Julian Allen, 2007)

In developing nations like India, where the production of fruits and vegetables depends upon the climatic conditions, geographical locations and infrastructure is a major challenge in the Agri-supply chain with the provision of urban freight movement. The urban freight system not only limited to the manufacturer/wholesaler to a distributor in the supply chain. It also provided the inputs (e.g., perishable products), processing the output (e.g., processing markets or distribution centers and perishable goods) using produce and transporting the products to the retailer or end consumer through the freight planning process in the wholesale market in urban areas (Gopal Naik, 2018). For managing the entire Agri Supply chain of perishable goods through freight where data is collected for urban freight as commodity flows, truck fleet, truck flows, vehicle km travelled, major freight generators along with the freight corridors in the city which helps in capturing the comprehensive collection of freight information for the wholesale market for efficient planning and management of urban freight distribution of agricultural produces. Freight Demand estimation is an essential stage in the agribusiness supply chain for adopting the approach involving the production, delivery, modal splitting and trip assignments of perishable products. The freight facility planning usually comprises of freight consolidation centers, cold chain facility, nearby delivery locations, truck terminals, and warehouses to cater the demand of perishable goods to meet the supply of current demand as well as for project in the future (Hemamala).

The system distribution in Agri-supply chain drivers are the key performance measure across the network which leads to the effectiveness of agriculture products in the supply chain. It is also acting as operating tools for the effective implementation of carrying out operations with the Agri logistics strategy in the supply chain. Drivers act as a pillar to support the effective operations of facility, inventory, transportation, sourcing, pricing, information and external factors. Including such, various external factors such as Infrastructure and regulatory structures may impact the overall performance and increasing the transportation cost and time in the supply chain (Sheoran A, 2015)

Various kinds of literature have been studied globally to understand the performance of Agri logistics supply chain management and urban freight distribution are given under.

(Madhavedi, 2010) suggested a model to improve efficiency and effectiveness of supply chain based on four criteria: waste elimination, lead-time performance, profit, and delivery consistency. This suggested model analyses the supply chain of agricultural produces in two levels i.e. chain level and operational level.

The supply chain council (SCOR) has also proposed 12 performance metrics. They are ideal order fulfilment, sensitivity, overall distribution expenses, cash to cash turnaround period, value-added competitiveness of workers, flexibility, order fulfilment and delivery days with turns of properties (Afianto, . and Udin, 2019) Sanjay (2010) identified the major bottlenecks in perishable goods supply chain are lack of extension infrastructure, inefficient pest and decease management, lack of marketing information, cold storage facilities near the wholesale markets, high transportation costs and poor marketing intelligence which also enabled to focus on the government interventions in the study to remove infrastructural bottlenecks from the supply chain like market linkages from wholesaler to distributors, cold chain system and conventional infrastructure provisions (Hemamala). The adopted key performance indicators from various literature which affects the overall operations and handling activities of markets, freight distribution and creating congestion due to lack of facility planning, long queues, auctioning space for handling the perishable products, grading technology and customer satisfaction, flexibility, efficiency, and transportation inventory costs which dealt with time, quality factors where responsiveness and efficiency are the major key performance for measuring and evaluating the successful supply chain. To understand the KPI in the Agri supply chain, a case study of rice supply chain in Chhattisgarh where it tends to develop sustainable Agri logistics by evaluating all the key performance indicators involved in the perishable goods supply chain through urban freight distribution in the urban areas. The case study focuses on understanding how extinct indicators of Agri supply chain performance assume a significant set of stakeholders by locational advantage, logistics infrastructure, and policy imperatives. In urban freight distribution, key performances like- vehicle km travelled, Tons per capita per day, tons per capita day, Total ton km travelled per day, Average distribution costs per ton-km (INR), the share of freight network, freight fuel consumption/total transport fuel consumptions are important in freight distribution of agricultural produce to measure the performance of urban freight and evaluate them through various transport or supply chain models to develop a sustainable urban freight distribution of Agricultural produces.

Different models and decision-making criteria like supply-chain operational reference model (SCOR) and Multi-criteria analysis (MCA) are incorporated while planning for supply chain and efficient distribution of commodities through urban freight where various models in the supply chain of agricultural produce and urban freight distribution have been adopted in the system (Afianto, . and Udin, 2019)

Based on the literature review, the focus of our research is then to understand and analyze the issues faced by urban freight which leads to higher distribution time and cost. We aim to do so by analyzing the urban freight distribution pattern of agricultural produces the case of Gurgaon-Manesar in Haryana. We then propose strategies or recommendations to improve their freight performance. This is detailed in the following sections where tools and techniques explored in the extant literatures are then used to suggest measures to overcome the challenges and improve Agri-supply chain and freight distribution efficiency.

