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# Perceived barriers and the price inflating effects of informal payments in fresh food retailing in urban Bangladesh

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## Abstract

Insufficient fruit and vegetable consumption in Bangladesh, currently 25% below the WHO-recommended level remains a major public health concern. One overlooked factor contributing to high consumer prices and limited access is the presence of informal payments within urban fresh food supply chains. This study investigates the extent, nature, and economic implications of informal payments among fruit and vegetable retailers in Bangladesh's urban markets. A mixed-method approach was employed, combining face-to-face surveys with retailers in two purposively selected areas, Dhaka City Corporation and Manikganj district and in-depth interviews with key supply chain stakeholders. Findings reveal that 36% of retailers reported making informal payments, with a markedly higher incidence in Dhaka (42%) than Manikganj (2%). Mobile (64%) and street vendors (44%) were disproportionately affected, while wet market retailers experienced fewer cases (14%). On average, informal payments amounted to BDT 2720 (US\$ 26.93) per month, equivalent to 9.6% of monthly profit—rising to 10.97% among street vendors and 7.09% among wet market sellers. Thematic analysis of qualitative data highlighted how such payments constrain business profitability, discourage formalization, and act as an indirect tax on consumers, thereby inflating food prices and reducing affordability. The study concludes that addressing informal payments is critical to improving supply chain efficiency and food accessibility. Policy interventions should prioritize the formalization and integration of informal retailers, alongside targeted investments in transport logistics, cold storage, marketing infrastructure, and financial inclusion through government support or public–private partnerships.

**Keywords** Informal economy, Supply chain governance, Food pricing, Market barrier, Fruit and vegetables, Bangladesh

## 1 Introduction

As of 2023, Bangladesh, the eighth most populous country globally, is home to over 170 million people, with approximately 40% residing in urban areas [1, 2]. With the rapid growth of the urban population, the demand for fresh foods is expected to rise



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substantially. Fresh foods constitute a critical component of a balanced human diet, with fruits and vegetables representing key nutritional elements. According to World Health Organization (WHO), recommended minimum daily intake of fruits and vegetables is 400 gram per person to reduce the risk of non-communicable diseases (NCDs) [3]. However, the current per capita consumption of fruit and vegetables in Bangladesh stands at merely 297.3 gram per day. Of this, approximately 201.9 gram derive from vegetable consumption, while only 95.4 gram are attributed to fruit intake [4]. This indicates that the average consumption is still around 25% below the recommended dietary requirement. Moreover, 96.2% of the population consumed fewer than the recommended five servings per day, indicating a high prevalence of inadequate intake [5]. It necessitates corresponding improvements in the supply chain and distribution systems to meet the nutritional needs of the population.

The fruit and vegetable supply chain in Bangladesh involves five key intermediaries: Faria, Bepari, Aratdar, Paikar, and Retailer [6, 7]. Farias are small traders sourcing from growers and selling to Beparis, retailers, or directly to consumers. Beparis purchase from Farias or growers and supply Aratdars, who handle bulk sales to Paikars or retailers. Paikars, as wholesalers, supply retailers, who then sell directly to consumers [6]. In urban Bangladesh, fruit and vegetable retailers primarily operate as wet market (WM) sellers or street/mobile vendors (SV/MV), both part of the informal economy [8]. Approximately 85% of the workforce is employed in this sector, contributing 40% to gross value addition of Bangladesh [9]. Even though due to their informal status, many SV/MVs operate without legal authorization and make regular informal payments to various actors—acting as a hidden tax that reduces efficiency and profitability, with much of the burden passed on to consumers [10, 11].

Although extensive literature exists globally on various aspects of fruit and vegetable market, there is a limited body of research focused on the context of Bangladesh. Available literatures are organized into three clear themes, such as consumption gaps and nutrition, informal payment practices and operational challenges.

Adequate fruit and vegetable consumption is strongly associated with a reduced risk of NCDs [12–16]. Despite this evidence, intake in many low- and middle-income countries, including Bangladesh, remains below recommended levels. Cost-effective interventions are therefore critical to enhance both production and consumption of fruits and vegetables, with the potential to address micronutrient deficiencies and improve a range of health outcomes [17, 18]. However, affordability remains a major barrier: for low-income households, the high cost of a healthy diet often restricts adequate intake [19–22].

A key but underexplored factor contributing to the high cost of fresh food is the prevalence of informal payments. These payments increase retailers' operating costs, which in turn are often passed on to consumers in the form of higher prices [23–25]. Agents soliciting informal payments typically assess visible traits such as business size, profitability, and willingness to pay [26–29]. Although widely recognized, this practice remains poorly documented in the Bangladeshi context, where fresh food markets play a vital role in daily nutrition. Recent studies suggest that the likelihood and amount of informal payments are closely tied to business size, with larger retailers experiencing both greater frequency and higher payment volumes [8, 30, 31].

