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ARTICLE

Anatomy of an Urban Food Supply in the Global South—The Case of Vegetable Supply to Hanoi City

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ABSTRACT

Documenting urban food supply systems is essential for understanding their functioning, impacts, and future evolution. While this task is a critical step in implementing urban food policies, it faces significant challenges—particularly in low- and middle-income countries. Through a case study of Hanoi, Vietnam, we use diverse empirical data sources to tackle the issue. We quantify the urban food supply system of Hanoi for one key product: fresh vegetables. By combining multiple investigative methods, we employ social network analysis to map the intermediary networks connecting production and consumption. Volume of food flows moving through different supply channels and the spatial expansion of the entire system have been determined. Our findings reveal that Hanoi currently sources vegetables from a vast area, encompassing all of northern Vietnam and parts of China. While local production (within Hanoi) still accounts for 46% of the supply, most locally grown vegetables pass through intermediaries—such as wholesalers, retailers, and street vendors. These intermediaries play a crucial role by bringing fresh produce closer to consumers, thereby enhancing the overall efficiency of the supply chain. The results align with predictions from previous research, indicating that food supply systems in Southern cities are in-

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creasingly following trends observed in Northern cities as urbanization progresses. We recommends that future food policies should explicitly address the role of middlemen, particularly street vendors. The roles and contributions of these informal operators to the urban food systems of the Global South should be formally recognized.
Keywords: Urban Food Supply; Food Flows; Intermediaries; Informal Economy; Food-Sheds

1. Introduction

During the last two decades, urban food has garnered much attention from society and has become a central theme in food research. Cities in developed regions such as North America or Europe are increasingly adopting new urban food policies, aimed at fostering more sustainable food systems [1]. In the Global South, while ensuring food security remains a priority, there is also a growing emphasis on transitioning toward a more resilient and sustainable food system [2]. Recently many South countries have begun initiatives to transform the food system into greener and more sustainable models [3–5]. Urban food lies at the heart of food system transformation, driven by its economic and demographic influence. However, despite the momentum, the issue of urban food supply has received surprisingly little investigation, particularly in cities of the Global South.

Understanding how food is supplied to cities is crucial for ensuring food security. Cities must secure their food supply because they typically lack significant local food production capacity. Since food often originates from distant sources, any disruption in supply chains can profoundly impact the lives of millions people [6]. Cities in the Global South are particularly vulnerable to this risk. Due to rapid urbanization, access to food in many Southern cities has become a challenge for low-income populations [7], especially as they lose access to local food sources due to peri-urbanization. According to a United Nations report, Africa, Asia, and South America are experiencing rapid urbanization, with 67% of the world's population projected to live in urban areas by 2050 [8]. This urban growth means that cities in the Global South must identify new sources of supply to compensate for limited local production and develop logistics infrastructure to ensure safe and efficient food distribution.

Over the past few decades, rapid urbanization has dramatically transformed food supply chains in Southern cities. Reardon et colleagues report that the volume of food moving through urban supply chains in Africa has increased by 600–800% over the last three decades [9], while Southeast Asia has seen a tenfold rise during the same period [10]. The development of supermarkets has been particularly notable [11,12], driven by the demands of an emerging middle-income class and the quest for food safety that traditional wet markets struggle to provide. Urban sprawl has also reduced the surface area available for urban agriculture. Heightened awareness of food security risks during crises, such as the COVID-19 pandemic, has led some countries to promote short supply chains and urban agro-ecological agriculture to enhance resilience of production system and supply chain [13–16]. The digitalization of economy starts to be diffused in food supply system, especially in modern distribution circuits like supermarkets. However, demographic factors remain central to the transformation of urban food systems in the Global South.

Southern cities now rely on larger catchment areas for food [9,17] and their supply chains depend heavily on intermediaries who play a critical role in ensuring efficiency. The contributions of intermediaries—such as collectors, transporters, cold storage providers, and wholesalers—are particularly significant, reflecting the division of labor within the food chain. Paradoxically, despite their importance, these actors remain largely invisible to the public and are often referred to as the "hidden" operators of the supply chain [10]. Several factors explain this invisibility.

First, the scarcity of suitable data largely results from private stakeholders' reluctance to disclose business information, a challenge that affects both the Global North and South, though the latter faces more severe information gaps. Second, investigating intermediaries in the food chain requires the ability to access them, but their spatial distribution can be extensive. A large

food supply area makes it difficult to track food origins and identify the operators responsible for handling the food [18]. While food traceability is mandatory in some countries, it rarely provides insights into the geography of supply—even in developed countries. Finally, a distinct challenge in Southern countries is the dominance of informal economies among food operators [19,20]. These actors are absent from official reports and statistics, significantly increasing the cost and complexity of data collection and validation, and making comprehensive analysis particularly difficult. Despite their contributions to the local economy—including tourism and cultural attractiveness—their role has often been overlooked or minimized [20]. Yet, they are key actors in the food supply systems of the Global South, and their transformation over the past decades has been described as a "quiet revolution" by some authors [12].

This situation explains why assessments of food systems in the Global South are often qualitative up to date. Few studies present empirical data due to data unavailability. Barrett et al. colleagues highlight that "*The large-scale, nationally representative household datasets—such as those from the World Bank's Living Standards Measurement Study (LSMS) or the Demographic and Health Surveys (DHS)—which have become workhorses in empirical development economics research, are ill-suited to explore the transformation of agri-food value chains* [12]." Access to data is essential for informed decision-making. Relying solely on qualitative data risks leading to incorrect decisions or inappropriate policy recommendations. For example, policies aimed at transforming urban food systems might focus excessively on farmers or consumers while overlooking intermediaries, who play a "hidden" yet pivotal role in the value chain [12,21]. In reality, it is very these intermediaries who hold the key to the entire system.

