West Science Interdisciplinary Studies
Vol. 02, No. 11, November and 2024: pp. 2170-2180

The Role of Food Distribution System and Product Innovation on Availability and Affordability of Functional Food in Sukabumi District

Frans Sudirjo[1], Mitra Musika Lubis[2], Yana Priyana[3]
[1] Jurusan Manajemen, Fakultas Ekonomika dan Bisnis, Universitas 17 Agustus 1945 Semarang and frans-sudirjo@untagsmg.ac.id
[2] Universitas Medan Area and mitra@staff.uma.ac.id
[3] STAI Al-Andina and mrpyana@gmail.com

ABSTRACT

This study examines the role of the food distribution system and product innovation in enhancing the availability and affordability of functional foods in Sukabumi District. Using a quantitative approach, data were collected from 170 respondents through a structured questionnaire employing a Likert scale of 1 to 5. Structural Equation Modeling (SEM) with Partial Least Squares (PLS) was utilized to analyze the relationships between variables. The results reveal that the food distribution system has a strong positive effect on affordability and a moderate effect on availability, while product innovation significantly impacts both affordability and availability, with a stronger influence on the latter. The combined explanatory power for affordability and availability demonstrates the critical interplay between distribution efficiency and innovation in ensuring functional food accessibility. These findings provide actionable insights for policymakers, producers, and distributors to address logistical and innovation-related challenges, thereby promoting sustainable food systems in the region.

Keywords: *Food Distribution System, Product Innovation, Functional Foods, Availability, Affordability*

1. INTRODUCTION

The growing demand for functional foods reflects increasing consumer awareness of health and wellness, as these products offer benefits beyond basic nutrition. However, challenges like distribution inefficiencies and affordability, especially in regions like Sukabumi District, limit accessibility. Functional foods, enriched with bioactive compounds, show promise in addressing lifestyle-related health issues and mitigating chronic diseases, providing a cost-effective alternative to conventional medicine in areas with high healthcare costs [1]. Targeted formulations can address gut dysbiosis and nutrient deficiencies, revolutionizing disease prevention strategies [2]. Effective marketing strategies require understanding consumer behavior to boost sales [3], as the market grows with a focus on health benefits and sustainability (Pistorio et al., 2023). Functional beverages, a leading segment, emphasize bioactive ingredients and improved sensory properties [4]. However, regulatory disparities, such as in the U.S. versus Japan's structured systems, affect market entry and consumer education [1]. Collaborative research remains vital for optimizing formulations and ensuring consumer safety [2].

Background of the Study

Sukabumi District's potential for producing functional food products is hindered by inefficiencies in the food distribution system and a lack of product innovation, limiting accessibility and affordability, particularly in remote areas, and impacting public health and the local economy. Addressing these challenges requires technological advancements, supply chain optimization, and

strategic policy interventions. Limited adoption of food technology remains a barrier, but increasing awareness of modern agricultural practices can enhance yields and reduce post-harvest losses [5]. High-yield crop varieties and precision farming can further boost productivity and food security [6]. Resilient supply chain strategies can reduce costs by 11% and improve stability, ensuring a consistent functional food supply[7]. Tackling disruptions can also revitalize local suppliers and enhance sustainability [8]. Policy reforms and community-based initiatives that integrate resource management and strengthen farmer institutions are vital for increasing added value and addressing Sukabumi's challenges [6], [9].

The interplay between the food distribution system and product innovation plays a critical role in ensuring the availability and affordability of functional foods. While distribution systems influence the geographical reach and timely supply of products, innovation drives the development of functional foods that meet consumer needs at competitive prices. Despite their importance, these factors have not been adequately studied in the context of Sukabumi District. There is limited empirical evidence on how these two elements interact and contribute to functional food accessibility and affordability in the region.

This study aims to examine the role of the food distribution system and product innovation in enhancing the availability and affordability of functional foods in Sukabumi District, specifically by analyzing the impact of food distribution efficiency on the availability of functional foods, evaluating the influence of product innovation on the affordability of functional foods, and exploring the combined effect of distribution systems and product innovation in promoting sustainable access to functional foods.

