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Supply Chain Issue and Challenges Faced by Street Food Business Units in Kerala

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Abstract: The small-scale food processing units in Kerala are significant to the economic condition of the state as they contribute to employment generation, enhance the hope for revenue generation, and provide a better opportunity for preservation of traditional food culture and patterns of eating. The units, although of significant importance, face distinct supply chain challenges that impact growth, profitability, and sustainability. The present research addresses these issues, specifically focusing on procurement, logistics, distribution, financial concerns, and quality assurance. Data were collected from registered small food units in North, Central, and South Kerala, utilising both primary and secondary data collection sources. Comparing them, it is evident that 78% of small food firms lack supply chain management experts, which reduces efficiency. Issues that have been raised from time to time include high raw material prices, inefficient production, storage problems, and delivery issues. Suggestions made in the research include establishing supply chain management departments, diversifying vendors to minimize risk, increasing production capacity, and investing in improved warehouse facilities. Increasing market space, as well as government-subsidised ones, could create room for new growth and decrease financial burden. They can make the enterprise competitive and bring sustainable growth to Kerala's food processing industry.

Keywords: Supply Chain; Small Food Business Units; Quality Compliance; Food Processing Industry; Sustainable Growth; Enterprise Competitiveness; Labour Utilisation; Processing Issues; Distribution Issues; Lack of Market Facilities.

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1. Introduction

Food processing is one of Kerala's dominant industries, comprising micro, small, medium, and large units that generate employment, contribute to higher incomes, and perpetuate traditional food preparation processes, as documented in local food economy studies [1]. Small and micro food processors in Kerala rely heavily on indigenous technology and manual processes,

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which limit their business size expansion and face growing demand, as per studies on technological constraints by Kumar [2]. Medium and large food processors, by contrast, have adopted new technology and high-capacity factories; hence, their production and efficiency are greater, as per modernisation and automation studies by Nguegan and Mafini [3]. All food business enterprises, regardless of scale, will be required to comply with the food control law to ensure that the food being processed, manufactured, or distributed meets a satisfactory standard of health and safety, as outlined in food safety models studied by Chen et al. [4]. The food supply chain encompasses fundamental processes, including production, storage, delivery, distribution, and retailing, all of which aim to make food accessible to consumers in a quality and safe manner, as outlined in supply chain models by Astill et al. [5].

The process of food production in the business begins at the farm level, followed by processing and packaging. Finally, the distribution process involves storage, movement, and delivery to the market, as outlined in the agri-food supply chain analysis by Ingram [6]. Kerala street food business ventures, which form a significant portion of the Kerala mini food business industry, face numerous supply chain problems that threaten their operational viability and growth, as evidenced in research articles on informal food business environments [7]. These businesses will be impacted by an unexpected and lower supply of raw materials, as they primarily involve local farmers and direct farm purchasing, which can induce seasonally mediated shortages, price volatility, and input quality variation, as reported in procurement issues studied by Pawar and Mali [8]. Labour issues also limit their operations, and most units struggle to retain and source quality workers, which impacts productivity and food safety levels, according to food labour force studies recorded by Dharni and Sharma [9].

The technological deficits also undermine the case for problem categories, as small and street food businesses will seldom possess the necessary equipment or the latest manufacturing technology, which increases hand workload intensity, decreases efficiency, and increases production costs, as evidenced by operational efficiency studies conducted by Farooque et al. [10]. Storage is also a crucial issue, as most street food stalls lack proper storage facilities to keep raw materials and finished goods. Consequently, they will experience higher wastage levels and financial losses, as indicated in research on storage capacity by Okezie [11]. Distribution also creates other problems, as such firms tend to employ casual retail and direct-to-consumer channels with no established logistics affiliations. Therefore, market coverage may not be expanded or modified to accommodate changes in consumer demands over time, as emphasised in logistics management studies addressed by Haessner et al. [12].

Financial constraints continue to be a persistent factor, whereby access to capital and credit is limited, hindering investment in increased equipment, supply chains, or expansion strategies, depending on the order of fiscal availability considered by Knorr [13]. Secondly, street food businesses must contend with complex and occasionally tedious regulatory procedures related to food quality and safety standards that often require specialized technical capabilities or equipment, causing additional hardship to their business, as referenced in the food compliance models discussed in Singh et al. [14]. Its uncertainty in tourist demand, owing to festivals and local tastes, subjects such firms to greater pressure to offer supply chain responsiveness in the event of resource shortage, as regulated in consumer demand volatility models studied by Kurthy et al. [15].

These interrelated problems underscore the need for professional solutions to supply chain management as a unified unit, particularly for street food businesses in Kerala, as revealed by integrated SCM models in Kasza et al. [16]. Here, the focus will be on exploring the specific application of supply chain management practices in small businesses and identifying the most critical issues that plague them at every stage of the supply chain, using empirical case methods as employed by Prasad et al. [17]. Understanding the ground realities, the study aims to add evidence-based knowledge and provide pragmatic solutions that render supply chain efficiency, food safety, and sustainability, as well as sustainable street food development in Kerala, feasible. Intervention in this regard is needed to help unlock the maximum contribution of such ventures to local economies without undermining the cultural integrity of Kerala's rich food culture.