This paper addresses the issue of lacking quantitative data through an empirical study. It sheds light on the organization of urban supply chains in a Global South agglomeration by estimating the size of different categories of food suppliers and the volume of food flows transiting between them. We focus on the case of Hanoi, Vietnam—a city with 5 million urban residents (9 million in the total metropolitan area)—and examine the vegetable supply chain. Our objective is to quantitatively explore Hanoi's vegetable supply by answering the following questions: Who are the main midstream stakeholders in the city's vegetable supply? How many are there? What volumes do they handle daily? We provide an inventory of all categories of stakeholders in the vegetable supply chain, including cooperatives, collectors, wholesalers, retailers, street vendors, and supermarkets. Beyond presenting empirical values, the study also introduces an innovative method for quantitatively assessing the geography of food supply, offering evidence-based characteristics of the urban food supply system in a Southern agglomeration.

Hanoi is chosen as a case study because it exemplifies the urban dynamics and challenges facing food supply systems in Asia. As mentioned earlier, Asia has experienced unprecedented urban expansion since 2000, with the cumulated change in its city populations surpassing the total change of Western Europe and North America combined. Hanoi's population has tripled, from 2.7 million in 2000 to 8.7 million in 2024 [22]. Alongside urban sprawl, the city's food supply faces challenges in both quantity and quality. The need for food often leads to the neglect of food quality, generating issues—particularly food safety concerns [23]. Food distribution in Hanoi relies heavily on wet markets and informal street vendors [24]. The lack of infrastructure, coupled with spatial constraints, poses another significant challenge: supplying large quantities while minimizing spatial occupation. The solution has been to increase the pace of supply, particularly at night, when there are fewer issues with public space utilization. Night work also reduces exposure to authority control, which is a concern for workers in the informal economy. These characteristics make Hanoi an illustrative case for many other cities in the Global South.

By examining the "hidden middle" of the supply chain, this study aims to contribute to the debate on food system transformation in the Global South. It raises the question: Which urban food policies should these countries and cities adopt to become more resilient and sustainable in the future? The paper is organized as follows. After the introduction, the second section presents the theoretical framework and data collection methods.

Findings are presented in the third section, followed by an in-depth discussion in the fourth section. The conclusion summarizes the essential points of the study.

2. Methods and Materials

2.1. Theoretical Framework

The term *urban food supply system* refers to a network of food supply chains that connect farms to urban consumers. In the literature, this concept is also known as the *agri-food value chain (AVC)* [12] or *food value chain*, though these chains specifically focus on consumers in urban areas. The terms *value chain* and *supply chain* can be used interchangeably in academic discourse. Their analysis originates from commodity chain analysis [25], which consists of identifying stakeholders within the supply chain, then mapping their connections to construct a diagram of stakeholders.

Historically, commodity chain analysis derives from the labor theory of value, which posits that each commodity is produced by adding labor value to transform its precedent status. The commodity chain represents a continuous process, in which a product accumulates value at various stages before reaching the end consumer. Immanuel Wallerstein was the first to use this term in his book *Historical Capitalism* [26]. He argued for replacing the simplistic market model—where producers and consumers interact directly—with a system where most transactions involve intermediaries along an extended commodity chain. Hopkins and Wallerstein later developed an analytical method [27], which is renewed by Gereffi and Korzeniewicz [28] and adopted by a generation of economists [29]. This method begins by identifying the nodes of the chain, starting from the finished product and moving backward. A similar approach, known as *filière analysis*, was developed by French economists post-1945 [25], though it remains less recognized due to its primarily French-language documentation. Both schools agree that the supply of a product can be decomposed into segments and nodes, with each node representing a distinct category of economic agents.

Social network analysis [30,31] was originally developed to study social relationships between individuals or groups. Initially rooted in sociology [32], its use has expanded exponentially with the rise of online social networks. Social network analysis examines the characteristics of individuals and groups, as well as the correlations between these characteristics and the connections within a social network. In this paper, we focus solely on the technical application of social network analysis, without delving into the social or economic implications of these connections. Specifically, we use social network analysis tools [33] to generate a graphical representation of the vegetable supply system.

Technically, each link in the graph connecting two categories of food suppliers is defined by four parameters: a starting point (seller), an ending point (buyer), a value (quantity of merchandise), and an attribute (origin of the vegetables). This information will be collected from various sources, primarily through surveys. The resulting graph will illustrate the network of food suppliers, with links representing the volume of food flows. By incorporating the origin attribute, it will also be possible to geographically assess the contribution of each supply source.

2.2. Qualitative Description of the Supply System

Social network analysis does not require prior knowledge of the network structure. However, the structure of Hanoi's food supply network has been documented in previous studies [34–37], which offer valuable insights into the overall organization of the system. While these publications are primarily qualitative or partially quantitative, they provide essential information about the roles of different stakeholder categories. Specifically, the supplier network consists of four key nodes:

1. Local farmers
2. Wholesalers
3. Retailers in planned markets and street vendors
4. Supermarkets and specialized food stores

Local farmers play a significant role in the urban food supply. Vegetables are cultivated in the rural areas of Hanoi, which still account for 53% of the city's land surface. Intensive farming occurs in the Green Belt,

approximately 30 kilometers from the city center. Vegetables are typically harvested at the end of the day and transported to city markets early the following morning, where they are sold to wholesalers, retailers, or street vendors [35].