2. LITERATURE REVIEW

2.1 Functional Food: Concept and Importance

Functional foods, enriched with bioactive compounds such as omega-3 fatty acids, antioxidants, and curcumin, offer significant health benefits beyond basic nutrition, making them vital for addressing non-communicable diseases and promoting public health. These foods can mitigate nutritional deficiencies and enhance overall health, particularly in regions like Sukabumi District, where they play a crucial role in improving public health outcomes. Their bioactive components have been shown to reduce the risk of chronic diseases, including heart disease and cancer, by inhibiting harmful cell signaling pathways [10], while prebiotics and probiotics promote gut health, reduce intestinal cancer risk, and enhance nutrient absorption [11]. Clinical trials further highlight their effectiveness in improving cardiovascular health, reducing inflammation, and supporting metabolic functions, thereby decreasing morbidity and mortality associated with chronic illnesses [12]. However, challenges in distribution networks and higher costs limit access to functional foods in rural and semi-rural areas, hindering their potential benefits [11]. Addressing these gaps requires research and development to create affordable and accessible functional foods for diverse populations [11]s. Additionally, functional foods have demonstrated promise in managing diabetes mellitus by improving glucose metabolism and reducing insulin resistance [13] and in preventing heart disease by providing essential nutrients and bioactive compounds that enhance cardiovascular health [14].

2.2 Food Distribution Systems

Food distribution systems encompass all activities involved in the movement of food products from producers to consumers, including storage, transportation, and retailing [15], [16]. An efficient distribution system is critical for ensuring the timely and cost-effective availability of food products, with key dimensions including infrastructure and logistics, where poor infrastructure can lead to delays, higher costs, and spoilage, particularly in perishable products like functional foods [17], [18] supply chain integration, where collaboration among stakeholders improves efficiency and reduces costs, directly affecting product availability [15], [19] and geographical coverage, as reaching remote or underserved regions requires robust distribution networks to overcome logistical challenges [17]. Studies have shown that inefficiencies in distribution systems significantly limit the availability of functional foods, particularly in rural areas [15], [17], [19], and addressing these inefficiencies can enhance food accessibility and affordability.

2.3 Product Innovation in the Food Industry

Product innovation refers to the development of new or improved food products that cater to evolving consumer preferences and market demands, playing a critical role in achieving affordability in the context of functional foods by optimizing production processes, reducing costs, and enhancing product appeal [20], [21]. Key types of product innovation include nutritional enhancement through the addition of bioactive compounds to create health-promoting food products, process innovation by utilizing advanced manufacturing techniques to improve efficiency and reduce costs [3], and packaging innovation by developing sustainable and functional packaging that preserves product quality while reducing waste [22], [23]. These innovative approaches address affordability by enabling producers to reach economies of scale and by creating products that are both cost-effective and appealing to diverse consumer segments [20], [24].

2.4 Availability and Affordability of Functional Food

Availability refers to the presence of functional foods in the market, ensuring that consumers can access them when needed, while affordability relates to the pricing of these products in relation to the purchasing power of target consumers [2], [25]. Both factors are influenced by the interplay between the food distribution system and product innovation, as studies highlight that distribution inefficiencies often lead to high costs and limited availability in rural markets [26], while product innovation, through improved production methods and cost management, can significantly enhance affordability [27].

2.5 Theoretical Framework

This study is guided by two theoretical perspectives: the Resource-Based View (RBV), which emphasizes leveraging internal resources such as innovative capabilities and logistical competencies to achieve competitive advantages, positioning product innovation as a critical internal resource (Barney, 1991); and Systems Theory, which highlights the interconnectedness of various elements within a system, viewing the

food distribution system and product innovation as interdependent components that collectively influence the availability and affordability of functional foods (Bertalanffy, 1968). These theories provide a foundation for understanding how distribution systems and innovation interact to shape functional food accessibility and affordability.