2.1 Study Area Profile

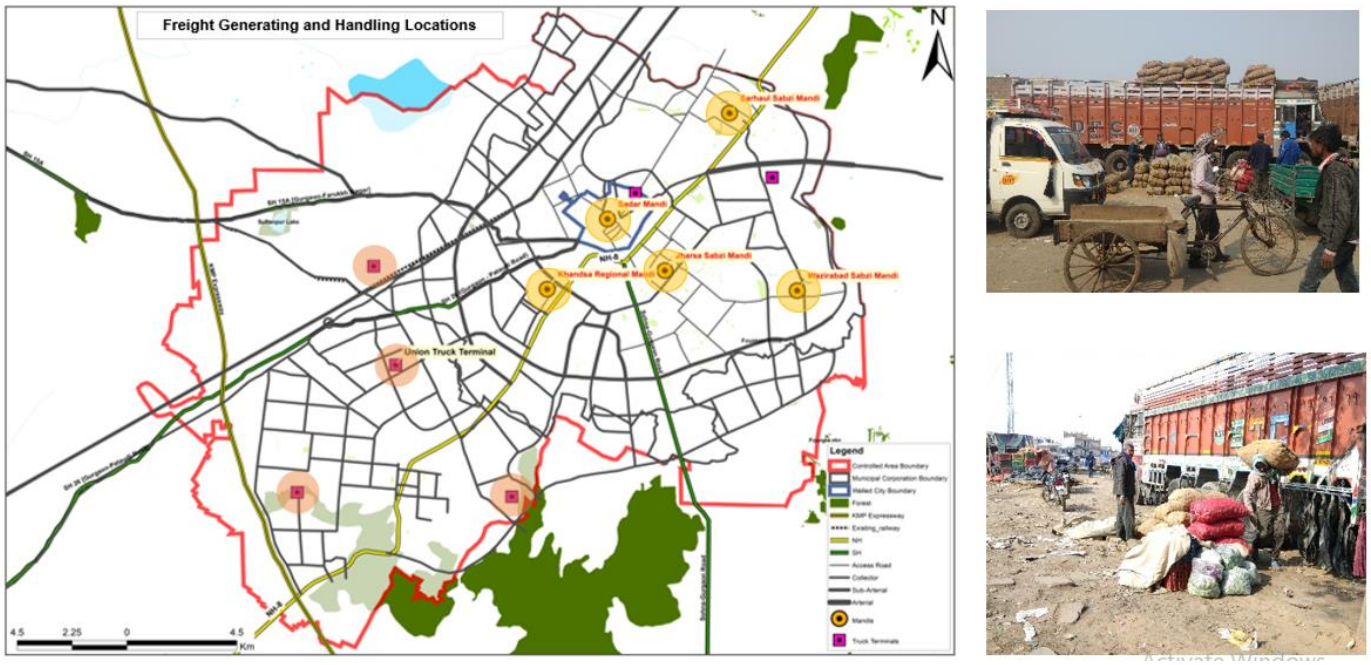


Figure 2- Freight Generating and Handling Locations in GMUC, Haryana

The logistics, cold storage and warehousing infrastructure in study area enjoys a locational benefit marked by its spatial confluence with the commercial arteries (DMIC, AKIC and Eastern peripheral corridor). The study area boasts a well-connected service network and transport infrastructure offering good prospects for multi-modal logistics infrastructure growth where investment regions such as Dharuhera, Bawal with broad infrastructure projects like freight corridors that traverse Gurgaon. The area of the entire study area is 467 square kilometers where corporation comprises 198 square kilometers of the area while Manesar constitutes 45 square kilometers of the area with 35 wards and 115 sectors. In the land use distribution of study area, we see the share of commercial area and transportation sector in the year 2020 will be high among other follows with 15% and 10% which shows the importance of freight movement and provisions of cold storages, warehouses and other logistical infrastructure for proposed land use 2031.

The total road network length within the planning boundary is 954.5 km out of which 743.8 km excluding the local streets but the total surveyed road network within the planning boundary is 473.4 km out of which 233.36 km of length is identified primary road network within GMUC boundary to conduct various surveys like road inventory, speed and delay and characteristics of the freight network.

3. Data Collection and Sampling Strategy

The research paper required identifying the problems areas and finding out a realistic and practical solution. Hence, the methodology adopted was as follows:

1. For existing freight transport system, extensive surveys have been conducted covering at freight generating and handling areas including transport operators follows with focused group discussions with wholesalers and distribution centers to compile their freight traffic and travel characteristics to improve the intra operational efficiencies of freight.
2. In order to collect the required information from various primary surveys like transport operator surveys on commodities and tonnage handled, average payload and transport cost follows with truck terminal and stakeholder surveys to know the operational details, Inbound & outbound commercial traffic volumes, dwell time, infrastructure adequacy, capacity utilization and Issues and challenges in the urban freight distribution planning process.
3. Based on literature, the sampling strategy focus on freight distribution and Agri-supply chain operations in the city where reconnaissance, face-to-face interviews were conducted in the identified freight generating and handling areas by adopting cluster sampling to identify the different homogenous strata based on a total number of employments, total shops, transport operators etc.

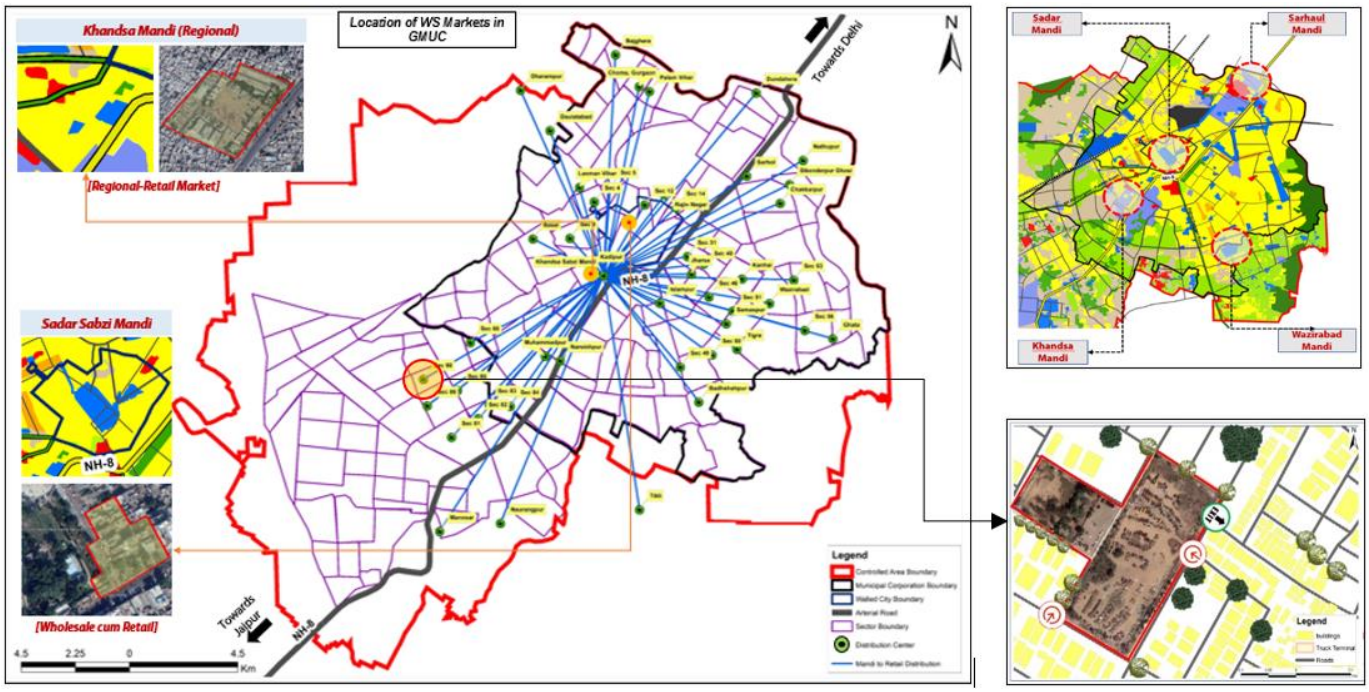
3.1 Analysis and Problem Identification

In the study area, distribution pattern of urban freight is observed and analyzed in four parts: (1) Freight Generating Areas (2) Freight handling areas (3) freight carriers/modes (4) Urban freight networks. Each component is dependent and affects the overall performance of the Agri-supply chain in freight distribution.