Wholesalers are central to the supply system, serving as the primary link between farms and wholesale markets. They act as the main entry points for all urban supply circuits, except for local circuits. Wholesalers either collect vegetables from farms themselves, or rely on collectors to gather merchandise, which they then distribute to retail and street markets [34]. These retailers, which are numerous, subsequently supply end-consumers and catering outlets in smaller quantities.

Supermarkets and specialized food stores represent a relatively new category of suppliers, with the earliest documentation dating back to 2015 [38]. However, they have expanded rapidly due to the growing urban demand for convenience and food safety. While data on the evolution of supermarkets in Hanoi is available, the volume of food transiting through this channel remains undocumented.

2.3. Method of Data Curation

One of the greatest challenges in this area of study is data curation. To address this, our strategy involves integrating multiple data sources, including publicly available datasets and empirical data collected by the research team. In total, three primary sources of data were utilized.

2.3.1. In-Depth Interview Surveys

Surveys were conducted at five nodes in the system, corresponding to five categories of vegetable suppliers: wholesalers, retailers, supermarkets, street vendors, and cooperatives. Quantitative questionnaires were used for the first four categories, while for cooperatives, only qualitative questions were applied. Within each category, respondents were asked to list their suppliers and customers. This approach allowed the identification of additional intermediary types beyond the five main categories mentioned above. A consolidated list of all stakeholders was then established and later used to construct the supplier network through social network analysis [33].

The survey consisted of two main phases.

(1) Several exploratory interviews were first carried out with key informants who possessed substantial knowledge of the intermediary system. These included two officers from the Hanoi Department of Agriculture and Rural Development (DARD), 25 vegetable market managers, and two researchers.

(2) Subsequently, in-depth individual interviews lasting 20–30 minutes were conducted with a random sample of intermediaries. This second phase was essential for collecting quantitative data. The procedure differed for supermarkets and specialized food stores: since these outlets belong to a limited number of companies, interviews were conducted at the headquarters of selected firms, covering more than 60% of the food stores in Hanoi.

2.3.2. Geo-Localized Data

This data source was used to analyze the roles of street vendors, supermarkets, and specialized food stores. However, these two contexts—street vendors and supermarkets & food stores—are not equivalent.

Concerning street vendors, geolocalized data for them were generated by our research team. While their role has been documented in several monographs [39,40], no prior publication has explicitly quantified their contribution to the food supply system. Previous studies have primarily focused on their legal status or social integration within the urban landscape [41].

To assess their contribution in terms of volume, we first mapped their spatial distribution in Hanoi. Using dash-cams mounted on motorbikes, we surveyed all streets in urban Hanoi with a population density exceeding 10,000 inhabitants/km^2. This effort covered 102 of the city's 168 urban wards [19]. GPS-tagged video coordinates were used to map street markets and count the number of street vendors, including those selling vegetables, at each vending point. Through desk-based analysis, we compiled a list of 336 street vending locations. This list was then used to randomly select vendors for interviews, as described in the preceding section (2.3.2).

For supermarkets and specialized food stores, we initially scraped data from Google Maps using keywords

such as "food stores," "food magazines," and "supermarkets." After removing duplicates, we obtained a list of user-located spatial objects. This list was cross-referenced with publicly available lists of supermarkets from the websites of operating companies. Once the spatial distribution of these stores was established, we conducted interviews with managers of selected companies to gather detailed supply data for all of their outlets.

Table 1 below summarizes the data collection methods used to investigate suppliers.

Table 1. Resume of categories of supplier and methods of investigation.

System Node	Method of Investigation	Sample Size
(1) Wholesale market	Interviews with the management committee, followed by interviews with vendors	75 vendors randomly selected. Market coverage : 5/5 markets
(2) Planned retail market	Interview with the management committee, followed by interviews with vendors	60 vendors randomly selected. Market coverage 20/106 markets.
(3) Street (informal) market	Spatial distribution of vendors, followed by interviews with vendors	Spatial screening cover 102/168 urban wards. Market coverage: 80 vendors from 8 selling points.
(4) Supermarket/shop	Interviews with regional managers of vegetable stores combined with Google map data scraping.	4 supermarket chains, and 5 food shop chains, representing more than 60% of the supermarket/store identified by Google map scraping

2.3.3. Official Statistics

The last source of data is the official statistics of Hanoi (at the provincial level). These data, provided by the National Statistical Office, concern the number of Hanoi farmers, the surface of vegetable planting by district, the volume of annual harvested output, the population of Hanoi and their average vegetable consumption per day. Production data allow to control the volume of local production in the supply, while population data help to estimate the urban demand in terms of vegetable consumption. In the study, official data have been used only to frame the volume of local production and local consumption of Hanoi.

2.4. Data Extrapolation

The final step in our method involves integrating data from multiple sources to construct a comprehensive picture of the urban supply network. As previously mentioned, social network analysis was used to map the network graphs. To estimate values for the agglomeration, we applied data extrapolation to the sampled values.

This process primarily involves two steps: first, estimating the total number of vendors in each supplier category, and then multiplying this number by the median value of individual supply quantities. The median value—measured in kilograms of vegetables sold per day—was chosen over the mean for its robustness. Two methods were used to estimate the total number of vendors: (1) direct counting and (2) projection from sample values.