Beyond informal payments, fruit and vegetable retailers in urban Bangladesh face a range of structural and operational challenges. These include limited access to finance,

risk of eviction, inadequate cold storage, high transportation costs, intense market competition, and vulnerability to adverse weather conditions [32–34]. Such constraints further weaken the resilience of supply chains and exacerbate inefficiencies in the distribution of perishable foods. When combined with informal payment pressures, these challenges threaten both the livelihoods of retailers and the affordability of nutritious diets for consumers.

Although informal payments are a well-documented challenge in many developing economies, most existing studies have concentrated on sectors such as healthcare, education, and large-scale business transactions. Much less attention has been given to the dynamics of informal payments within fresh food markets, especially in urban settings where food security and nutrition are directly shaped by the efficiency and fairness of small-scale distribution systems. In Bangladesh, urban fresh food markets play a critical role in supplying affordable fruits and vegetables to the population, yet there is limited empirical evidence on how informal payments affect vendors in these markets. To the best of current knowledge, no prior study in Bangladesh has quantified the scale of informal payments made by urban fruit and vegetable retailers using a mixed-method approach, making this research a novel contribution to understanding the hidden costs in informal retail markets.

This gap is important because informal payments not only increase the operating costs of vendors but also create inequities across seller types and locations. These hidden costs can influence food prices, vendor participation, and ultimately consumer access to nutritious food. While anecdotal reports and policy discussions acknowledge the presence of harassment and informal fees in urban markets, there has been little systematic research to quantify the prevalence and determinants of such payments. Without solid evidence, it is difficult to design effective interventions to protect vendors and ensure smoother, more transparent food distribution systems.

We addressed this gap by providing empirical evidence on the determinants of informal payments among fresh food vendors in Bangladesh's urban markets. Using regression analysis on a large vendor sample, the study identified the most vulnerable groups and emphasized the importance of these findings for enhancing the supply chain of fresh and nutritious foods. This focus rendered the research both innovative and policy-relevant, providing insights into how reducing informal payments could strengthen market systems and help meet the nutritional needs of the urban population.

## **2 Methodology**

### **2.1 Study design, sample and data collection**

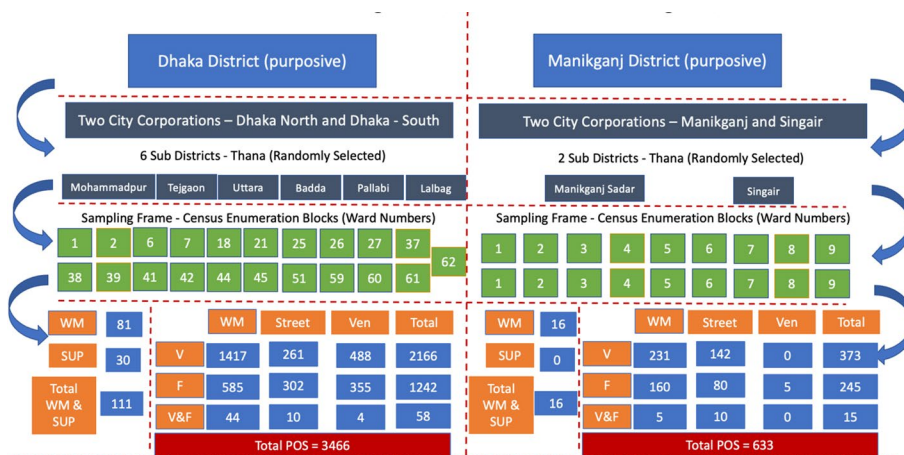
We employed a sequential explanatory mixed-methods research design. We initially surveyed retailers to identify primary barriers within the supply chain. These identified constraints were subsequently examined in greater depth through qualitative interviews with additional stakeholders involved in the supply chain. The quantitative component is structured as a cross-sectional survey, conducted through face-to-face interviews in two purposively selected urban locations in Bangladesh: Dhaka City Corporation and Manikganj district. Within Dhaka, six upazilas (administrative sub-districts; Badda, Lalbagh, Pallabi, Tejgaon, Mohammadpur, and Uttara) were randomly selected, while in Manikganj, two upazilas (Manikganj Sadar and Singair) were randomly chosen.