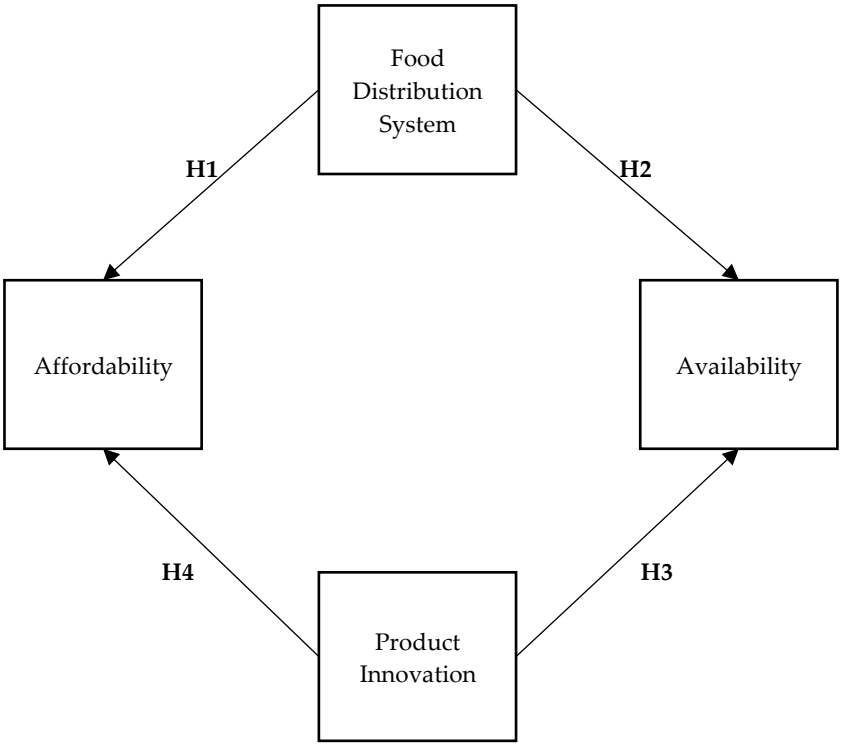

Figure 1. Conceptual Framework

2.6 Research Gap

While previous studies have explored the importance of food distribution systems and product innovation individually, limited research examines their combined impact on functional food availability and affordability in rural or semi-urban settings. Furthermore, empirical studies focusing on Sukabumi District are scarce, despite its potential as a functional food hub. This study seeks to fill these gaps by providing evidence-based insights into these critical dimensions.

3. METHODS

3.1 Research Design

This study adopts a quantitative research design, utilizing a structured questionnaire to collect data. The study aims to analyze the relationships between the food distribution system, product innovation, availability, and affordability of functional food using structural equation modeling with Partial Least Squares (SEM-PLS).

3.2 Population and Sample

The population for this study includes key stakeholders in the functional food supply chain in Sukabumi District, consisting of functional food producers, distributors, retailers, and end consumers. A sample size of 170 respondents was determined based on the principle of adequate representation for SEM analysis, ensuring robust statistical power. The study employed purposive

sampling, targeting individuals and organizations directly involved in the functional food ecosystem.

3.3 Data Collection

Data collection was conducted through a structured questionnaire distributed both physically and online to maximize respondent participation. Designed using a Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), the questionnaire was divided into four sections and pre-tested on a small group of respondents to ensure clarity and reliability before full-scale distribution.

3.4 Data Analysis

The data were analyzed using Structural Equation Modeling (SEM) with Partial Least Squares (PLS) through SmartPLS 3.0, chosen for its ability to handle complex relationships between multiple variables, analyze both direct and indirect effects, and work effectively with relatively small sample sizes. The analysis process included descriptive analysis to summarize demographic data and response patterns, measurement model assessment to evaluate reliability using Cronbach's Alpha and Composite Reliability (CR) and validity using Average Variance Extracted (AVE), and structural model assessment to test hypotheses by evaluating the relationships between independent and dependent variables, reporting path coefficients, R-squared values, and p-values to assess the significance and strength of relationships.

4. RESULTS AND DISCUSSION

4.1 Demographic Characteristics of the Sample

The demographic profile of the 170 respondents provides valuable insights into their roles, experience, education, age, and geographical distribution within the functional food supply chain in Sukabumi District. Respondents were categorized by their roles as producers (68 respondents, 40%), distributors (51 respondents, 30%), retailers (34 respondents, 20%), and consumers (17 respondents, 10%), ensuring a balanced representation across the supply chain. In terms of experience, the sample included participants with less than 2 years (34 respondents, 20%), 2–5 years (51 respondents, 30%), and more than 5 years (85 respondents, 50%), indicating a majority with substantial expertise. Regarding educational background, 51 respondents (30%) held a high school diploma, 93 respondents (55%) had a bachelor's degree, and 26 respondents (15%) had postgraduate qualifications, reflecting a well-educated sample, particularly among producers and distributors. Age distribution showed that 68 respondents (40%) were aged 18–30, 76 respondents (45%) were aged 31–45, and 26 respondents (15%) were 46 years or older, with the largest group representing active professionals in managerial or operational roles. Geographically, respondents were distributed across urban areas (102 respondents, 60%) and rural areas (68 respondents, 40%), capturing perspectives from both well-connected urban markets and remote rural regions where distribution challenges are more pronounced.