For wholesalers, we used direct counting. We automatically count their presence across all five wholesale markets under study, representing 100% of Hanoi's wholesale markets. This count was verified during exploratory interviews with the wholesale market management committees. The same method was applied to licensed retailers: we counted vendors in each market and cross-checked the numbers with market managers.

The projection method (**Table 2**) was employed when surveys covered only part of the supply system. This applied to three supplier categories:

- Retail (planned) markets: 20 sampled from 106 official markets.
- Street vending: 102 of 168 urban wards in Hanoi.
- Supermarkets and specialized food stores: The number of selling points surveyed represented only 60% of the total identified.

Table 2. Method of extrapolation for each category of supply operator.

Category of Intermediaries	Method of Extrapolation
Wholesaler	Direct counting (checked with the manager)
Retailer	Direct counting (checked with the manager), then projecting for all the urban area

Table 2. *Cont.*

Category of Intermediaries	Method of Extrapolation
Street vendor	Direct counting thanks to GPS-localized data, then projecting for all the urban area
Supermarket/shop	Google Map scraped data combined with public data

The final step in data extrapolation involves validating the two ends of the supply network: production value and consumption value. Official statistics were used for this purpose.

- Production Value: Local production is constrained by the capacity of Hanoi's farmers, which depends on their available land and the crop yields reported by the Statistics Office. This implies that any supply exceeding local production capacity must originate from remote production zones. This information will be cross-referenced with the vegetable origin data collected from surveys.
- Consumption Value: Household consumption is determined by the size of the eating population and their average daily vegetable demand. Any volume exceeding household consumption must be absorbed by other stakeholders—such as restaurants or meal companies—or exported outside Hanoi.

The official statistics used for these calculations are detailed in Section 2.3.3.

The full methodological process is presented in the **Figure 1**.

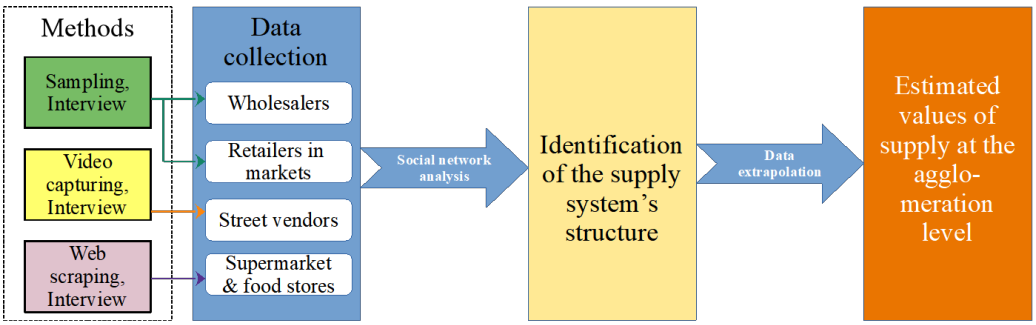

Figure 1. Resume of methodology.

2.5. Strategy of Bias Mitigation

The data obtained may be subject to several sources of bias. The first is self-report bias, which arises from stylistic factors or socially desirable responses [42]. Collecting self-reported data is not ideal for quantitative modelling; However, it remains the only feasible approach when studying informal economies where official statistics are unavailable.

To mitigate this bias, careful attention was given to the questionnaire design, which included similar questions phrased in different ways. This served as a first-level control to test the internal consistency of responses. A second-level verification was conducted by cross-checking respondents' answers with information provided by market managers (see Section 2.3.2). The convergence of these two data sources helped reduce potential errors.

In certain cases, it was not possible to eliminate self-report bias entirely. For example, when asking about the origin of vegetables, retailers often tend to overstate the share of locally sourced produce because such responses are perceived as socially desirable. Conversely, wholesalers were more likely to report that their goods came from distant regions. In these cases, additional checks were made, and respondents were re-questioned when necessary. In situations of uncertainty, the answers provided by wholesalers were prioritized, as they operate upstream in the supply chain and generally possess better knowledge of production zones than retailers.

Another potential bias concerns the estimated number of vendors, which is critical for data extrapolation. Direct headcounts may vary depending on the day and time of observation. Street vendors, in particular, are mobile, raising the risk of double-counting if they move between selling points. To reduce these errors, ob-

servations in open markets were conducted during peak selling periods: from 4:00 a.m. to 6:00 a.m. in wholesale markets, from 5:30 a.m. to 8:00 a.m. in street markets, and from 9:00 a.m. to 12:00 p.m. in popular markets. For street vending, distinct vendor profiles were developed to better capture variations in activity. Fortunately, mobile street vendors accounted for only a small proportion of the total, which limited—though did not entirely eliminate —the risk of bias.

3. Results

The results from 4 key categories of intermediaries of the supply will be first presented. These elements help to understand their role and their characteristics, which condition how the supply system work.

3.1. Wholesalers

Hanoi's vegetable wholesalers are a key node in the supply system. They collect products from production zones and redistribute it to downstream stakeholders in the value chain. Across the five vegetable wholesale markets, their total number is estimated at approximately 2199 entities. By "entity," we refer not to an individual but to a group—often a family-run business. While these entities function as enterprises, we avoid classifying them as such due to their informal economic status.

Wholesalers source vegetables from collectors or purchase them directly from farmers. Local farmers typically transport their products to markets early each morning. Some wholesalers, however, bypass collectors by buying directly from remote farmers or remote cooperatives. In such cases, they also arrange transportation from supply zones to the market. Many of these wholesalers originally hailed from these regions before establishing their businesses in Hanoi.