Table 1- Details of Freight Generating Areas Characteristics - GMUC

Freight Generating Areas								
Mandi	**Location**	**Tonnage Handled**	**Tonnage Capacity**	**Freight (IN)**	**Freight (OUT)**	**Consumption**	**Cold storage**	**Storage Capacity**
Khandsa	NH-8	1650	2240	(48%)	(51%)	F&V	1	960 MT
Sadar	Sec-10	1016	1280	(51%)	(49%)	F&V	0	
Sarhaul	Delhi Border	590	780	(50%)	(50%)	V	0	
Wazirabad	Sec-54	600	852	(52%)	(48%)	F	0	
Jharsa	Sec-33	445	750	(50%)	(50%)	V	0	
Pataudi	Panchgaon	1200	1566	(51%)	(49%)	F&V	1	780 MT

Table 1 indicates the characteristics of freight generating areas of Gurgaon-Manesar to understand the distribution pattern of urban freight flows, generation of goods from single node or freight analysis zone (FAZ) through a defined path to another zone is freight generating areas. Khandsa and Sadar acts as a urban level mandi follow with two types of consumption pattern fruits and vegetables i.e. freight (In) 48% and 51% (Out) and 51% freight (IN) and 49% freight (Out) with the handling capacity of 1650 and 1016 with total tonnage capacity is 2240 and 1280 where one 1 large cold storage is available in the Khandsa mandi but closed due to some reason.



Map 1: Distribution Pattern of Wholesale Prominent Mandi's and location of Truck Terminal, GMUC

Supply Chain of Mandi's in Gurgaon-Manesar Urban Complex [LTL – WS] - Gurgaon-Manesar is the largest Importer of fruits and vegetables, it only exports specialized grains to various regions in India, where the share of importing fruits and vegetables to the mandi in Gurgaon are 75% for urban areas and 25% for rural. Khandsa, Sadar and Pataudi mandis are the ones who import fruits and vegetables from states like Maharashtra, Gujrat, Rajasthan, West-Bengal, Andhra-Pradesh, Karnataka, Madhya-Pradesh and Uttar-Pradesh. Fruits like- Apple, Banana, Coconut water and pomegranate are the major commodities which are to be imported in Gurgaon Mandi's and Onion, Potato, Tomato are one imported from Maharashtra and U.P state. Procurement process from the farmer, pre-cooling stage, cold-storage and exporting from HTL to terminals for deconsolidation then LTL will take goods to the mandi's or hubs for distribution in the city. Wholesaler and commissioning agents negotiate the charges and distribute it locally to the retailers, distribution centers, reddy and local shops around the market. The loading and unloading will take place in the truck until all the product will not be unloaded based on the demand and supply from the market.

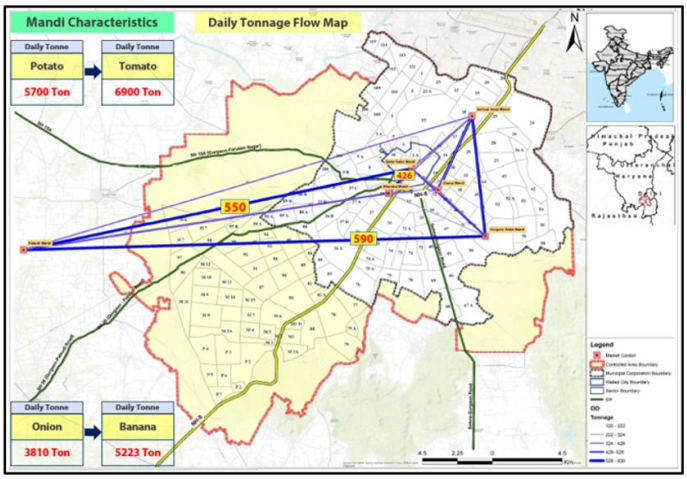
The city has 4-5 truck terminals where Union truck terminals with an area of 15 Ha is the largest one located near to the Khandsa mandi and well connected with NH-8 (Delhi-Jaipur Highway) and Sh-15A (Gurgaon-Farrukhnagar). Freight traffic of inter and interstate at Union Truck Terminal will the highest for HGV (31.79%) and MAV (29.23%) in Inter freight traffic in the city whereas in Intra freight-traffic LCV and GCR are the most prominent to be parked and used for distribution of commodities in the city with a share of (35.56%) and (25.64%) respectively with freight handling capacity 5825 Ton/Day and capacity utilization is 65.2% as most of the goods vehicles parked on the road due to one entry and exit point.

3.2 Urban Freight Traffic

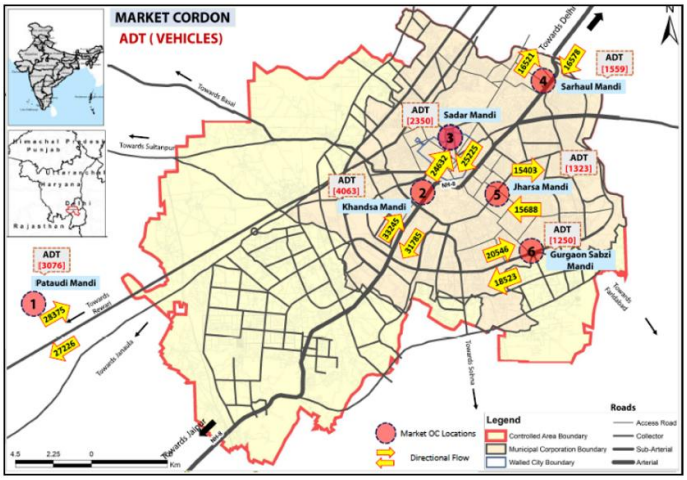
Traffic data from Inter-City gives a description of the share of freight traffic from overall travel on regional roads and its effect on regional vehicle traffic. At the outer cordon location, total traffic is found 887538 PCU with 48.51% (430604 PCU) traffic entering into the study area and 51.49% (456934 PCU) exiting the study area.

3.2.1 Intra-City Freight Traffic Characteristics

In this research, the intra-city freight traffic data provides the share of freight out of total traffic plying on the urban roads and its social, economic and environmental impacts on passenger traffic. In (Figure 5) mode and market wise average daily traffic and hourly variation of freight traffic was recorded and has been analyzed.