1.1. Research Problem

Small food processing industries in Kerala are among the most important areas for economic development, entrepreneurship, and employment generation; however, they are plagued by serious supply chain issues that hinder their success. Issues such as raw material sourcing and storage problems, inefficiency in labour utilisation, processing issues, distribution problems, a lack of market facilities, and the unavailability of finance restrict their functioning and competitiveness in the market. Although they are of utmost priority, there is a lack of literature regarding individual issues in the supply chains of small food business units. The present research aims to identify and address supply chain problems faced by small food businesses in Kerala, and explore means to improve their operational efficiency.

1.2. Study Aims

- To explore common uses of supply chain management in small food processing units.

- To discuss the challenges with which small food business operators are faced in embracing supply chain management practices in Kerala.

2. Literature Review

Small food business firms are among the primary drivers of the Kerala economy, generating employment, facilitating local farm producers, and supporting the retention of the state's rich culinary heritage, as demonstrated by economic contribution studies [11]. Although they are of significant concern, supply chain problems and issues with such units have received little systematic study, particularly in the street food industry in Kerala, as indicated by the research gaps described in Astill et al. [5]. Most books written on supply chain management place conditions on large companies or provide general advice that small firms can draw parallels from, without considering the unique nature of the food sector in making comparisons, as emphasized by comparative models of SCM employed by Nguegan and Mafini [3].

Kerala street food business establishments face a variety of issues common to them and distinct from those of other companies and locations, as noted in studies on the informal economy by Singh et al. [14]. These include local sourcing issues, where companies are heavily dependent on local supply or direct sourcing from farmers through farm-to-table direct sourcing, to help address unstable supply, seasonality limitations, and cost fluctuations that disrupt manufacturing schedules and cost management, as pointed out in Astill et al. [5]. The second most critical area of concern is labour issues, such as how street food businesses struggle to retain and source high-quality staff, resulting in inefficiencies and quality control issues in food preparation and transportation, as reported in human resources reports by Kasza et al. [16].

Apart from these issues, process-related problems are prevalent because most units are outdated or have aged equipment, manufacturing is manual, and there is minimal use of technology, all of which contribute to increased production costs and decreased production efficiency, according to process efficiency studies by Ruteri [7]. Distribution issues contribute to their activities even further since there are no set logistic networks within most street food businesses, and they conduct retail or direct-to-consumer selling operations, thus making it effectively impossible to raise activities, extend market access, or even compete with better-organised or larger-sized food service firms in logistical systems studied by Kumar [2]. Marketing problems are also a hindrance to development, as such companies might lack resources, knowledge, or access to effective marketing solutions and media through which they can reach new customers and build brand loyalty, as stated in microenterprise promotion strategies by Pawar and Mali [8].

Their lack of supply chain management units in such shops is responsible for all these issues, subjecting them to disruptions, inefficiency, and lost opportunities, as would be understood in organisational capability assessment by Farooque et al. [10]. A money constraint is also present, a typical constraint that prevents such firms from investing in better infrastructure, technology, storage, or expansion, as shown in microfinance access barriers by Kurthy et al. [15]. There is no literature on studies analysing how these issues are interconnected to create a network of supply chain issues that affect the survival and development chances of Kerala Street vendors, as analysed in system reviews by Haessner et al. [12]. While some other studies mention general issues such as financing access or inadequate technology in small firms, they do not explicitly explain how these problems are clearly manifested in the informal and dynamic street food business environment, as presumed in context-based microenterprise research by Nguegan and Mafini [3]. The regional factors specific to Kerala, such as dependence on seasonally provided horticultural crops, the contribution of smallholder producers to supply chains, and the impacts of tourism on demand structures, are also not adequately addressed in the current literature, as emphasised through regional agroeconomic reports submitted by Singh et al. [14].

In addition, the role of shifting food quality and safety policies affecting street food business enterprise supply chain operations remains a relatively understudied area, even as it becomes more salient, as described in food safety compliance literature [15]. This research requires assistance in identifying the need for a comprehensive professional study on supply chain issues in the Kerala street food business, encompassing operations, finance, technology, regulation, and market-oriented aspects, underpinned by the paradigms of development studied by Kasza et al. [16]. This study thus aims to fill this gap by providing a qualitative, context-specific assessment of the supply chain issues faced by these companies and proposing real-world, tailor-made solutions to overcome them, employing techniques used in empirical case studies [17].

3. Research Methodology

The study employs an empirical research design to investigate the supply chain issues and challenges faced by street food business units in Kerala. The study population consists of individuals enrolled in small food business units distributed throughout the state. Random sampling was used to cover different sections of the state, various operating conditions, and supply chains. The sample size consisted of a cumulative sum of 150 small food business units, split into two groups of 50 each for North Kerala, Central Kerala, and South Kerala. Statistical information was collected through comprehensive questionnaires

on key issues, including procurement, manufacturing, storage, distribution, market development, and government assistance. The responses revealed dominant trends that highlighted the operational issues faced by these firms. 53.3% of the respondents fell in the experience-years bracket of 1-5 years, 22.7% of the respondents fell in the experience-years bracket of less than one year, then 14.0% with an experience of more than 10 years, and 10.0% fell in an experience of 6-10 years, hence one can observe that most of the enterprises were youthful and contributed to the growth stage or survival stage.