Choosing Dhaka and Manikganj for a study on urban diversity in Bangladesh is justified because their contrasting features offer a broad overview of the country's urban landscape. Dhaka, as the capital and a hyper-urbanized mega-city, represents the pinnacle of urban development, with its immense population density, socio-economic disparities, and diverse, industrial-heavy economy. Conversely, Manikganj, a smaller district town with strong ties to its agricultural surroundings, reflects the process of emerging urbanization. It highlights the intersection of traditional rural life with growing urban centres, showcasing a less developed economy and different environmental challenges. By including both locations, the study captures the full spectrum of urban experiences in Bangladesh, from the fully developed, globalized city to the rapidly growing semi-rural town, thereby providing a more comprehensive and nuanced understanding of urban diversity.

The target population comprised fruit and vegetable retailers operating as WM, SV, and MV. Due to the absence of official records of fruit and vegetable retailers in the study areas, a preliminary mapping exercise was conducted to establish a sampling frame. This mapping identified a total of 3466 fruit and vegetable retailers across the selected sub-districts in Dhaka, distributed across 81 WM and 30 super shops. Among them, 2166 were exclusive vegetable sellers, 1242 were exclusive fruit sellers, and 58 sold both. In the two selected upazilas of Manikganj, the mapping exercise identified 633 retailers, with 373 selling vegetables, 245 selling fruits, and 15 selling both. The complete mapping procedure is illustrated in Fig. 1. The sampling design idea is adopted from Khan et al. [64].

The semi-structured questionnaire was translated into Bengali and digitalized using Survey CTO, a mobile-based data collection platform [35]. The tool was piloted twice—initially on paper and subsequently in digital form—for validation. Data collection took place over seven weeks in September–October 2021, carried out by six teams, each with two enumerators. We used a systematic random sampling approach, surveying one-third of the mapped retailers at each site by selecting every third retailer ( $k = 3$ ) from the sampling frame. The final sample included 1319 fruit and vegetable retailers—1121 from Dhaka and 198 from Manikganj—with an overall non-response rate of approximately 11%. Further sampling details can be found in Hossain et al. 2023 [8].

Figure 1 shows the mapping of retailers according to the type of market and food. Based on the mapping result, during the field survey, the trained field enumerators



**Fig. 1** Flow diagram illustrating the mapping of retailers in Dhaka and Manikganj.

considered the prominent street for business activities in the enumeration block and walked around to select the SVs. In the enumeration areas within Dhaka city, there were some streets locally known for the “morning/evening market”. These markets are temporary and the retailers perform business on the street with moveable carts for a stipulated time every day. While preparing the sampling frame, those were also considered. Regarding recruiting the MVs the enumerators walked around the residential places of the enumeration areas and approached and surveyed the vendors at their first point of contact and similar approach was used for super shops (SUP).

In the qualitative phase, we conducted in-depth interviews with diverse stakeholders involved in the fruit and vegetable supply chain. We followed a two-stage process to select the participants. Initially, a stakeholder engagement meeting was convened, involving purposively selected participants representing a broad spectrum of sectors, including policymakers, legal professionals, food regulatory authorities, local government representatives, officials from relevant ministries, associations of fresh food suppliers, wholesalers, growers, and transporters, nutrition experts, and representatives of civil society organizations. Subsequently, we used the contact information provided by these primary participants to identify additional interviewees through a snowball sampling technique.

The final sample comprised 20 participants, categorized into four stakeholder groups: farmers ( $n=3$ ), wholesalers ( $n=11$ ), transporters ( $n=4$ ), and policymakers ( $n=2$ ). All interviews were conducted face-to-face in Bengali and were audio recorded, transcribed, and translated verbatim into English. Participation was entirely voluntary. To ensure contextual relevance and depth, distinct interview guides were developed for each stakeholder group. The guides for farmers, wholesalers, and transporters focused on their operational experiences, encountered barriers, and suggestions for mitigating these challenges. Interviews with policymakers explored their perspectives on the structure and dynamics of the fruit and vegetable supply chain in Bangladesh, associated costs and pricing mechanisms, policy frameworks promoting healthy diets, and existing regulatory infrastructures.

Combining qualitative findings from in-depth interviews with quantitative survey results provides a comprehensive and nuanced understanding of the fruit and vegetable market in Bangladesh. While the survey of retailers offers a broad statistical overview of prices, distribution, and market patterns, the qualitative interviews with farmers, wholesalers, transporters, and policymakers offer the crucial “why” and “how” behind these numbers. For instance, the survey might show price spikes, while the interviews can reveal that these are due to transportation challenges or specific market policies, thereby contextualizing the data. This integration allows for data triangulation, where the insights from different stakeholders’ experiences enrich and validate the statistical findings, turning a series of data points into a complete and actionable narrative of the entire supply chain.

Details of the thematic areas covered in each interview guide are provided in Annex 2, and demographic profiles of the participants are summarized in Table 1. The integration of qualitative insights with quantitative data enabled the identification of critical policy gaps and informed the development of targeted policy recommendations tailored to distinct segments of the supply chain.