Wholesalers sell vegetables to a diverse range of customers, including licensed retailers, street vendors, restaurants, caterers, neighborhood households, and provincial wholesalers. Interviews and graph analysis revealed that wholesalers are interconnected. There are three types of wholesalers :

- Direct wholesalers
- Level-1 wholesalers.
- Level-2 wholesalers.

Direct wholesalers are the most common case, accounting for over 90% of vendors in this category. They operate at the interface between the early stage (collectors or farmers) and the later stage of the value chain (retailers or street vendors). Level-1 wholesalers receive vegetables from collectors and redistribute them to level-2 wholesalers. Level-1 wholesalers often specialize in specific vegetables, trading large quantities of a limited range. In contrast, level-2 wholesalers function more like retailers, offering a broad range of vegetables but in larger quantities than retailers. We estimate the volume of individual sale as following (these figures represent median values).

- A direct wholesaler sells approximately 670 kg of vegetables per day.
- A level-1 wholesaler sells about 870 kg per day.
- A level-1 wholesaler sells around 380 kg per day.

In total, approximately 1300 tons of vegetables pass through Hanoi's wholesale markets daily. This quantity is then redistributed to wet markets, urban restaurants, and collective kitchens throughout the city, as well as to rural markets in the greater Hanoi area.

3.2. Retailers

The retailer category includes two types of operators, (a) licensed retailers and (b) temporary retailers, both of which operate in (planned) retail markets. The main difference between them is their legal status. A licensed retailer possesses a business license, which grants him/her a permanent place inside the market. A temporary retailer does not have a license and takes only a temporary place that could be reaffected to another one if he/she does not come. Our interviews showed that there was little difference in the sales volume between these two subcategories. A retailer sells 108 kg/day on average. Several of them sell as much as 500 kg/day, rivaling level-2 wholesalers.

3.3. Street Vendors

Street vendors are individuals who sell vegetables on sidewalks or in unauthorized locations, commonly re-

ferred to as street markets. Depending on their profile, a street vendor typically sells between 40 to 100 kg of vegetables per day. One exceptional case was recorded, where a vendor reported selling 550 kg per day—likely a wholesaler operating outside the official wholesale market system. On average, however, a street vendor sells approximately 54 kg of vegetables per day.

The spatial screening process identified 336 street markets in the dense urban areas of Hanoi, as described in the methodology. The presence of street markets diminishes toward the city's periphery. Using ward population density as a proxy, we estimate there are approximately 416 street markets across the entire urban area of Hanoi. At the agglomeration level, the total number of street vendors is projected to reach 5800 compared to 5300 retailers.

These figures highlight the significant role of street vendors, who dominate in terms of effective numbers. In terms of sales volume, street vending accounts for an estimated 318 tons per day, while retailers operating within official retail market perimeters handle 428 tons per day.

3.4. Supermarkets and Food Shop

As mentioned above, supermarkets and safe food shops occupy a symbolic place in the Hanoi urban food supply since they represent the modern distribution system. The largest supermarket chains selling fresh food are Vincom hypermarkets (including Winmart and Fivimart), AEON, BigC and Coop mart. Among food shop chains, the Win+ system is the country's largest, with more than 500 shops in urban Hanoi alone. Other food shop chains include Bac Tom, Big Green, and Coop food. Based on interviews with these companies, we obtained data about their business segment in Hanoi.

Despite rapid and impressive growth in recent years[38], the volume of vegetables traded through this channel is still weak. On average, a supermarket sells 550 kg/day, while a shop sells only 31.4 kg/day. Interviews with the regional managers of these chains enabled us to estimate an average daily traded volume of 22.6 tons for the supermarkets and 20.7 tons for the food shops under study. According to managers, these values are more or less consistent throughout the year. These rather modest figures might be explained by the fact that safe and well controlled certified vegetables sold in supermarkets are relatively expensive, and are purchased only by a high-income segment of Hanoi's population. Consumers in Hanoi still massively demand vegetables from traditional markets rather than supermarkets. However, this value can evolve very quickly in the future, because supermarket shopping has become a trend for many young Hanoi consumers.

3.5. Upstream and Downstream Stakeholders

Once the number of food operators was estimated, we assessed the supply and customer patterns for each category of intermediaries. The results, obtained by aggregating the responses from all vendors under study, are presented in **Figure 2**.

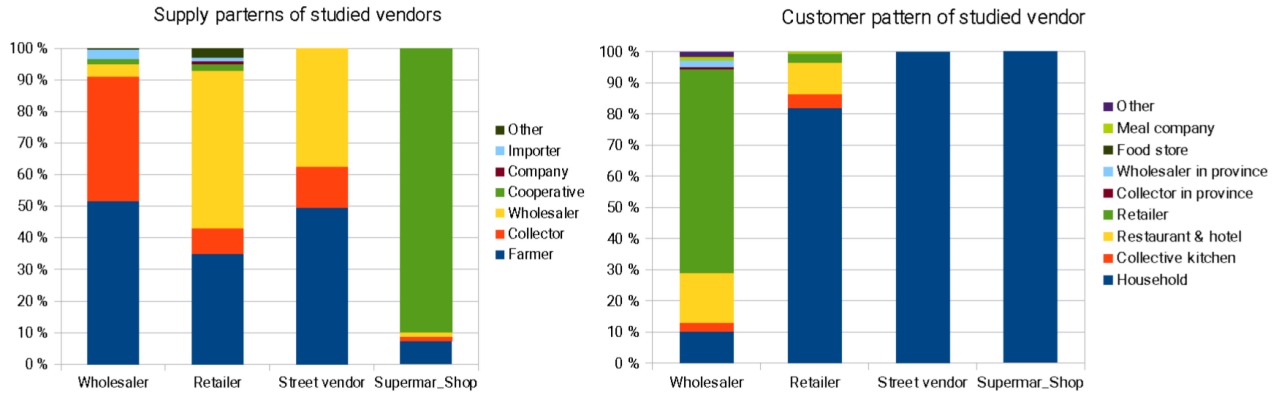

Figure 2. Patterns of supply and customers for the food chain middleman category.