A substantial 78.0% of the firm's street food business units lacked a set supply chain management function, which in turn had a significant impact on their ability to better manage sourcing, logistics, and distribution. Regarding raw material procurement, 47.3% were sourced from national suppliers, 34.0% were bought directly from farmers, and smaller rates used national suppliers or other sources. Most of the source problems relevant to the study were not offering competitive raw material prices (42.0%), low availability and reliability (20.0%), seasonality (17.3%), and poor-quality raw materials (16.0%). All these factors were affecting stability in their operations, as well as increasing production risks. The proportion of production was characterised by high expenses (26.7%), unavailability of human capacity (21.3%), and substandard machinery or technology (16.0%), which were the most frequent issues to emerge, reflecting production inefficiency gaps and the limited use of technology. Thus far, 61.3% of the respondents have admitted to difficulty in keeping raw materials or products in stock, an indicator of difficulties in preservation houses as well as stock management. For distribution, 46.7% of the units were sold at retail, 32.0% were sold wholesale, 13.3% were sold directly to consumers, and 8.0% were sold through other channels. The majority of these units encountered logistical issues and faced restricted market access.

Up to 76.0% reported that achieving physical extension of coverage was difficult for them due to rising competition, limited resources, and operational challenges. Financial limitations in the context of operating under the supply chain were identified by 74.7% of the units, highlighting the need for stronger financial tools to support street food enterprises. With government support, 32.0% mentioned subsidies or financing, 22.7% cited enhanced access to technology, and 20.0% highlighted infrastructure development. The lowest percentages were represented by training and capacity building (18.0%) and regulatory streamlining (7.3%). These findings confirm the intricate supply chain of problems that undermine the scalability and sustainability of Kerala Street food enterprises. Infringement, supply chain arrangements, and infrastructure and access limitations make them more susceptible to disruption. Evidence-based solutions, including building formal supply chain human capacity, improving access to low-cost raw materials, enhancing production technology, and optimising storage and distribution channels, are emphasised by the evidence. Additionally, a model implementation of government programs and incentives for collaboration with local manufacturers and retailers can help such units enhance their supply chain activities and contribute to the state's economic and cultural diversity.

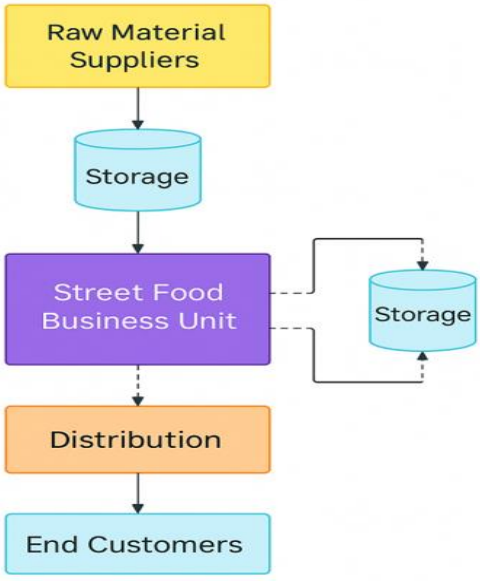

Figure 1: Integrated supply chain flow model for Kerala street food enterprises

Figure 1 illustrates a lean deployment model of Kerala Street food business units' converged architecture. The central unit of the architecture is named “Food Business Node.” It monitors procurement, manufacturing, and logistics of delivery. The architecture is based on fundamental concepts, including “Raw Material Source,” “Vendor Interaction Module,” “Local Market Distribution Node,” and “Consumer Interface.” They are associated with controlled communication links to illustrate the actual data and product flow. There are support processes, such as the "Regulatory Interface" and the "Waste Management Unit," to

facilitate compliance and sustainability operations. Despite extremely low internal tagging rates, the deployment organisation is a perfect example of how every module has a next module dependency for a traceable, unbroken flow from buyer to user.

Ironically, there are very low rates of communication nodes to prevent clogging and ensure parsimonious operations, a notable example of which is street vendors on a microscopic scale. Implementation also suspends the role of digital touchpoints in order processing and inventory management as street food environments are gradually digitalised. Third-party service reliance, such as “Transport Services” and “Storage Units”, is a prime example of plug-in modules, whereby the scalability and modularity of configurations are facilitated by business unit size or site needs. The deployment model is an effective and strategic stakeholder map that demystifies and visualises the value chain process of Kerala street food units, aiming to achieve improved coordination, reduced operational inefficiency, and enhanced delivery performance across the value chain. Figure 1 is thus a reengineering supply chain and sustainable measures guide instrument.