Map 2: Freight Tonnage Distribution between wholesale mandi's of GMUC



Map 3: Average Daily Traffic Freight Traffic at Market Locations, Gurgaon-Manesar, Haryana

From (Figure 6) Almost 273747 goods vehicles will be passing by these mandis in Gurgaon where Khandsa mandi (45% IN & 51% Out, Pataudi Mandi (51% IN and 49% out) and Gurgaon Sabzi Mandi (52% IN and 48% Out) with the highest share of freight movement. Hence, these are major distribution points to retailers or distribution centers. From the analysis of freight traffic composition, it is found that the share of LCV and Trucks (MAV) are having the highest share in Pataudi (40%), Sadar (37%)and Wazirabad Sabzi Mandi (62%) where the overall share of mode in markets is higher in trucks and LCV's with 20% and 47% which also shows the increase in LCV in last years and frequent mode for intra-distribution in the city.

In Gurgaon, the ADT was found to be around 13621 considering all the commercial vehicles where Khandsa Mandi and Pataudi Mandi have the highest ADT share (%) are 29.8% and 22.6% respectively. It is observed from the survey that GCR is the most frequent mode used for the distribution of fruits and vegetables in the market whereas LCVs take 2-3 trips for heavy orders from the distribution centers. Tractors/trailers or tempo will be used for local distribution to the reddy and local shops in the vicinity. From the analysis, (45.35%) of the E-I movement happened from LCV in the study area, where truck accounts for (54.80%) E-I, MAV (52.64%) and Goods commercial rickshaw (44.66%) in I-I.

3.3 Performance Measurement of Freight Distribution from Market to Distribution Center

Based on the KPI's for assessing the performance of urban freight distribution in the city for agricultural produces of the segment from Wholesale to Distribution center. Various parameters of UFT used in this study include: avg payload, vehicle capacity utilization, total ton, and vehicle km travelled per day will help you to understand the bottleneck of freight distribution pattern and their environmental impacts on the environment. For assessment of freight distribution pattern of perishable goods in the city, the city is classified into 4 zones as per the Municipal Corporation Gurgaon (MCG) where all the distribution center served with each wholesale mandi and also categorized into mandi, route and fleet characteristics to easily understand and assess the performance measure of urban freight distribution in the city.

Tempo and Goods commercial rickshaw will be used for further distribution. Based on the establishment data at market cordon and focused group discussion with a transport operator, the detailed supply chain is mapped from the procurement location of the commodity to its handling location and distribution in the city. The detailed assessment of freight generation, distribution, handling efficiency to determine the performance of urban freight.

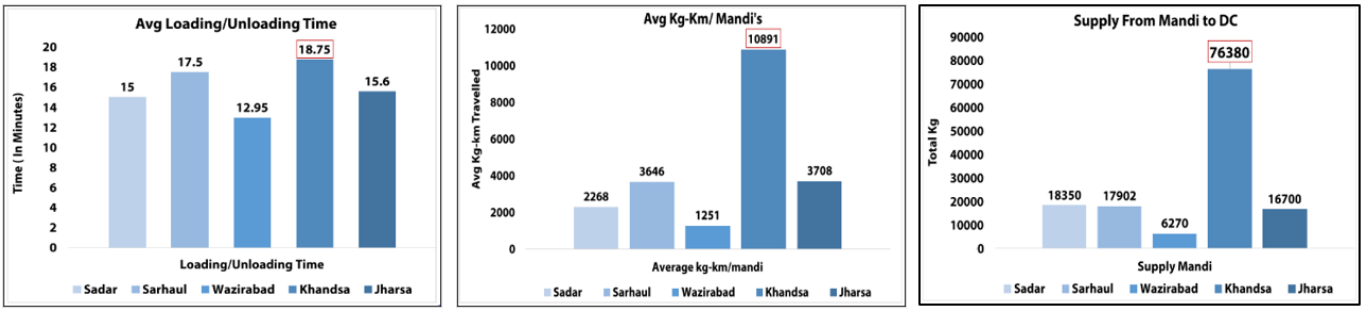


Figure 3: KPI's Analysis of Mandi Characteristics, GMUC

From the analysis of mandi characteristics, it is observed that in the handling process of perishable goods carefully it takes a lot of time to unload the goods from HGVs, MAVs and load it into the LCVs and Tempos for distribution in the city where inbound freight in the mandis takes more time rather than average loading for distribution time at Khandsa and Sarhaul mandi is 18.75 and 17.5 mins per vehicle. The average distance kg-trips per distribution center of Khandsa Mandi is much higher than other mandis in Gurgaon with an average of 10891 kg-km/Mandi where LCV and GCR are the prominent modes of distribution and in the Supply from Mandi to distribution center it is observed that the total supply from Khandsa mandi to their distribution center is 76,380 kg per day as compared to supply of other mandis to their distribution center which shows the demand of LCV's and GCR is much higher in Khandsa mandi to save time in loading/unloading.