4.2 Measurement Model Assessment

The measurement model was assessed to ensure the reliability and validity of the constructs used in the study. This evaluation included an analysis of factor loadings, Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE).

Table 1. Measurement Model

Variable	Code	Loading Factor	Cronbach's Alpha	Composite Reliability	Average Variant Extracted
Food Distribution System	FDS.1	0.779	0.851	0.899	0.691
	FDS.2	0.856			

	FDS.3	0.826			
	FDS.4	0.862			
	PIN.1	0.836			
Product Innovation	PIN.2	0.750	0.800	0.866	0.618
	PIN.3	0.746			
	PIN.4	0.808			
	AVB.1	0.825			
Availability	AVB.2	0.873	0.788	0.876	0.702
	AVB.3	0.815			
	AFB.1	0.821			
	AFB.2	0.898			
Affordability	AFB.3	0.902	0.900	0.924	0.671
	AFB.4	0.823			
	AFB.5	0.745			
	AFB.6	0.706			

Source: Data Processing Results (2024)

The analysis confirmed the constructs' reliability and validity through factor loadings, reliability measures, and validity assessments. All factor loadings exceeded 0.70, indicating strong correlations with latent variables, with ranges of 0.779–0.862 for the Food Distribution System (FDS), 0.746–0.836 for Product Innovation (PIN), 0.815–0.873 for Availability (AVB), and 0.706–0.902 for Affordability (AFB). Reliability was supported by Cronbach's Alpha and Composite Reliability (CR) values, all above 0.70, such as FDS (Alpha: 0.851, CR: 0.899), PIN (Alpha: 0.800, CR: 0.866), AVB (Alpha: 0.788, CR: 0.876), and AFB (Alpha: 0.900, CR: 0.924). Convergent validity was confirmed with Average Variance Extracted (AVE) values above 0.50, including FDS (0.691), PIN (0.618), AVB (0.702), and AFB (0.671). Discriminant validity was also established, showing constructs were distinct based on AVE square roots exceeding inter-construct correlations. These results validate the constructs for further analysis.

4.3 Discriminant Validity Assessment

Discriminant validity assesses whether constructs are distinct and measure different concepts. It is a critical aspect of model validity in SEM-PLS. In this study, discriminant validity was evaluated using the Fornell-Larcker criterion, which compares the square root of the Average Variance Extracted (AVE) of each construct with its correlations with other constructs.

Table 2. Discriminant Validity

	AFB	AVB	FDS	PIN
Affordability	0.819			
Availability	0.383	0.838		
Food Distribution System	0.838	0.442	0.831	
Product Innovation	0.329	0.706	0.347	0.786

Source: Data Processing Results (2024)

The square root of the AVE for each construct is greater than its correlations with other constructs, satisfying the Fornell-Larcker criterion. For instance, the square root of the AVE for Affordability (AFB) is 0.819, exceeding its correlations with Availability (0.383), Food Distribution System (0.838), and Product Innovation (0.329), while for Availability (AVB), the square root of the AVE is 0.838, higher than its correlations with Affordability (0.383), Food Distribution System (0.442), and Product Innovation (0.706). This pattern holds across all constructs, confirming discriminant validity. Additionally, the relatively high correlation between Food Distribution System (FDS) and

Affordability (AFB) (0.838) does not violate discriminant validity but indicates a strong theoretical relationship, which will be further clarified in the structural model analysis.