3.1. Data Collection and Description

Secondary data are collected using a questionnaire as the major source of data gathering for the current research. Data from 150 small-scale food business units in Kerala provides us with adequate information regarding some of the issues and operational challenges faced by these units. More than half of the respondents (53.3%) had experience ranging from 1 to 5 years, followed by 22.7% with less than one year of experience, 14.0% with more than 10 years of experience, and 10.0% with experience ranging from 6 to 10 years. The majority (78.0%) of them reported that they did not have a formalized supply chain management department, which reflects the operational constraints of formalized supply chain practices. Out of the raw material sources, 47.3% were utilising local suppliers, and 34.0% were sourcing directly from farmers, reflecting an intensive reliance on the local environment. Raw material price (42.0%) and variable supply (20.0%) were the primary concerns of sourcing.

Regarding production issues, human resource insufficiency (21.3%) and high production costs (26.7%) were significant concerns. Additionally, 61.3% of the firms reported warehousing problems, including massive inventory gaps and inefficient warehousing processes. As for distribution methods, retail distribution (46.7%) was the most common, followed by wholesale (32.0%) and direct-to-consumer (13.3%). Greater access to the market was of interest to 76.0% of the respondents, reflecting market penetration barriers and expansion barriers in the market. Additionally, 74.7% of the companies were financially constrained in carrying out their supply chain operations. With government assistance, 32.0% of them reported being subsidized or assisted financially, while the others reported advantages such as greater access to technology (22.7%) and infrastructure development (20.0%). These all represent the business environment and reflect the most prominent supply chain and production-faceted issues, which are accountable for slowing down Kerala's sustainable development of the small food industry.

4. Analysis and Interpretation

Findings on supply chain problems and the Kerala Street food business firms reveal an extensive and interconnected network of determinants that collectively hinder the smooth operation and sustainable growth of such firms. The very first impediment confronting the naked eye is the lack of formal supply chain infrastructure and managerial systems. They operate informally for the most part and lack formal systems and teams to handle procurement, storage, production, and distribution. Inefficient formal supply chain management prevents the operators from systematically arranging their business, and daily spontaneous procurement of raw materials at a reasonable price is always troublesome. The multi-objective supply chain cost minimisation model is:

$$\min Z = \sum_{i=1j}^{m} \sum_{=1}^{n} c_{ij}\, x_{ij} + \sum_{j=1}^{n} h_j\, I_j + \sum_{j=1}^{n} \sum_{k=1}^{p} f_{jk}\, y_{jk} \quad (1)$$

where, c_{ij} =cost of transporting from supplier i to facility, x_{ij} =quantity transported, h_j =holding cost at facility j, I_j =inventory at facility, f_{jk} =fixed cost of using distribution channel k from facility j, y_{jk} = binary decision variable for using channel k.

Economic order quantity (EOQ) with shortage cost and quality loss is,

$$EOQ = \sqrt{\frac{2DS(C_o + C_q)}{C_h(1-\sigma)}} \quad (2)$$

Where, D =demand rate, S =ordering cost, C_o =cost per order, C_q =cost due to quality loss, C_h = holding cost per unit, σ =shortage probability.

Table 1: Comparison of supply chain, sourcing, and production problems

Category	Most Frequent	Std Dev	T-value	Significance
Years of experience	1-5 years (53.3%)	0.93217	28.292	0
Supply chain team	No (78.0%)	0.41563	52.451	0
Raw material source	Local suppliers (47.3%)	1.06781	23.245	0
Sourcing challenges	High cost of raw materials (42.0%)	1.19074	25.303	0
Production challenges	High production costs (26.7%)	1.60431	23.666	0

Table 1 presents a detailed analysis of the five key areas affecting the supply chain issues of Kerala street food business units: years of experience, presence of a supply chain team, raw material sourcing, procurement issues, and production issues. There are the. The greatest number of respondents are in the 1-5 years of experience group, and the industry is. Dominated by those companies that are included in the initial growth stage, which are operationally unstable in character. The most glaring conclusion that can be drawn from Table 1 is that there. There are 78% of firms that do not have a dedicated supply chain management department. This informal organisation would necessarily be the root cause of inefficiency in procurement, warehousing, and distribution operations. For raw material purchases, most units buy locally and separately from farm procurement. It is favourable to the local economy, but it exposes such companies to price volatility, seasonality, and supply chain volatility.

The resulting high raw material cost was the most common source of problem mentioned, and in a scenario of fluctuating supply and fluctuating seasonality, the problem is intensified. The production issues listed in Table 1 include high production costs, a lack of skilled human resources, and inefficient machinery. The problems generally limit the efficiency of companies in producing, expanding production, or maintaining quality continuity. Standard deviations and T-values indicate significant variations in experience across companies. Therefore, although adjustments can be made in some sub-units, others have substantial gaps in challenge. Table 1 collectively indicates the key supply chain structure and resource shortfall in terms of the competitiveness of such street food enterprises.