3.3.2 Route Characteristics

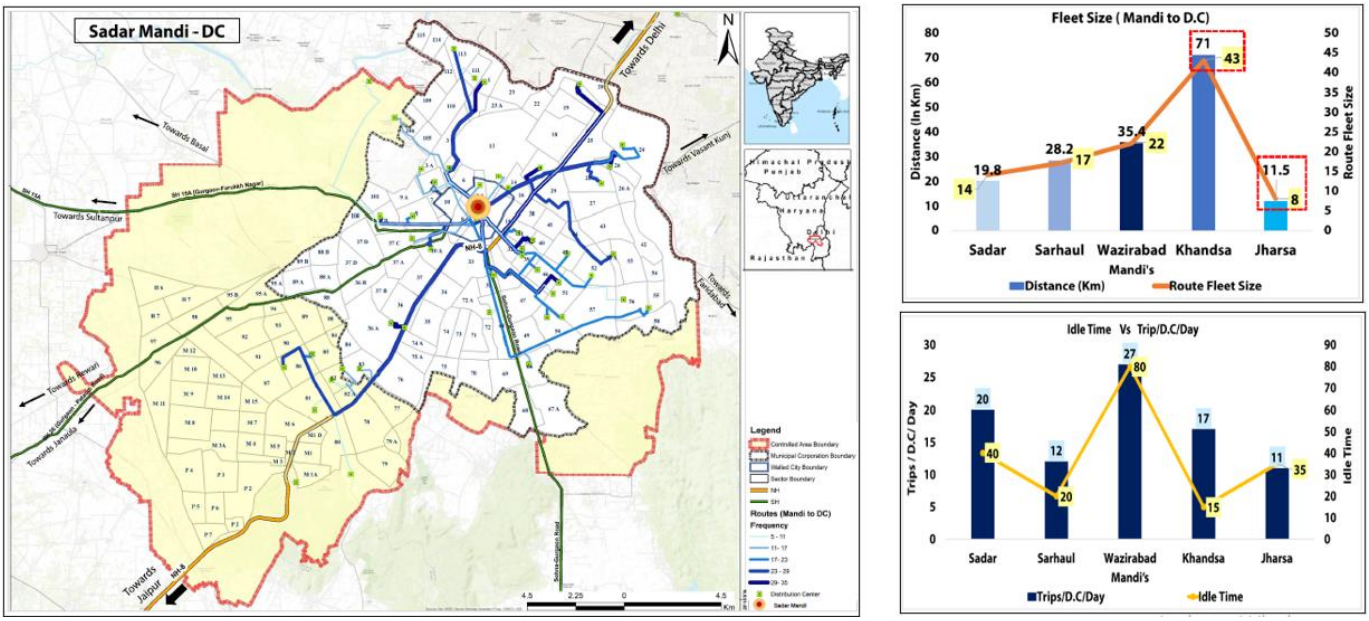


Figure 4: KPI analysis of Route Characteristics, GMUC

To understand the freight distribution pattern of the city the transit time for distance is the most important criterion to know the performance of urban freight. In trips/D.C/day to know the idle time in each mandi, it is observed that the 80 mins in Khandsa mandi the vehicles have to wait for order processing, vehicle-breakdown, loading-unloading and queue on toll for the waiting time and the average distance travelled from mandi to distribution center in Khandsa is around 7.91 km from LCV's and GCR in a day experiencing a lot of delay and increasing operating costs. Khandsa Mandi to the distribution center where 43 fleets travelled the distance of 71km and Jharsa mandi with more distance travelled with less fleet size shows underutilization on the route.

3.3.3 Fleet Characteristics: Wholesale Mandi to Distribution Centre

This metric is a test of the efficiency of the automobiles. A truck will be used as intensively as possible, so that the demand for freight is adequate to cover the direct running costs on the market. Kilometers per car are determined by driving speeds, the ratio of idle to the duration and day-to-day running times. In an urban freight service, speeds suffer from the number of delays, the time required for late order delivery by the fulfilment center creates congestion.

Table 2: Relation between Vehicle Km travelled and Kg-Km Travelled

Mandi	No of D.C	VKT	Kg-Km Per Day	Kg-Km /Veh /Day
Sadar	10	38.4	225024	16073
Sarhaul	8	41	234643	13803
Wazirabad	7	119.2	898768	40853
Khandsa	12	76	250800	5833
Jharsa	8	17.7	62216	7777
Total		**292**	**1671451**	**84338**

From (table 2) it is observed that the vehicle kilometer is obtained after calculating the mode wise haulage length in km with the number of trips per distribution center per day and the resultant VKT will multiple with total kg- per day by per mode for total kilometer per day where Wazirabad and Sadar at local level distrusting the highest Kg-km per vehicle per day to their distribution center following by VKT of Sadar mandi (38.4) and Wazirabad 119.2 km per day. For loaded vs Empty share, In Gurgaon, LCV's and GCR are the prominent modes used for urban freight distribution of agricultural produces where there is a lack of reverse logistics practices in all the supply chains of the market-distribution center. 81% and 77% of freight vehicles are loaded and 21%-23% remaining empty due to imbalanced flow, short hauls and regulatory constraints.

In the freight distribution process, the payload is the important factor that determines the performance of freight distribution based on their carrying capacity, where LCV(4W) having VCU of 66% and GCR with 81%, the average capacity utilization per vehicle is 73.62% which is underutilized.

3.4 Performance Measurement of Freight and Agricultural Produces

Based on the KPI's identified for measuring the performance effectiveness of both urban freight and perishable goods in the city. It is easy to identify the economic and environmental impact of urban freight and performance measures of agricultural produces affecting the freight distribution with lack of logistical infrastructure, lack of flexibility, reliability, responsiveness and food quality of the product. For performance evaluation of urban freight, environmental, economic and transport terminals with their operational details, terminal capacity, cost of operation, UFT fuel consumption and vehicular emission is to be analyzed to provide effective solutions for urban freight distribution. Further analysis was carried out to determine the performance of truck terminal of freight distribution pattern in the city where economic and environmental impact includes the cost of operation, excess cost, UFT fuel consumption and vehicular emissions from Wholesale to Distribution chain of freight distribution in the city.

Table 3: Environmental Impact and Vehicular Emissions per Day analysis of UFT

Mode	Mileage (km/ltr)	Fuel Consumption	Avg Veh Km/Day	Fuel Cons/Day	Avg Kg Km/Day	Fuel Consumption (ltr/ton km)
LCV	10.43	0.18	12378	68767	53429000	0.001287
GCR	6.21	0.2	18492	92460	33980000	0.002721
Average	8.32	0.19	15435	80613	43704500	0.002004

From (table 3) The consumption of fuel per day was estimated to be 80613.3 ltr/day and 0.02 consumption ltr/Ton km. The environmental cost of UFT operations was estimated based on rates per ton-km published by the 'Total Transport System Study', 2008. Planning Commissions, Govt of India. The estimated annual cost of UFT operations for Gurgaon was estimated to be 1.56 Crore.

Agri-Supply Chain Performance – SCOR Model

For measuring the performance of the Agri-supply chain by using the regression analysis in SPSS to identify the factors contributing to transport performance and the factors affecting the perishability of the fresh produce. To substantiate the objectives for the condition of the roads influencing the damage level of fresh produce during transit (Transport Performance) and the spoilage of fresh produces will affect the overall performance of fresh produce supply chain (Perishability).

From these dimension of transport performance and perishability, various attributes are identified to study the performance of road transport operators in the fresh produce supply chain where transport performance (y) is the major dependent variable which is influenced by nine independent variables are: Loading/unloading time (x1), frequency of services (x2), losses during transit (x3), vehicle capacity (x4), Reliability of delivery (x5), Information sharing (x6), skills of drivers (x7) and vehicle condition (x8). Similarly, for the performance of perishability, perishable (y) is the major dependent variable and independent variable (x1 to x9) are physical damage (x1), lack of effective packaging (x2), lack of cleaning and washing (x3), lack of plastic crates during transportation (x4), loading and unloading time. For testing the performance of the Agri-supply chain various Chi-squares and ANOVA framed for this study for which the significance level (i.e., $\alpha = 0.05$).