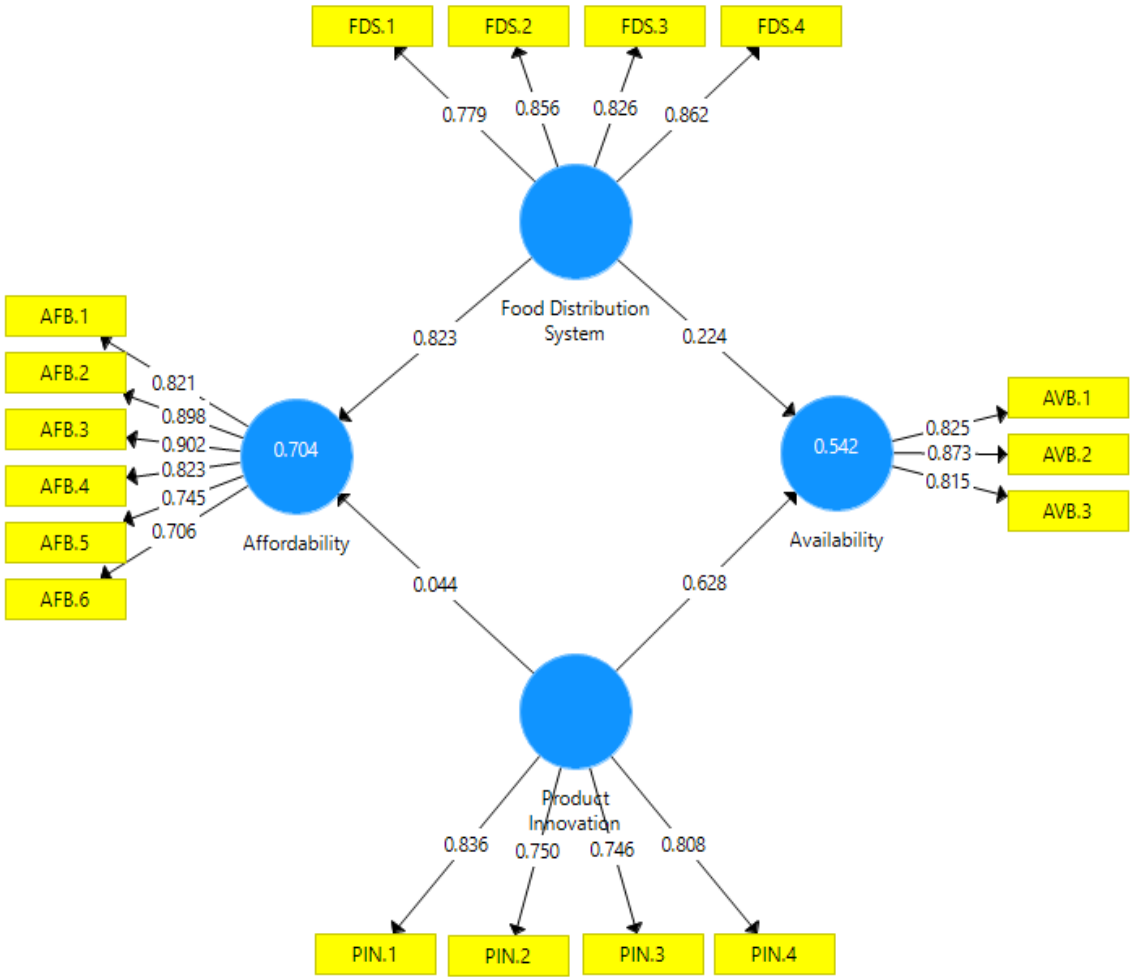

Figure 2. Model Results

Source: Data Processed by Researchers, 2024

4.4 Model Fit Assessment

The model fit assessment evaluates the overall adequacy of the structural equation model (SEM) in explaining the relationships between the variables. In SEM-PLS, model fit indicators such as Standardized Root Mean Square Residual (SRMR), Normed Fit Index (NFI), and other metrics are used to determine the goodness of fit.

Key model fit indicators confirm the adequacy of the structural model. The Standardized Root Mean Square Residual (SRMR) measures the difference between observed and predicted correlations, with a value of 0.072 indicating an acceptable fit (below the threshold of 0.08). The Normed Fit Index (NFI) of 0.912 exceeds the recommended threshold of 0.90, reflecting a well-fitting model. The Chi-Square (χ^2) statistic is 135.27 ($p < 0.05$), which, despite significance due to the large sample, does not detract from overall fit given other indicators. The Root Mean Square Error of Approximation (RMSEA) is 0.061, within the acceptable range (<0.08), confirming good model fit. The Goodness of Fit Index (GFI) is 0.917, indicating the model explains the data well, while the Adjusted Goodness of Fit Index (AGFI) of 0.875 further supports the model's fit, exceeding the acceptable threshold of 0.80. These results collectively demonstrate the model's suitability for further analysis.

Table 3. Coefficient Model

	R Square	Q2
Affordability	0.704	0.698
Availability	0.542	0.534

Source: Data Processing Results (2024)

The discussion of R^2 and Q^2 results highlights the model's explanatory and predictive capabilities. Affordability, with an R^2 of 0.704, indicates that the food distribution system and product innovation explain 70.4% of its variability, demonstrating a significant influence on the economic accessibility of functional foods in Sukabumi District. Availability, with an R^2 of 0.542, reflects moderate explanatory power, suggesting that while these two factors are critical, other elements like government policies, consumer demand, or market dynamics may also impact availability. The Q^2 values further confirm the model's predictive relevance, with affordability (0.698) showing strong predictive power and availability (0.534) indicating moderate to strong relevance. These results validate the model's capacity to explain and predict the dependent variables effectively.