On the supply side, our findings confirm that farmers play a prominent rôle for all categories of suppliers. They supply 50% of wholesalers, 35% of retailers in popular markets, and nearly 50% of street vendors. Farmers also supply almost 100% of the vegetables sold in supermarkets and shops, with this supply channel passing through cooperatives.

In terms of consumption, urban households, restaurants, and hotels are the main customers in the system. Among other stakeholders, we identified catering companies, collective kitchens (industrial service zones located near Hanoi), and certain collectors and provincial wholesalers who purchase vegetables from Hanoi's wholesale markets. Hanoi's geographic location makes it a logistics hub where middlemen can collect, batch, dispatch, and trade merchandise.

Within this context, a special subcategory of supplier was identified during the survey: the collector. The literature contains little information about them. Two kinds of collectors in Vietnam have been reported: assembler collectors and broker collectors [34]. However, no further information about them has been provided, and in general, collectors are largely absent from studies on Vietnam. One reason for this is that they are not easily accessible. They are present in wholesale markets only briefly, during merchandise delivery. Another reason is that collectors are essentially informal vendors and are not motivated to discuss their (big volume) business for academic studies, which may attract regulatory control.

We focused on several collectors to gain a better understanding of their work. Although the number of interviews is insufficient to be statistically significant, they do provide valuable insights. For instance, it appears that a large proportion of collectors originate from farming households. Traditionally, these collectors gathered products from their own farms and those of their neighbors. As demand for vegetables increased, they began to specialize in vegetable collection, expanding their coverage to increasingly larger areas—from the mountainous regions in the north to the Central Highlands of Vietnam, thousands of kilometers from Hanoi.

In the market economy, collectors have replaced agricultural cooperatives in securing markets for farmers. In terms of the vegetable supply, collectors play a key rôle in connecting Hanoi's vendors with remote agricultural producers.

3.6. Estimation of Vegetable Suppliers and Food Flow at Agglomeration Level

The last final part of our study involves extrapolating the data to obtain the overall figure for vegetable flows at the agglomeration level. This information has been partly reported in the preceding paragraphs. The estimated number of vegetable suppliers is summarized in **Table 3** below. According to the extrapolation, there are approximately 5300 vegetable retailers working in urban popular markets in Hanoi and approximately 5800 street vendors working in street markets. More than half of the vegetable stalls in Hanoi are run by street vendors. They supplement official markets in the provision of food to households. These two subcategories together account for approximately 11,100 retailers (in an urban population of more than 5 million).

Table 3. Extrapolation of the number of vendors per category.

Category	Estimated Number in the Urban Hanoi
Direct wholesaler	1670
Level 1 wholesaler	243
Level 2 wholesaler	286
Retailer in popular market	3816
Temporary retailer in popular market	1559
Street vendor	5840
Safe food shop	812
Super/Hypermarket	85

The social network analysis has been applied to produce the network supply system, that is reported in **Figure 3**. We use the Sankey diagram to present the system. This method requires that for each node, the volume of all entry flows should be equal to the volume of all exit flows, which is important because there's a high risk of double counting in supply study. For example: a wholesaler and a street vendor declare each selling 50 kg of vegetable, but there is only 50 kg and not 100 kg of supply in the system, because the street vendor buys from the wholesaler to re-sell it to a household consumer.

Our analysis shows that every day, 1837 tons of vegetables (all categories included) are sent to urban Hanoi, of which 712 tons are from Hanoi's vegetables and 1125.5 tons are from other provinces or imported

from China. The urban demand is estimated at 1287.1 tons per day, and the rest are sent to the rural markets of Hanoi or other provinces. Household home consumption represents up to 72% of the demand. The other 28% is composed of the demand for restaurants and hotels and collective kitchens. The latter could be underestimated, and we return to this point later in the discussion section.

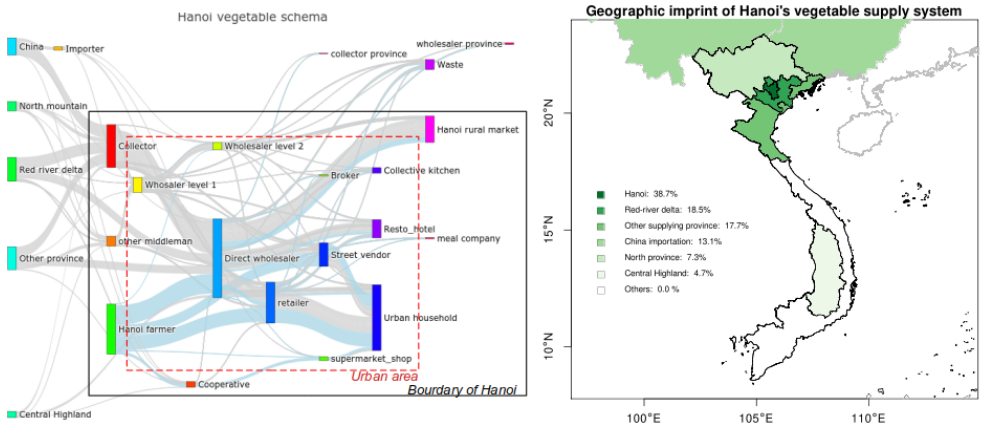

Figure 3. Distribution channels and spatial footprint of the vegetable supply system in Hanoi.