Production cost minimisation with technology and labour constraints will be:

$$\min C = \sum_{i=1}^{n} (a_i^k L_i + b_i T_i + c_i^m L_i T_i) \quad (3)$$

were, a_i, b_i, c_i =cost coefficients, L_i = labour hours for process i, T_i =technology use level for process i.

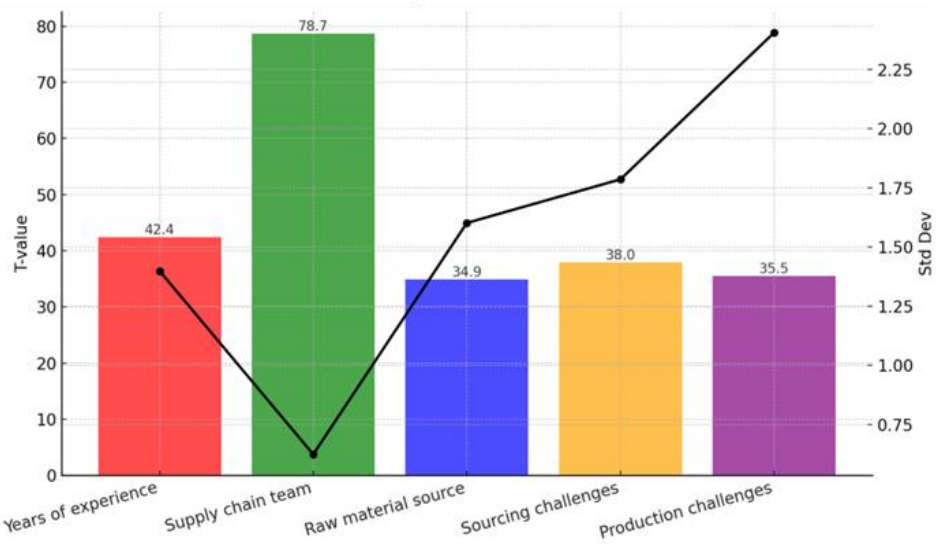

Figure 2: Visualisation of T-values and standard deviations

Figure 2 is a visualisation of T-values (as coloured bars) and standard deviations (as a line) comparing different categories in Kerala's street food business units. The factors considered are years of experience, presence of supply chain personnel, source of raw materials, sourcing problems, and production problems. Colored bars are nothing more than a convenient means of looking at T-value comparisons between such variables when there are similarly wide differences in factors to deal with. For instance, the raw material source category and supply chain team category both exhibit higher T-values, indicating that

companies have more differences or greater discretion regarding supply chain performance. The black standard deviation line offers even more insight into variability within the same segment and how typical it is for companies to encounter this type of issue. A two-axis plot can be used to simultaneously screen for magnitude (T-value) and spread (standard deviation), providing a rough sense of supply chain issues in such units.

Demand-supply balance with seasonal variation is:

$$Q_t = S_t + cx(D_t - S_t) + \beta(S_{t-1} - S_t) \quad (4)$$

Were, Q_t =quantity fulfilled at time t, S_t =supply at time t, D_t =demand at time t, cx, β =adjustment factors.

Table 2: Comparison of storage, distribution, market, finance, and government support problems

Category	Most Frequent	Std Dev	T-value	Significance
Storage issues	Yes (61.3%)	0.48862	34.758	0
Distribution channel	Retail distribution (46.7%)	0.82533	37	0
Market reach difficulty	Yes (76.0%)	0.42851	35.441	0
Financial constraints	Yes (74.7%)	0.43638	35.176	0
Govt support type	Subsidies/financial support (32.0%)	1.33882	23.358	0

Table 2 examines another set of key operational and external environmental factors that influence the supply chain management of street food companies in Kerala. They include storage problems, distribution channel issues, market extension problems, financial restrictions, and the type of government support received. Most companies reported that storage is their primary issue, which negatively impacts stock management, product safety, and operational efficiency. Ineffective storage facilities are a significant cause of high loss and wastage, particularly in industries that deal with perishables. Retail distribution is the most effective distribution channel. While retail channels enable companies to reach customers directly, relying solely on this channel makes them inaccessible to larger markets and exposes them to the risk of fluctuations in local demand. Statistically, it has proven challenging for most companies to expand their market base.

This area has largely been attributed to logistics limitations, competition, and the absence of effective marketing power. Finances were the second common problem, limiting investment in new technology, equipment, or distribution channels. Table 2 also shows the type of government support the firms sought, with funding and subsidies being the most common types of support discussed. However, access to technology, infrastructure development, and capacity-building programs was limited, implying a lack of publicity or information about these programs. The standard deviations and T-values also suggest that there is a significant amount of volatility in the way these issues are affecting firms. While some units were able to mitigate them to some extent, others are still reeling from more than one phase of their supply chain activities.