From the analysis it is observed that the supply chain efficiency ranking for fresh produce is 3.158. It means that they think the score is good. Economic costs (3.795), return on investment (3.733), appearance / freshness (3.835), shelf life (3.792), food protection (3.506), salubrity (3.477) and order fill performance (3.333) are the following measures which contribute positively to the ranking. Whereas the metrics that have led to the poor efficiency of the supply chain are freight costs (2.897), quantity volatility (2.969), distribution versatility (2.979), shipment failures (2.749), traceability (2.612), storage and transport conditions (2.918) and fresh produce promotion (2.309) and these measures are essential for change. However, the average production ranking for fresh produce in the supply chain is 2.997, 3.129, 3.261, and 3.363 at producers, distributors, manufacturers, and transporters.

4. Urban Freight Transport Modelling of Agricultural Produces

In modelling, the methods and tools are used in modelling process the methodology has been adopted first to generate the mode-wise matrix for each commodity and secondly, the average payload of each mode is multiplied to obtain the tonnage-based O-D matrices for each commodity where the TLFD is obtained using the data from the O-D survey, after that TLFD and supply chain of commodities are compared and similar are categorized. These steps are individually done for the flow of commodities by freight analysis zone wise.

Freight modelling is prepared by using PTV VISUM software the current situation and forecast using a traffic network model. The more complex processes are explained well in Commodity-trip based modelling to implement in VISUM. The network interface and steps in VISUM were tonnage generation, tonnage distribution, and tonnage assignment. The network model (nodes and links) used to model and analyze traffic flows and traffic relations of areas by tour-based freight generation and distribution. A total trip was generated in between commercial areas a truck with regression analysis to estimate the vehicular trips of fruits and vegetables in GMUC with the establishment where total freight tonnage generation of fruits are 16511 (P) and 9474 (A) and of vegetables with 13694 (P) and 6054 (A).

The Trip length frequency distribution of base year and modelled was estimated for HY-2031 to see the change in the distribution pattern of perishables goods as there will an increase in the production and attraction due to upcoming sub-mandi's and expansion of truck terminals in the city. From the base year freight distriution in between emplyement production and freight trip attraction, it is found that the intensity of freight movement is high between zones of commercial

areas and truck terminals. In figure 7, also the intensity of freight trips found high between TAZ4 and TAZ 6 with availability of truck terminals and most of the trips have been assigned in between 12-14 km and 18-20 km of distance in peak hours.