**Table 1** Sample size of in-depth interviews.

Source: authors' calculation

Stakeholders/Respondents	Sample	Average age (Years)	Average experience (Years)	Average schooling (Years)	Average interview duration (Minutes)
Farmers	3	52	11.7	9.3	30
Wholesalers	11	44.5	15.9	10.3	34
Transporters	4	29.7	8.3	5.5	32
Policymakers	2	48.2	9	17	40

## 2.2 Ethical standard

Ethical considerations were carefully addressed in conducting the survey, given the sensitivity of topics such as pricing, sales volume, profitability, and informal payments. Participants were fully informed about the study and provided with an information sheet prior to participation. Written consent was obtained, and respondents were assured of their right to refuse any question or withdraw at any point. Ethical approval was granted by the National Research Ethics Committee (NREC) of the Bangladesh Medical Research Council (BMRC) (Ref: BMRC/NREC/2019–2022/983; Registration No.: 326 12 08 2020).

## 2.3 Quantitative data analysis

Data were summarized descriptively using measures such as means and proportions. Hypothesis testing employed statistical methods including t-tests, chi-square tests, and F-tests. We examined retailers' basic characteristics, business features, and formalities, alongside the extent of informal payments in relation to these factors. Respondents' perceptions of various operational barriers were assessed using Likert-scale statements, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) [36]. Alongside descriptive analysis, multiple logistic regression models were used to identify determinants of informal payments. Covariates included retailer characteristics—such as age, gender, and education—and business-related factors, including daily turnover, years of experience, type of retail operation, location, and product category. This model assessed the influence of these variables on the likelihood of informal payments among fruit and vegetable retailers. The potential drivers and their relative effect on the odds of informal payments by the fruit and vegetables retailers were determined adopting the following stochastic regression model,

$$p(y_i = 1) = \Phi(X' \beta + \epsilon_i)$$

Where,  $y$  equals 1 if the retailer regularly experiences informal payments and 0 otherwise,  $X$  represents the vector of independent variables,  $\epsilon$  is the error term and  $\Phi(\cdot)$  denotes the cumulative logistic distribution. We evaluated model performance using classification accuracy by the Hosmer–Lemeshow goodness-of-fit test [37], ROC curve analysis, and sensitivity plots [38]. All analyses were performed using STATA version 17 [39].

## 2.4 Qualitative data analysis

to explore the translated qualitative data, following Braun and Clarke (2006) [40]. The analysis was centred on identifying barriers for Bangladesh's fruit and vegetable supply chain actors. A structured coding framework was iteratively developed to reflect the



salient themes emerging from the interviews. Subsequently, data from each interview were systematically charted and organized using Microsoft Excel, with separate sheets categorized by thematic domains and stakeholder groups. The final phase involved interpretative synthesis, where related codes were clustered to distil key findings under the overarching theme of structural and operational barriers. This thematic consolidation allowed for triangulation of perspectives on both the identified challenges and the actors' proposed solutions. As all supply chain actors exert varying degrees of influence on the pricing of fruits and vegetables at multiple transaction points, these qualitative insights offer a nuanced understanding of the systemic constraints they face.

### 3 Results

#### 3.1 Socio-demographic and business profile of the retailers

Socio-demographic and business characteristics of the 1319 surveyed fruit and vegetable retailers were reported. Among them, 41.77% operated in WM, 35.63% as SV, and 22.59% as MV. Vegetable retailing accounted for 64.22% of businesses, while 34.34% focused on fruits. The sector is predominantly male-driven, with 98% of retailers being male. Educational attainment was low, with 33% having no formal education and 41% completing only primary school. The average age of retailers was 38 years, with approximately 10 years of business experience. Most had an initial investment below BDT 50,000 (US\$ 495), with 92.42% relying on self-financing. Additionally, 35.33% reported borrowing from friends or relatives, and only 8.29% accessed funds from NGOs, banks, or other financial institutions. As informal sector participants, these retailers typically rely on personal or informal funding sources. A location-wise breakdown of these characteristics is detailed in Table A1 (Annex 1).

#### 3.2 Informal payments and the dynamics

Table 2 contains the informal payments and their dynamics found among the fruit and vegetable retailers of Dhaka and Manikganj district in Bangladesh. Informal payments were reported by 36% of surveyed retailers, with significantly higher prevalence in Dhaka (42%) than in Manikganj (2%). MV (64%) and SV (44%) were most affected, while WM retailers (14%) reported far fewer instances. The issue is largely concentrated in urban Dhaka, with minimal occurrence in smaller towns like Manikganj.