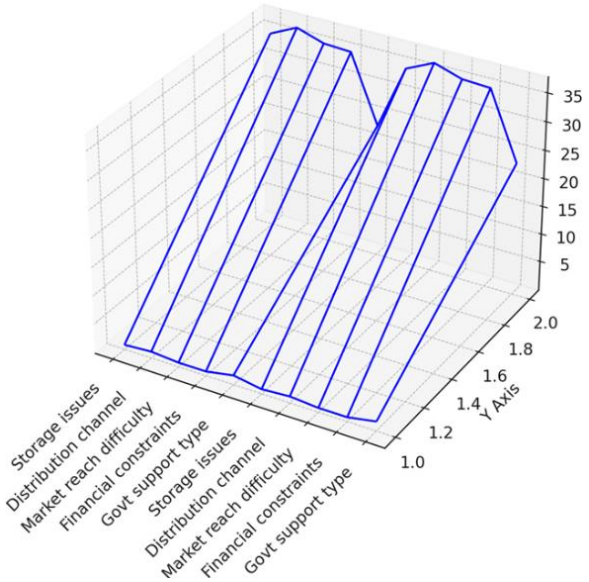

Figure 3: Representation of the interaction between different categories

Figure 3 is a denser mesh plot, used for plotting the interaction between categories such as storage issues, distribution channels, market access facilities, financial issues, and types of government assistance. T-values and standard deviation interactions are plotted using a mesh plot with a wireframe structure for these categories. 3D visualisation, as found here, is used to track the interaction range and the variety of these parameters. The mesh surface shows peaks and troughs, and makes it easy to observe where supply chain management is most and least regular. Redundant categories distort the eye and emphasise trends among many factors of operation. Supplier diversification risk minimisation (portfolio model) is:

$$\min R = \sum_{i=1}^{n} w_i^2 \sigma_i^2 + \sum_{i=1 j=}^{n} \sum_{1 j_i --}^{m} . w_i w_j \sigma_i \sigma_j \rho_{ij} \quad (5)$$

where, w_i =proportion sourced from supplier i, σ_i =standard deviation of cost from supplier i, ρ_{ij} =correlation between supplier i and j.

Table 3: Comparison of experience, distribution, supply chain, production, and assistance

Category	Most Frequent	Std Dev	T-value	Significance
Years of experience	1-5 years (53.3%)	0.93217	28.292	0
Distribution channel	Retail distribution (46.7%)	0.82533	37	0
Supply chain team	No (78.0%)	0.41563	52.451	0
Production challenges	High production costs (26.7%)	1.60431	23.666	0
Govt support type	Subsidies/financial support (32.0%)	1.33882	23.358	0

Table 3 combines variables from Tables 1 and 2 to provide a comprehensive overview of how the most significant operating variables influence and interact with supply chain problems in street food business units in Kerala. Table 3 records years of experience, channels of distribution, availability of supply chain teams, production problems, and the form of government assistance. Firms are monopolising most initial experience courses, and thus, such firms are struggling with market creation complexity as well as supply chain organisation. A shortage of supply chain teams is a determinant shortage, as most firms lack a well-organised supply chain management system. Representation hinders them from making procurement, making, storing, and delivering processes easier. Distribution via retail remains the dominant mode of interaction with the market, with minimal diversification of distribution channels.

Production problems—high production costs and inefficient technology—are most under pressure from the respondents, defining system inefficiencies that contribute to business costs and limit size. Credit subsidies and subsidies are utilized most as government assistance to access, along with other forms of assistance, such as technology upgradation and infrastructure development. The standard deviation and T-values plot a varied range of experience in these categories. The following Table illustrates the interrelationship between these variables: companies with better-organised teams, enhanced government assistance, and varied channels of distribution are better positioned to address production and supply chain issues. In contrast, companies lacking any of the factors mentioned earlier have broader areas of weakness in retaining and growing their businesses.