Among the regions that supply vegetables to Hanoi, the Hanoi region itself accounts for 38.7% of volume, the Red River Delta 18.5%, other neighbouring provinces adjacent to the southern Red River Delta 17.7%, and China 13.1%. The Hanoi's main vegetable foodshed is then located within a radius of approximately 500 km (see **Figure 2**). Vegetables from the Hanoi periurban make up a non-negligible portion of the supply. According to our calculations, 43.6% of the total urban vegetable demand comes from Hanoi production. This percentage varies depending on the customer category: in the case of households, it represents 49.6%, while it is only about 27% for restaurants (**Table 4**). This difference is because restaurants buy vegetables mainly from wholesale markets, which in turn are much dependent on remote sources of supply. In total, Hanoi has strong urban agriculture to feed itself, but 56.4% of the vegetables consumed in urban Hanoi are still coming from remote areas of production.

Table 4. Estimates of the demand per category and percentage of local vegetables from Hanoi.

Category of Urban Consumer	Estimated Demand	Volume of Local Supply	% Local Supply
Household	933.9	463.2	49.6%
Restaurant & hotel	259.5	70.0	27.0%
Catering company	16.7	5.0	29.6%
Collective kitchen	77.0	23.7	30.7%
TOTAL URBAN DEMAND	1287.1	561.8	43.6%

Within the urban perimeter, popular markets, street markets, and supermarkets/shops are the three main channels through which fresh vegetables are distributed to households. As reported earlier, street vendors are more numerous, but each supplies far less than vendors in official markets. Consequently, their total supply volume remains lower than that of licensed retailers. Street vending accounts for 34.1% of household demand, compared to 45.9% for retail (planned) markets. We estimate that supermarkets and shops satisfy only 5.5% of household demand (or 51.6 tons per day), a surprisingly low figure given expectations.

We also asked vendors about vegetable loss rates, a time-consuming question but one that provides insight into daily loss volumes. Loss rates naturally vary depending on the type of vegetable, conservation methods, and individual vendors' strategies. Generally, interviewed vendors aim to sell all their stock each day to restock fresh produce the next. They avoid holding vegetables overnight, as this often results in losses. When

waste or losses do occur, vendors typically lower prices or exchange unsold produce for other goods before discarding it. The total loss is estimated at 142 tons per day, representing approximately 7.8% of the total traded volume in the entire supply system.

4. Discussion

Our work sheds new light on the food supply system of Hanoi and demonstrates that some common perceptions about food provisioning in cities of the Global South require reconsideration when moving from a qualitative to a quantitative perspective. For example, the strong presence of urban agriculture might suggest a close connection between farmers and urban consumers. However, this is not the case in Hanoi. Local vegetables mainly pass through wholesale and retail markets before reaching consumers. In reality, production and marketing are two distinct activities: local farmers cannot simultaneously cultivate and sell their produce. In our survey, vendors were randomly selected, and almost all of them were full-time traders. Very few reported having family members engaged in farming. In Hanoi, therefore, "local" does not necessarily mean proximity to consumers within the value chain, nor does it guarantee higher quality or greater sustainability.

Another finding concerns the surprising role of street vendors in the food supply system. Most publications on street vendors in developing countries are qualitative, focusing primarily on their social status or living conditions in urban areas [40] . Based on empirical data, we show that street vendors play a significant role in food distribution. Vegetables are highly perishable and must be sold quickly after harvest. Contrary to common belief, street vendors are essential actors in the distribution chain despite their modest individual sales volumes. Collectively, this channel rivals licensed retailers in total sales, and ensures that fresh products reaches consumers in areas underserved by official markets. From a policy standpoint, this contribution deserves greater recognition. Street vendors enhance the efficiency of the urban food system and reduce the time consumers spend shopping.

Our quantitative analysis also revealed that the vegetable foodshed of Hanoi extends far beyond its immediate production zone. While vegetables grown in the greater Hanoi area still represent a large share of the city's supply —46.3% of urban demand and 49.6% of household consumption—these figures also highlight the city's dependence on a much wider supply region encompassing all of Northern Vietnam and parts of southern China. Similar findings have been reported in Africa, where major cities rely increasingly on food sourced from distant production zones [43,44]. Hanna Karg and colleagues, in their studies of Ouagadougou (Burkina Faso) and Bamako (Mali), found that both capitals are embedded in extensive supply networks connecting remote agricultural areas to urban consumers [44]. This pattern aligns with the predictions in the litterature: as urban agglomerations grow, their food systems must draw on more distant sources to meet rising demand [10]. Large cities in the Global South follow this same structural logic. This result can help design policies to support the development of urban food distribution systems in developing countries in a way that is more aligned with reality.

Moreover, our findings indicate that the spatial expansion of supply areas is accompanied by increasing specialization of production. Farmers around Hanoi specialize in specific vegetables, typically leafy and aromatic types such as lettuce, morning glory, chives, and coriander, which offer high value but require careful handling. By contrast, distant suppliers provide mostly root and tuber crops that can withstand long-distance transport, such as Chinese cabbage, pumpkins, carrots, and tomatoes—some of which are grown exclusively in other provinces or in China. Crops like maize and rice are rarely produced near urban centers, since other regions can grow them more efficiently and at lower cost, while they yield little added value for peri-urban farmers. Though this data is solely qualitative, it helps better understanding the spatial nature of the food supply transformation.