##### 3.2.1 Payment destination and frequency

Informal payments among fruit and vegetable retailers are primarily directed to "locally influential persons," especially among MV (70%) and WM retailers (61%). Administrative personnel also receive payments, particularly from MV (37.3%) and SV (36.9%). Multiple responses indicate that around 11% of retailers pay more than one group. These payments are routine, with over 90% of those paying influential persons doing so daily. WM retailers also largely pay daily (83%), highlighting the regular and burdensome nature of these informal costs.

##### 3.2.2 Payment magnitude

Monthly informal payments to locally influential persons averaged BDT 2900 (US\$ 28.71) for WM retailers, BDT 2647 (US\$ 26.29) for SV, and BDT 2417 (US\$ 23.93) for MV. Payments to administrative persons were highest among SV (BDT 2173 or

**Table 2** Informal payments and the dynamics. *Source:* authors' calculation

Prevalence of informal payment	(%)
Informal payment by retailer	
Mobile seller ( <i>n</i> = 298)	63.76
Street vendor ( <i>n</i> = 470)	43.83
Wet market seller ( <i>n</i> = 551)	13.61
Total ( <i>n</i> = 1319)	35.71
Informal payment by location	
Dhaka ( <i>n</i> = 1121)	41.66
Manikganj ( <i>n</i> = 198)	2.02
Recipients of the informal payments( <i>n</i> = 523)	
Locally Influential Persons	60.93
Administrative Persons	35.03
Others	15.07
Payment frequency to locally influential persons ( <i>n</i> = 287)	
Daily	90.59
Weekly	7.32
Monthly	2.09
Payment frequency to administrative persons ( <i>n</i> = 165)	
Daily	86.06
Weekly	2.42
Monthly	11.52
Average monthly informal payment in BDT by retailers type	Mean (SD)
Mobile vendors ( <i>n</i> = 190)	2330 (1703)
Street vendor ( <i>n</i> = 206)	2499 (2730)
Wet Market retailers ( <i>n</i> = 75)	2649 (2657)
Total ( <i>n</i> = 471)	2455 (2355)
Average monthly payment in BDT by different location in Dhaka city	
Pallabi ( <i>n</i> = 113)	2767 (2330)
Badda ( <i>n</i> = 88)	2115 (1899)
Mohammadpur ( <i>n</i> = 107)	3070 (2697)
Lalbagh ( <i>n</i> = 38)	3379 (2176)
Uttara ( <i>n</i> = 53)	1908 (2868)
Tejgaon ( <i>n</i> = 68)	1390 (1315)

BDT indicates Bangladeshi Taka

**Table 3** Average informal payments and their share in retailers' profit margin. *Source:* Authors' calculation

Business type	Average informal payment (BDT)	Percent of profit (%)
Mobile vendor (MV)	2367.17	10.08
Street vendor (SV)	2924.70	10.97
Wet market seller (WM)	3204.29	7.09
Overall	2720.17	9.60

US\$ 21.51). Overall, payments to locally influential persons (BDT 2580 or US\$ 25.54) exceeded those to administrative agents (BDT 1909 or US\$ 18.90). The amounts varied significantly across Dhaka city areas ( $p < .001$ ).

On average, informal payments amount to BDT 2720 (US\$ 26.93) per month, equivalent to 9.6% of profit for the business owners who pay them (Table 3). Among different groups, street vendors face the highest burden, with informal payments representing 10.97% of their profit, while wet market sellers bear the lowest at 7.09%. From the sellers' perspective, these payments reduce profitability, discourage business growth, and perpetuate informality, ultimately harming both micro-entrepreneurs and the broader