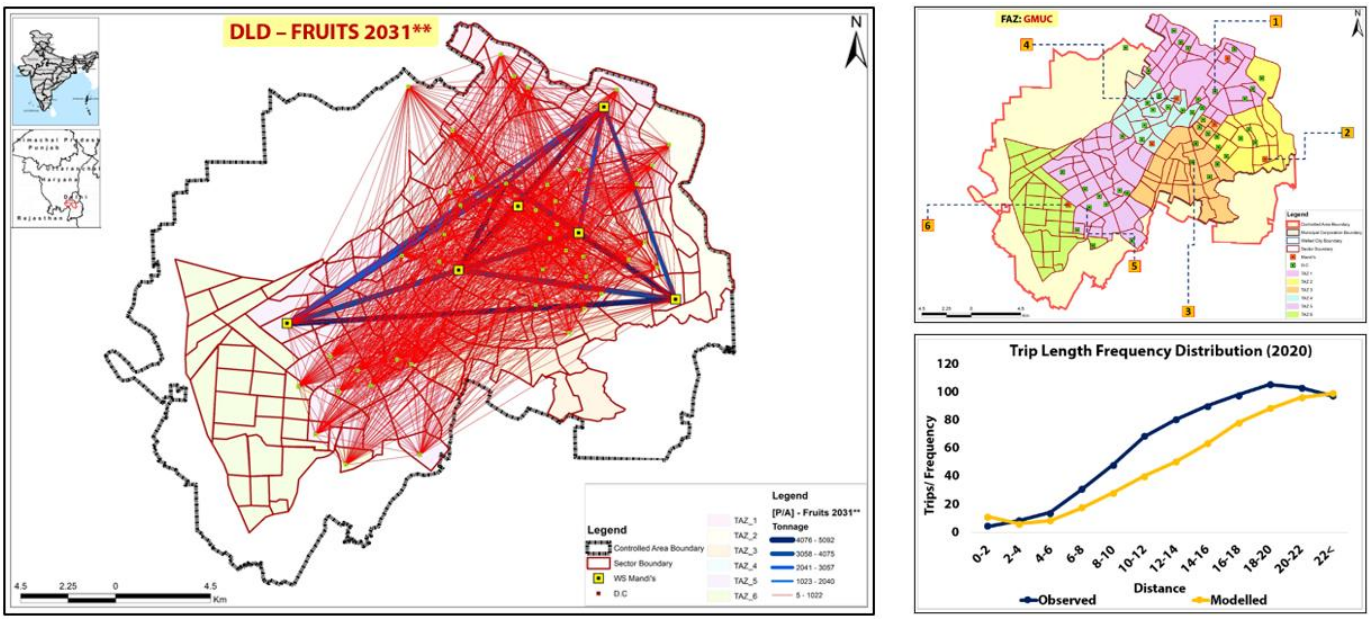


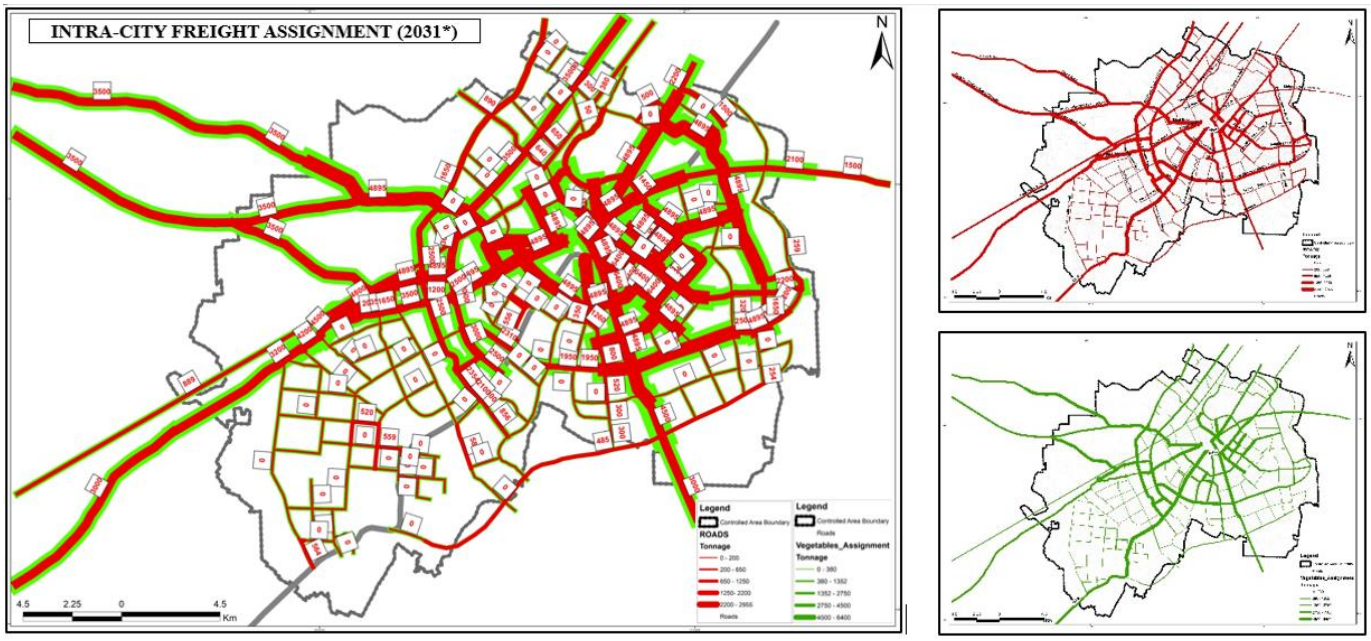
Figure 5: Freight Trip Distribution: DLD of perishable goods for HY- 2031 & Trip Length Frequency Distribution (TLFD), GMUC*

In an attempt to plan for the enhancement of performance of the freight transport system, it's evident to think about at time-frame and phasing of the plans to be implemented to sustain the upcoming needs of the town, employment and population. Therefore, a horizon of 10 years was considered to plan the urban freight distribution system for the performance enhancement of the prevailing UFT in (GMUC). The growth in commercial areas was projected using the data available from the Integrated Comprehensive Mobility Plan of Gurgaon-Manesar Urban Complex. The existing and proposed area under different commercial activities was used to calculate freight generation rates per hectare of commercial land which were further used to estimate freight demand for 2028.

Table 4: Estimated Growth in Commercial Areas (Ha) of GMUC by 2031

Year	Commercial Area (Ha)			Total Commercial Area (Ha)
	Retail & WS (Ha)	Regulated Markets	Other Commercial Areas (Ha)	
2010	352	128	52	532
Proposed 2031*	678	285	84	1054
Growth/ Annum	**17.5**	**10.0**	**3.4**	**30.9**
Estimated for 2020	482	248	78	808
Estimated for 2040	**556**	**296**	**110**	**962**

The freight demand for HY-2031 estimated or projected for tonsbyusing 2 different methods – 1) By taking 0.15 per capita consumption rate (tons per capita) and 2) 23.50 Per hectare freight generation rate (Tons per hectare of commercial areas) for year 2020. So after calculating the average daily freight generation (Intra-city) 2031 (Ton), the PCCR is estimated to be 20,433 and PHFG is 22.489. A total of 26,400 trips/day are occurring within the Gurgaon Manesar Urban Complex (GMUC) limit for year 2031 while the estimated share of tonnage handled in 2031 is 20,433 and average payload (tons) of 2.49. There will be increase in growth of vehicle trip of GCR for year 2031 as they will be the prominent modes of urban freight distribution in the city for providing last mile delivery with unorganized practicing modes with higher pollutant emissions.



*Map 3: Intra-City Freight Assignment of Fruits and Vegetables (Tonnage) for 2031**

The majority of the tonnage load will be on NH-8 [Delhi-jaipur Expessway] which is the main route for import and export as well as distribution of goods from markets to sub markets and distribution centres. 50% tonnage load will be applied on Gurgaon-Sohna Road, 36% on Delhi-Jaipur Expressway followed by Sarhaul Mandi and 25% each loaded for Wazirabad and Khandsa Mandi for optimal and effective distribution of perishable goods in HY-2031. Heavy freight vehicle should be replaced by Electric cargo vehicles in order to distribute the load by reaching the product in less time, cost and resources. For projected tonnage of fruits and vegetables for HY-2031 will be assigned with the increase in share of tonnage on major freight corridors or freight generating areas. 19.6% and 18.7% of tonnage will be assigned for fruits distribution from Wholesale to Distribution center for Sadar and Khandsa route to cater more demand in future and 22.4% and 24.8% will be for vegetable distribution for same network.

4.1 Findings of the Model

By projecting the VKT for HY-2031 of LCV and GCR will have a large number of distances travelled with the increase in the urban radius of the city with new upcoming sub-wholesale and retail mandi's in the city areas. Sadar and Wazirabad mandi's will be travelled more for the distribution of goods in the future. Trips estimated with 32.09% variation in 2031** where there is huge increase in LCV and GCR in Khandsa and Sadar mandi with the increase in urban radius as well as lead time. Estimated that increase of 104% by 2031** in ton km travelled where Khandsa and Sadar Mandi are the prominent for demand for goods.

4.2 Scenario: Cluster Based Distribution

After detailed analysis of Agri-supply chain and Urban freight in the city, the alternative scenario is to be prepared for the HY-2031 for effective freight distribution system in the city which is Scenario 1: Cluster Based Distribution. In this scenario, the two-wheelers markets are assigned to distribute perishable goods to specific distribution centers.

1. Developing cluster of markets based on proximity among each other.
2. Supply by wholesale markets is sufficient to meet the requirement of clusters market.

From the Scenario Building for Cluster Based Distribution where two options where assessed to give an optimistic and ideal scenario of urban freight distribution in the city with distribution of goods using LCV, Lorries and LEV, Cargo bikes which distribution with LCV and Lorries will distributed the tonnage of 155T, 810.19 tonne-km with 724.60of vehicle-km and 144

kg of CO2 emissions where the distribution from cargo bikes, LEV will save CO2 emissions 0kg with 548.8 Tonn-km which is the ideal scenario 'zero-emission' vehicles via road.