Taken together, these observations suggest that transforming Hanoi's urban food system sustainably—and more broadly, that of large cities in the Global South—requires multiple conditions. Developing effective agroecological urban agriculture is a valuable start-

ing point [45], but this strategy depends on the creation of distinct market channels for agroecological products [46]. Because farmers do not sell directly to consumers, their markets consist primarily of intermediaries. Support for urban agroecology must therefore be coupled with the development of new distribution networks for such products. Unfortunately, these initiatives are still not a priority in most developing countries. At present, emerging food markets in the Global South are viewed mainly as sources of income rather than as levers for sustainable transformation.

In this context, which policies could help advance sustainability? Several directions can be proposed.

First, policy should better address the role of hidden intermediaries. Current food-system reforms mainly focus on strengthening the capacities of farmers, local authorities, and consumers. Our findings suggest that these programs should also target intermediaries within supply chains. Since their numbers are limited, they represent a manageable group in which behavioral change is achievable. The main challenge is reaching them, as many operate informally. A reasonable starting point would be formal recognition of their contribution and the improvement of working conditions for all informal actors, including street vendors. Recent studies [20] have emphasized this issue, arguing that regulatory frameworks should acknowledge the rights of street vendors and prevent discriminatory practices.

Second, improving the management of food loss and waste seems to be another policy perspective. Our study shows that this issue is a major concern for market managers in Hanoi. In general, food loss and waste have received little attention in the context of developing countries, yet the rapid growth of their cities changes the stakes. We estimate that food losses represent roughly 8% of the total fresh-vegetable volume sold, particularly in wholesale markets. These figures, based on sellers' declarations, likely underestimate actual losses along the supply chain. Two main causes stand out: the tropical climate and the lack of investment in storage and preservation facilities. It is not too late to integrate this topic into political agendas. Encouraging investment in cold-chain infrastructure and other conservation technologies in the Global South is an urgent policy priority. However, the debate on the overall impact of this solution is still on-going. Energy consumption and the gas used in cold chain are source of indirect emission. The combat against food loss and waste can also rely on a better coordination between stakeholders thanks to digital applications.

Looking forward, implementing sustainable urban food policies in the Global South remains a formidable challenge. Economic and demographic pressures on food systems are immense in an increasingly mobile and globalized world. The growth of middle- and high-income classes continues to attract migrants from rural areas seeking employment and better living standards. This inflow not only increases food demand but also intensifies pressure on housing, leading to urban expansion and the reduction of land available for urban agriculture. The development trajectory of Southern cities mirrors, in many ways, that of Northern cities in the past. While we hope that urban demand for sustainable foods will eventually provide higher incomes for farmers, this demand currently represents only a niche market and has yet to become transformative. A broader set of policies—such as regulating urban expansion—should therefore be considered to support food-system sustainability in the Global South. In any case, raising public awareness is important to discuss food and urban policy on the same agenda of policy-makers in the South countries, especially at the agglomeration level.

Finally, our study has several limitations. Because our survey targeted intermediaries and reconstructed the supply system from their responses, some biases may remain. For instance, our approach likely underestimates the extent of direct sales between farmers and consumers, which still occur in peri-urban zones. Similarly, certain intermediaries—such as catering companies—may source vegetables from outside Hanoi, process them, and supply them to urban consumers in prepared form. This could explain why demand from restaurants and caterers accounted for only 28% of the total urban fresh-vegetable supply in our data. Future research should aim to generate more comprehensive and precise data on the intermediaries shaping urban food supply systems. Especially, it would be expected that future research reduce the risk of self-report

bias, and enrich the present findings by addressing several aspects such as seasonal variations of supply, the role of direct sale networks, or the digitalization of the supply chain. These information is crucial to have the full and comprehensive understanding of the supply system of Hanoi.

5. Conclusions

Despite the availability of extensive databases and advanced statistical tools, understanding the food supply at the agglomeration level remains a significant challenge in many countries. This is especially true for urban agglomerations in the Global South, such as Hanoi. In this study, we collected data using multiple methods to assess the roles of different intermediaries in Hanoi's vegetable supply system. We generated statistics on the number of intermediaries in each category, the volume of food consumed, and the geographic distribution of the vegetable supply. Our findings indicate that vegetables grown in and around Hanoi account for approximately 46.3% of the agglomeration's total demand—a notably high proportion compared to cities in developed countries. A substantial share of Hanoi's vegetable supply travels through long supply chains (e.g., remote producer-collector -wholesaler-retailer-consumer). Middle intermediaries play a critical role in the system's functioning. Hanoi's vegetable foodshed extends beyond the city, encompassing imports from across northern Vietnam and southern China. Our results confirm that urban food supply systems will increasingly rely on remote areas as urban populations grow. Urbanization also displaces vegetable production zones farther from city centers. While this dynamic is intuitive, our study provides the first empirical evidence from a large-scale supply chain survey to support it.

Author Contributions

H.V.P. led the conceptualization and methodology, and contributed to data analysis and the writing of the paper. V.Q.H. contributed to data curation, data analysis and validation of findings, T.T.L.N. led the data collection, contributed to data analysis and validation of findings. H.V.P. acquired the funding to support the project. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, Pham Hai Vu, upon reasonable request.

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Conflicts of Interest

The authors disclosed no conflict of interest.

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