**Table 4** Regression result: determinants of informal payment. *Source:* Authors' calculation

Independent variables		Logistic regression model ( Dependent variable; prevalence of informal payment = 1, otherwise = 0)			
		Model 1 AOR	Model 2 AOR	Model 3 AOR	Model 4 AOR
Daily turnover		0.999(0.000)	0.999(0.000)**	1.000(0.000)	1.000(0.000)
Business experience in years ( <i>ref: less than 5 years</i> )					
5–10 years		0.601 (0.085)***	0.688 (0.107)**	0.792(0.132)	0.818(0.17)
More than 10 years		0.599 (0.091)***	0.725 (0.121)*	0.669 (0.116)**	0.805(0.19)
Type of seller ( <i>ref: mobile vendor</i> )					
Street vendor		–	0.430 (0.066)***	0.506 (0.083)***	0.505(0.084)***
Wet market seller		–	0.078 (0.014)***	0.088 (0.017)***	0.082 (0.016)***
Type of item sell ( <i>ref: only vegetables</i> )					
Only fruits		–	0.775 (0.109)*	0.699 (0.104)**	0.750 (0.113)*
Fruits, vegetables and others		–	1.701 (0.919)	1.505 (0.57)	1.660 (0.946)
Location ( <i>Dhaka = 0, Manikganj = 1</i> )			–	0.026 (0.013)***	0.026 (0.014)***
Age ( <i>ref: below 25 years</i> )		–	–	–	–
25–40 years		–	–	–	0.977 (0.220)
41–55 years		–	–	–	0.624(0.160)*
More than 55 years		–	–	–	0.351 (0.125)***
Gender ( <i>male = 1, female = 0</i> )		–	–	–	0.623(0.267)
Education ( <i>ref: No formal education</i> )					
Primary		–	–	–	0.781(0.130)
SSC/HSC/Equivalent		–	–	–	0.782(0.154)
Above HSC		–	–	–	0.448(0.345)
Constant		0.902(0.112)	2.172(0.371)***	123.05(70.01)***	267.777(195.7)***
Observations		1319	1319	1319	1319
Regression Diagnostics	Correctly classified	64.29%	72.10%	76.27%	75.76%
	Goodness of fit test (Prob >chi2)	0.274	0.143	0.175	0.160
	Area under ROC curve	0.557	0.758	0.806	0.815

Asterisks (\*) used in the regression indicate the significance level at \*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$ . Parentheses indicate corresponding standard error of the regression coefficient

economy. From the consumer perspective, informal payments function as an indirect tax, making goods more expensive and less accessible, and thereby imposing an additional economic burden.

### 3.3 Multiple logistic regression: determinants of informal payment

Table 4 shows the regression results, highlighting the factors that influence informal payments by vendors and their implications for the food supply chain. In the baseline model (Model 1), business experience emerges as a significant factor. Vendors with less than five years of experience are more likely to pay informal fees, whereas those with five to ten years, and especially those with more than ten years of experience, are considerably less vulnerable. This suggests that informal payment systems disproportionately affect newer entrants, placing additional barriers on small-scale or emerging vendors. In the food distribution context, this undermines the participation of younger businesses that could otherwise strengthen the fruit and vegetables supply chain.

Model 2 highlights the importance of seller type and product type in determining vulnerability to informal payments. Compared to MV, both SV and WM sellers are significantly less likely to make such payments. WM sellers, in particular, experience far lower odds, indicating that vendors operating in more formalized settings enjoy greater protection. On the other hand, MV who often play a crucial role in bringing fresh foods directly to neighbourhoods remain the most exposed group. Protecting MV from such practices could therefore be critical for ensuring that fresh foods are available at the community level, especially for low-income households.

When location is introduced in Model 3, a stark contrast emerges between Dhaka and Manikganj. Vendors in Manikganj face a dramatically lower likelihood of paying informal fees than their counterparts in Dhaka. This suggests that vendors in large urban centres, where market oversight may be weaker and competition is intense, are more prone to exploitation. From a policy perspective, this finding points to the need for decentralizing food distribution and supporting regional markets outside Dhaka. By doing so, policymakers could not only relieve vendors of exploitative costs but also promote more equitable access to affordable fresh foods across different areas.

Finally, Model 4 incorporates demographic variables, showing that age plays a significant role. Younger vendors, particularly those under 25 years old, are the most likely to pay informal fees, while older vendors are better shielded. Although gender and education do not show consistent significant effects, the trend suggests that higher education may reduce vulnerability to some extent. These findings underline the generational inequities in the supply chain: younger vendors, who represent the future of food distribution, are disproportionately burdened. Supporting their participation through protections, training, and institutional backing could help stabilize the supply chain and improve long-term access to fresh foods.

Overall, the progression of the models shows that vulnerability to informal payments is shaped by a mix of structural (type of seller, location), experiential (years in business), and demographic (age) factors. Reducing these hidden costs is directly linked to improving affordability and accessibility in the food supply chain. Since fruits and vegetables are central to nutritional security, addressing informal payments particularly among MV and younger sellers in urban areas would help ensure more reliable distribution of healthy foods to the population. By formalizing vendor protections, decentralizing distribution hubs, and supporting new entrants into the market, policymakers can simultaneously strengthen the supply chain and promote better nutritional outcomes for communities.

The regression diagnostics indicate progressive improvement in model performance across the four specifications. The percentage of correctly classified cases increases from 64.29% to around 76%, showing better predictive accuracy. All models pass the goodness-of-fit test ( $\text{Prob} > \chi^2 = 0.274, 0.143, 0.175, 0.160$ ), with  $p$ -values above 0.05, suggesting no significant lack of fit and that the models adequately represent the data. The area under the ROC curve (AUC) improves substantially from 0.557 to 0.815, moving from weak to strong discriminatory power. Overall, these results demonstrate that the models progressively achieve better classification accuracy, maintain acceptable fit, and increasingly differentiate between outcome categories, indicating that the final

specification provides a robust and reliable representation of the underlying relationships in the data.