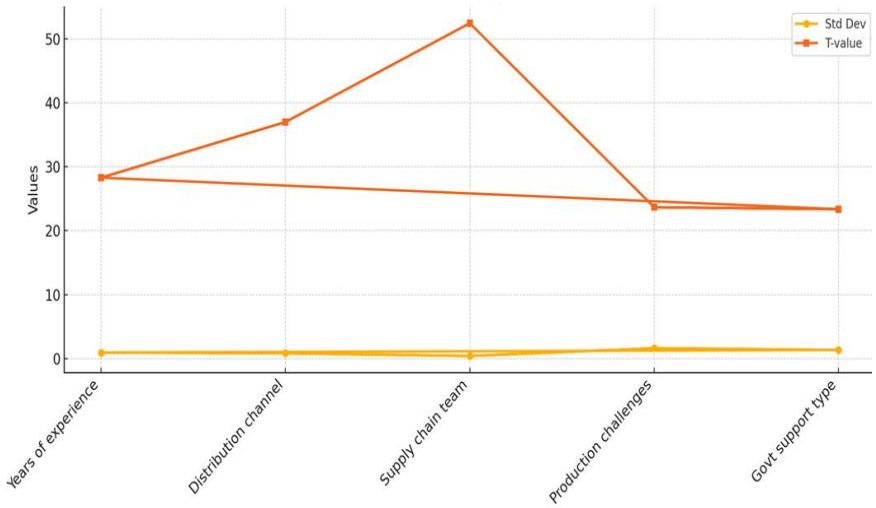

Figure 4: Conspiracy of standard deviation and T-values of different categories

Figure 4 illustrates the relationship between the standard deviation and T-values for two different lines, categorised by years of experience, distribution channel, supply chain team, production problems, and type of government aid. The graph compares variability and significance in such usage, highlighting the highest areas easily. Line demarcation markers where variation takes place or deviates from the statistical effect, and give a snapshot picture of supply chain issues. Such a presentation is straightforward to track trends and peaks across categories at a glance. These farms are heavily reliant on small farmers and local providers and are therefore vulnerable to price volatility, unstable supply, and seasonally influenced quality of large inputs. The fact that there are no long-term, partnership-based supply or diversified procurement processes exacerbates these problems, leaving companies vulnerable to both environmental and market uncertainty. The study also revealed production issues in a very sharp manner.

The majority of street vendors continue to use conventional production techniques, lacking exposure to new technologies or machinery that could increase efficiency and quality. The absence of technology, compounded by insufficient experience, constrains the potential of such businesses to achieve the same level of productivity, maintain costs at reduced levels, and respond to changing clients' demands in terms of quality and sanitation. Storage is also a problem, as all street food businesses lack proper facilities for storing raw material and finished goods. This implies additional wastage, spoilage, and losses, particularly during periods of peak demand or during the peak-demand season. Direct sales to consumers at the distribution stage and unorganised retailing outlets restrict the market coverage of such companies. Access to a chain of logistics is limited, rendering such companies incapable of selling commodities beyond their immediate local markets, thereby lessening their growth opportunities and competitiveness. All segments in the value chain were driven by access to finance.

The restricted availability of working capital, credit, and investment capital prevents these companies from leveraging improved technologies, enhancing their warehousing facilities, or expanding their distribution chains. It also denies numerous businesses the opportunity to benefit from bulk purchase discounts or secure extended, steadier supply contracts, thereby further increasing their operational costs. Compliance with food safety adds another layer of complexity. Street vendors must adhere to specific norms and standards to ensure food safety and quality in the products they provide. However, in most cases, they fail to do so because they lack technical qualifications, have inadequate infrastructure, or receive insufficient support from the relevant authorities. The complexities of navigating the regulatory machinery and the lack of institutional support are typically another barrier for such small businesses. Issues related to marketing were also the main limiting factor for expansion. Not every street food vendor has the capabilities, knowledge, or funds needed to market their product or establish loyalty with clients.

This makes them incapable of being unique in a competitive market and winning new customers. Furthermore, the volatility and unpredictability of demand, influenced by seasonally caused visitation, festivals, and changing consumer tastes, create a necessity for some degree of supply chain resilience. However, this is often not feasible for street food vendors due to a lack of resources. The study discovers that they are related issues, and addressing one sequentially is not more likely to lead to sustainable change. For example, implementing technology to enhance productivity in manufacturing will not yield results if the procurement of raw materials is not secure or if distribution channels are weak. The research calls for a comprehensive and concerted effort toward conceptualising supply chain management for Kerala Street food stalls. All such initiatives aimed at improving supply chain planning, enhancing access to finance, easing technological and infrastructure inputs, and strengthening regulatory capacity are the future path for allowing such units to overcome common problems. By addressing all these problems as an integrated whole, street food business units will enhance their operating efficiency, product safety, and quality, and explore new growth opportunities, thereby contributing more to Kerala's local economy and cultural heritage.

5. Discussion

Discussions of the data, Tables, and graphs provide a general impression of the most common supply chain issues and street food business unit issues in Kerala. The outcome always indicates the absence of systematic supply chain management systems as the solution to operational inefficiencies. Table 1 shows that the majority of street food firms lack specialist supply chain staff. As the mixed bar-line graph (Figure 2) illustrates, the presence of supply chain staff and production issues has a significant impact and high variability on the graph. Buying from local sources in the long run and purchasing directly from manufacturers, as shown in Table 1, exposes companies to supply inconstancy, seasonality, and price volatility. This is well reflected through the high T-values in raw material procurement and procurement issues, both presented in Tables and graphically in Figure 2. Inefficient labor, poor technology, and inefficient cost drain away the efficient production process, where procurement issues are high, as depicted in the Tables and trends. Table 2 and the mesh plot (Figure 3) indicate that warehousing problems plague most companies, rendering them helpless to cope with stock and deliver quality products.

The latter is directly connected to available finances, which are often expressed as limited funds, thereby limiting investment in improved warehouse machinery, the latest technology, or market development initiatives. Dependence on consumer-type distribution channels (Tables 2 and 3) constrains business scope and expansion, as indicated by the high T-values and dispersion in Figures 2 and 4. This is illustrated in the multilined graph (Figure 4), which shows how manufacturing problems and

government assistance levels correlate with business performance dispersion, providing evidence that firms that benefit from the existence of aid and structured operations have a higher likelihood of success. While some of these are state-subsidised, as documented in the Tables, assistance in infrastructure is the standard. An accessible building is the norm. This translates to either existing gaps in coverage or poor business awareness. Such a possible loss further exacerbates the disparity between those companies that can endure storms and those that cannot. The results largely validate that supply chain problems in Kerala street food firms are compounded issues, rather than isolated ones, where faults in one area (e.g., a lack of supply chain personnel) necessarily cause others (e.g., poor sourcing, production, storage, and delivery).