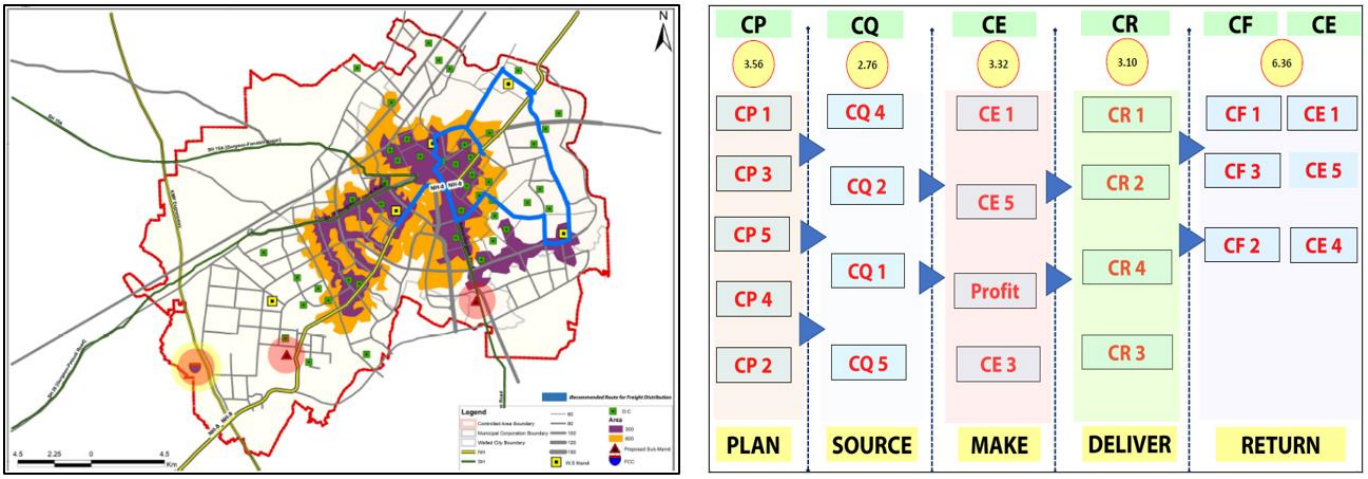


Figure 6: Proposal Freight Distribution of Perishable Products for HY-2031 & SCOR Model for Agri-Supply Chain

Table 5: Scenario Building of modes for distribution

OPTION I – DISTRIBUTION USING LEV, LCV AND LORRIES					
MODAL CHARACTERICTICS					
Modes	**Avg No of Trips/Day**	**No of Modes**	**Avg time taken/trips (min)**	**Avg Ton Carried/trips**	**Avg Distance / Trip (km)**
Lorries	4	4	10	0.8	0.4
GCR	7	18	77	0.5	4.2
LCV	3	10	95	0.3	6.3
Total	14	32	182	42	10.9
OPTION III – DISTRIBUTION USING LEV AND CARGO BIKES					
Cargo Bikes	4	12	10	0.3	0.4
GCR	7	19	77	0.5	3.7
Total	11	31	87	0.8	4.1

From the detailed analysis in the research, it is important to identify the metrics after assessing the Agri-supply chain metrics and on the basis of the responses by retailers or distribution centers on their functions. In Agri-supply chain it is always mandatory to plan first the product quality (3.56) source processes (2.763), making the efficiency (3.328) and the deliver the reliability to both wholesaler and distribution centers with the customer feedback responses (3.100) then deliver the flexibility with efficiency to the customer (6.36).

4.3 Recommendation and Strategies

Urban Freight - It is reasonable to assume that demand for freight transport will continue to rise with further economic growth. However, there should be support for measures that may reduce overall demand. It is important to remember that more effective transport networks can not only mitigate emissions for a given a quantity of ton-kilometers transported, but will also facilitate the transportation of a greater quantity of ton-kilometers. Policies which contribute to more effective transport systems on which transport demand should therefore be enforced uniformity. For long distance deliveries, use of less polluting modes is highly recommended.

1. Efficiency-enhancing technologies as well as restructuring schemes will lead to a reduced number of freight-vehicle trips in cities.

2. Encouraging the use of low emission cars, enhancing operation and coordination driver appear to be the simplest steps to introduce and are likely to be strongly accepted by private sector operators.
3. Lorry-routing schemes: Voluntary or mandatory schemes for the provision of adequate road networks and roads for heavy goods vehicles.

Measures for Improving Supply Chain and its effectiveness - Systematic improvements ought to make place at various rates-producers, intermediaries and customers. A critical position may be played by government, corporate, public-private partnerships, cooperatives, infrastructure companies and even the media. Infrastructure such as bridges, rail, ICT and cold storages are critical criteria for improved supply chain performance where-

1. A more technical approach is public-private collaboration. Supply chain such as cleaning, waxing, marking, packing, wrapping, pre-cooling, storage protection and manufacturing facilities will bring importance to the operation of the supply chain.
2. Linking in Marketing channel – Proper marketing and knowledge on other considerations must be sufficiently accessible to ensure reasonable productivity for the food supply chain and thus for the production of a healthy economy.

4.4 Proposal

From (Figure 9) The network analysis tools from ArcGIS has been adopted to analyze the vehicle routing of freight distribution time from waholesale markets to distribution center in peak team by getting the shortest path and serviceable areas to serve the proposed mandis in buffer of 300m and 600m in order to achieve the target of reducing the time dwell time, transport cost and loading/unloading time by replacing the conventional distribution system with cross docking facilities where the time taken to cover all the six mandi's in the study area is 1 hr. 24 min to consolidate and distribute goods in markets with long-term year proposal for freight consolidation center to limit the freight movement in urban areas to avoid congestion.

5. Conclusions

The study reveals the low truck-utilization in the markets with distribution of perishable goods in distribution centers dealing with Agri-supply chain performance metrics flexibility, responsiveness, efficiency and freight distribution measures to identify the challenges faced with markets linkages, demand forecasting, total transport cost and time per tonnage handled. There the freight modelling and SCOR model proposed in the analysis can help to estimate the tonnage handled for horizon year and increasing the efficiency in supply chain. In order to implement this various stakeholder's consultation between APMC markets and other departments to provide the holistic and sustainable freight transport operation in the study area to effectively utilize a truck by improving the vehicle utilization.

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