### 3.4 Qualitative findings

#### 3.4.1 *Barriers: perceived by the retailers*

Retailers face several barriers in three key areas: competition, financial and supply chain issues, and legal challenges. Competition with MV and WM retailers is more prominent than with super shops which pose minimal competition due to their limited presence in urban Bangladesh. “Competition with online retailers” is the lowest-ranked statement detailed in Table A2 (Annex 1). As a financial and supply chain barrier, retailers report perishability of fruits and vegetables as a major issue, linked to the lack of cold storage. Access to finance, low sales, high supplier prices, and transportation costs are also significant challenges, while very few reported noting but a lack of storage facilities. Legally, informal payments matters as a barrier, with a notable difference between SV and WM retailers. In addition, government restrictions and poor business premises have been cited as obstacles in doing business by the retailers. The response on the other statements is also shown in the Table A2 (Annex 1).

#### 3.4.2 *Barriers: other agents in the supply chain*

Farmers, positioned at the top of the supply chain, typically do not face informal payments but are heavily reliant on middlemen (“bepari”) who collect products and set prices. Since farmers rarely sell directly to consumers, they are often bound by the prices offered by these intermediaries. As mentioned by one of the participants in this category, *“We have sometimes prior knowledge about the market prices, and we bargain on the basis of that with the middle men. If the middle men are selling something at 25 BDT ( $\approx .23\$$ ) per kg, they would be buying it from us at 15 BDT ( $\approx .123\$$ ) per kg.”* (Farmer, ID No-03.)

Limited market information, lack of marketing skills, and dependence on middlemen force farmers to sell at lower prices. To address these challenges, farmers suggest better access to finance and loans, subsidies on inputs, improved communication with agricultural authorities, technical support, and facilities for direct marketing and transportation

Wholesalers mainly source fresh products from local farmers, merchants, or middlemen. Their key challenges are poor transportation and high transport costs, driven by rising fuel prices and hidden road expenses. These costs contribute to higher consumer prices. Wholesalers also report facing extortion and harassment, informal payment especially at night in city areas

*“If you enter a city with a pickup at night you will see young kids standing with sticks. They harass the pickup drivers and extort them. Then we have to pay commissions and charges at 3–4 different places. This is the main problem that we face.”* (Wholesaler, ID No-6)

*“If someone doesn’t pay the extortionists then he is harassed. They are not allowed to conduct business here. Government tries to keep us free from illegal extortions but the problem lies deep within the system. People within the government are dishonest.”* (Wholesaler, ID No-2)

Although price regulation and syndicate formation are reportedly possible, all interviewed wholesalers denied involvement in such practices

Transporters (all interviewed) travel nationwide to deliver fresh fruits and vegetables, working closely with local merchants or middlemen. Depending on labour, fuel, and hidden charges, their profits varies 30–40% per trip. Key challenges include road safety issues, poor connectivity, traffic congestion, high fuel prices, and widespread extortion. As one transporter noted,

*“In Dhaka, once upon a time, there were no illegal extortions. Now it’s full of it. Wherever you go with your truck, you will face numerous illegal extortions, especially in the south city corporation.”(Transporters, ID No-1)*

They suggest reducing hidden costs, regulating fuel prices, and prioritizing product-carrying vehicles to maintain product quality

Policymakers interviewed believe that the multi-level supply chain—typically involving 4–5 stages—leads to a significant price gap between what farmers earn and what consumers pay. Prices are influenced by availability, production levels, the number of intermediaries, transportation, labour, fuel, input costs, and taxes. They suggest that stricter and regular government monitoring can help stabilize prices. Additionally, they recommend subsidies and incentives for farmers during global fuel price hikes to maintain steady supply and reduce risk.

#### 4 Discussion

Food inflation is a major contributor to overall inflation in Bangladesh. It is often driven by factors such as natural disasters, political instability and international affairs [41]. Informal payments contribute to increased product prices even further, ultimately affecting consumers by limiting their ability to afford essential goods. This undermines consumer rights and restricts their choices, often leading to reduced consumption of fresh, healthy foods like fruits and vegetables. The impact is particularly concerning for health, as inadequate intake of fresh food can cause both immediate and long-term health issues. Some studies have highlighted how such barriers in the food supply chain negatively affect nutrition and public health outcomes [42–45].