The graph validates these results with obvious peaks and troughs when they are at their worst. The argument suggests that solutions need to be constructed by addressing the structural gap, improving access, enhancing sourcing and channel diversity in distribution and finance, and increasing government support levels to facilitate the uptake of improvements, thereby aiming to achieve sustainable development. The charts and statistics also corroborate that targeted interventions—such as formalising supply chain activity, training in best practices, and investing in facilities for production and storage—will have a significant impact in reducing variability and improving resilience. These conclusions reveal that while street food businesses hold a pivotal place in Kerala's economy and identity, their supply chain mechanisms and practices require substantial development to ensure long-term sustainability and competitiveness in the current challenging market situation.

6. Conclusions

The above study highlights that small-scale food processing businesses, such as those in Kerala's street food enterprises, have significant gaps; yet, substantial opportunities exist in supply chain management practices. These organisations are often operated without professional supply chain personnel, resulting in inefficiencies in manufacturing, sourcing, warehousing, and distribution. Structural failure of this nature notwithstanding, there is a clear appreciation among entrepreneurs for the value of supply chain efficiency as a means of ensuring business sustainability. Significant challenges have been raised, including prohibitively costly raw material prices due to overdependence on domestic sources, variable supply, and fluctuating seasonality. Production procedures are often hindered by antiquated equipment, substandard specialist staff, and high operational costs. Storage space is directly responsible for wastage and economic loss, and distribution is severely restricted to in-town sales channels, restricting marketplace exposure.

To compensate for such limitations, companies must establish proper supply chain departments and organise staff training to provide them with a growing ability to function effectively. It can be made more effective at a lower expense by obtaining inputs from multiple suppliers, organising the manufacturing process to reduce waste, and implementing new inventory systems. Additionally, expansion into new markets through the internet and social networking sites, as well as participation in government programs for subsidies, technology access, and infrastructure, can make new sources of growth possible. By synergistically integrating similar strategies, small food units can be consolidated into shock-resistant, risk-resistant, and competitive units that contribute a valuable addition to the sustainable development of Kerala's food processing business without compromising its rich cultural heritage.

6.1. Limitations

Research on supply chain problems and challenges in Kerala's street food business units, although extensive in scope, has some limitations. Among the primary disadvantages is the exclusive attention given to registered street food business units, which fail to account for the supply chain realities of unregistered or informal operators, yet still maintain the majority of the industry. The fact that most vendors are operating informally implies that some valuable information from this sector may have been lost. The second limitation is the application of self-reported data that were collected using standard questionnaires. Anchors could have given socially acceptable responses or underemphasized some of the issues to avoid disclosure or regulation. The research also does not account for seasonality effects, geographic disparities, or external shocks, such as pandemics, natural disasters, or market imperfections, that can significantly impact supply chain behaviour. The limited longitudinal data restrict what can be concluded about over-time trends or in response to targeted interventions in supply chain issues. Furthermore, the study does not examine broader problem categories across sector-specific idiosyncrasies, such as the tourism role, cultural issues, or consumer behaviour trends unique to the case of Kerala street food. There is also minimal explicit financial data to impose the brakes on the estimation of the economic impacts of such matters on business viability and profitability. Future research can shed light on these aspects through the application of qualitative interviews, case studies, and an increased sample with informal operators to offer a more realistic picture of the industry.

6.2. Future Scope

The destiny of solving the supply chain problems and issues faced by Kerala street food business units rests in embracing holistic, pragmatic solutions that offer operational effectiveness alongside sustainable development. There is an enormous scope

for firms to structure their supply chain operations by establishing specialised supply chain management departments and developing current personnel through customised training packages. Diversification of vendors is also a long-term plan that has the potential to help minimise dependency on local sources, which can be a key strategy in mitigating risks due to supply variability and price volatility. Companies can also benefit by employing alternative sourcing methods and negotiating favourable terms with vendors to control runaway raw material expenses. More opportunities lie in making operations more efficient and minimising waste in the process to lower production costs and maximise efficiency. Advanced inventory control programs and smart storage systems would represent a significant leap towards resolving the warehousing issue.

Entrepreneurial opportunities in scientific market development, based on market surveys, competitor analysis, and the application of web marketing tools for customer acquisition, are also common in this context. Developing customer relationships to foster loyalty and generate word-of-mouth promotion can help increase market presence. Economically, reliance on alternative sources of capital, such as loans, grants, and government-backed schemes, is a viable option for mitigating capital constraints. Through long-term studies and interventions, all the recommendations can be implemented in the design of an efficient supply chain mechanism that not only addresses current needs but also promotes the sustainable, long-term success of the Kerala street food industry in a more dynamic and competitive marketplace.

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