We explored the frequency and determinants of informal payments among fruit and vegetable retailers in urban Bangladesh. Ensuring a smooth, fair-priced supply chain is essential for improving fruit and vegetable consumption, especially in developing countries. Findings show that a significant share of urban retailers, particularly MV and SV make informal payments, especially in Dhaka compared to Manikganj. This result supports the existing evidences [46–53]. Informal nature of the businesses, lacking formal establishments, contributes to this issue. Informal payments are influenced by business type, size, location, items sold, and experience. Logistic regression revealed that more experienced retailers are less likely to pay informally, while MVs face the highest risk. On average, monthly informal payments amount to BDT 2465 (US\$ 24.4), varying across different areas and vendor types in Dhaka.

Fruit and vegetable retailers in Bangladesh, particularly SV and MV, operate with limited finances and are highly vulnerable to shocks [54, 55]. Beyond financial constraints, key challenges include product perishability, high business premise costs, lack of storage, inflated supplier prices, and government restrictions. Qualitative insights from other supply chain actors reveal systemic issues that drive up prices. Farmers, for instance, cite reliance on middlemen, limited market information, and poor marketing capacity as reasons for low selling prices [56, 57]. Further down the chain, inefficiencies such as weak

transport links, high fuel costs, and lack of cold storage also raise costs [58–61]. Transporters highlight hidden costs and extortion as major obstacles. Overall, the fragmented and informal nature of the supply chain, along with multiple actors, significantly contributes to price escalation from farmer to consumer which may create health concerns in future [62, 63].

## 5 Conclusion

Because of its informal nature, retailers are poorly integrated into the supply chain, leading to operational challenges and increased informal transaction costs. To address this, policy efforts should focus on formalizing retailers, integrating them into the supply chain, and tackling issues such as hidden transport costs, lack of cold storage, inefficient marketing, and limited access to finance. These barriers vary across supply chain actors but collectively drive up consumer prices. Effective and targeted policies are essential for price stability and increased consumption of fruits and vegetables.

Recommendations such as retailer formalization and better supply chain integration can be realized through a combination of government-led policies and collaborative initiatives with the private sector. For instance, governments can offer simplified registration processes, tax incentives, and subsidized credit to encourage retailers to formalize, while partnerships with banks and fintech companies can expand access to affordable finance and digital payment systems. Cold storage investments might be supported through public subsidies, concessional loans, or public–private partnerships that allow logistics companies and cooperatives to build and operate storage facilities, reducing post-harvest losses. Similarly, addressing hidden transport costs could involve infrastructure upgrades financed by the state alongside digital logistics platforms developed by private startups. By combining subsidies, infrastructure investment, regulatory reforms, and cooperative models, these recommendations become actionable pathways to reduce inefficiencies and improve retailer participation in the supply chain.

Informal payments and inefficiencies in the fruit and vegetable retail sector not only create economic burdens but also carry important public health implications. Higher transaction costs, hidden transport expenses, and inadequate cold storage often raise consumer prices and limit the availability of fresh foods, which can discourage adequate fruit and vegetable consumption among urban households. This reduced intake is closely linked to increased risks of non-communicable diseases such as diabetes, hypertension, and cardiovascular conditions, which are already a growing concern in Bangladesh. By framing the problem as both an economic inefficiency and a public health challenge, the case for policy interventions such as retailer formalization, cold chain investment, and improved supply chain integration becomes stronger, as these measures can simultaneously lower costs, improve access, and promote healthier diets.

The study's strength lies in highlighting multi-level barriers across the supply chain, a relatively underexplored area in Bangladesh. However, its limitation is the survey's narrow focus on urban retailers in only two cities because of budget constraints. Future research should expand to include all urban areas for a more comprehensive analysis.

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1007/s43621-025-02286-3>.

Supplementary Material 1

## Supplementary Material 2

**Author contributions**

The study was conceptualized and designed by RH, SMA and SI. Data collection was facilitated by NH. SI and TH analysed the data and NH supported the analysis design. The original manuscript was written by SI, NH and SMA. Manuscript drafting was supported by SS, HE and RH. Study tool and implementation was supported by SS, TH and NH. All co-authors commented and edited the first draft. The final manuscript was checked and approved by all authors.

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**Data availability**

Research data will be available upon request to corresponding author.

**Declarations****Ethical approval**

The National Research Ethics Committee of the Bangladesh Medical Research Council (BMRC) (Ref: BMRC/NREC/2019–2022/983; Registration Number: 326 12 08 2020) provided the ethics clearance for the study.

**Consent to participate**

All participants provided written informed consent.

**Consent to publish**

All authors consent to the submission and publication of this work.

**Conflict of interests**

The authors have no conflicts of interest. There are no financial interests to disclose; all co-authors have seen and approved the manuscript's contents. We certify for the submission's originality and confirm that it is not under review for any other publication.

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