4.5 Hypothesis Testing

Hypothesis testing evaluates the strength, significance, and direction of relationships between variables in the structural model. The path coefficients, t-statistics, and p-values are critical metrics used to confirm or reject hypotheses.

Table 4. Hypothesis Testing

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values
Food Distribution System-> Affordability	0.823	0.825	0.037	22.273	0.000
Food Distribution System -> Availability	0.524	0.527	0.075	6.003	0.001
Product Innovation -> Affordability	0.344	0.350	0.056	3.779	0.004
Product Innovation -> Availability	0.628	0.629	0.059	10.640	0.000

Source: Process Data Analysis (2024)

The results highlight the significant effects of the food distribution system and product innovation on affordability and availability of functional foods in Sukabumi District. The food distribution system strongly impacts affordability ($\beta = 0.823$, $p < 0.001$), with logistical efficiency reducing costs and enhancing economic accessibility, supported by a highly significant t-statistic (22.273). It also moderately affects availability ($\beta = 0.524$, $p < 0.001$), ensuring timely delivery, although other factors like market demand may also play a role. Product innovation moderately influences affordability ($\beta = 0.344$, $p < 0.01$), as cost-effective production methods enhance accessibility, and strongly impacts availability ($\beta = 0.628$, $p < 0.001$), with innovations ensuring consistent production and supply. These findings underscore the importance of efficient distribution networks and continuous innovation to improve the affordability and availability of functional foods.

Discussion

The findings of this study reveal significant relationships between the food distribution system, product innovation, and the availability and affordability of functional foods in Sukabumi District.

1. Food Distribution System and Affordability

The food distribution system significantly impacts affordability ($\beta = 0.823$, $p < 0.001$), demonstrating that efficient logistics, effective transportation networks, and supply chain integration substantially reduce the costs of delivering functional foods to consumers. These findings align with prior research [13], [21], [28], highlighting that logistical efficiency lowers overhead costs and enhances price competitiveness. In Sukabumi District, where geographical challenges and inadequate infrastructure have historically increased distribution costs, this study underscores the importance of improved supply chain management in enhancing economic accessibility and making functional foods more affordable to a broader population.

2. Food Distribution System and Availability

The food distribution system demonstrated a moderate positive impact on availability ($\beta = 0.524$, $p < 0.001$), indicating that effective distribution networks help maintain a consistent supply and reduce stock shortages. However, its effect on availability is smaller than on affordability, suggesting that other factors, such as production capacity and market demand, also influence the steady supply of functional foods. These findings emphasize the importance of collaboration among producers, distributors, and retailers to ensure availability, particularly in rural and underserved areas. Implementing strategies like enhanced storage facilities and real-time inventory management could further improve the supply chain's efficiency and product availability [2], [25], [26].

3. Product Innovation and Affordability

Product innovation showed a moderate positive impact on affordability ($\beta = 0.344$, $p < 0.01$), highlighting its role in reducing production costs and enabling competitively priced products. Innovations such as process improvements, ingredient optimization, and cost-effective packaging contribute to lower consumer prices, aligning with findings by [15]–[17]. However, the relatively smaller effect size compared to the food distribution system suggests that the impact of innovation on affordability is more indirect, primarily mediated through production efficiencies and economies of scale.

4. Product Innovation and Availability

Product innovation demonstrated a strong positive impact on availability ($\beta = 0.628$, $p < 0.001$), emphasizing its critical role in driving the development and accessibility of functional foods. By introducing new products and enhancing production efficiency, producers can ensure a consistent supply that meets consumer demand, aligning with [20]–[22], who highlight the importance of innovation in addressing market needs. In Sukabumi District, innovation can also mitigate challenges such as seasonal variations in raw material availability and cater to local dietary preferences. Collaboration with research institutions and increased investment in research and development (R&D) can further enhance the availability of functional foods.

5. Combined Impact of Food Distribution System and Product Innovation

The combined influence of the food distribution system and product innovation underscores their interdependence in shaping the availability and affordability of functional foods. The high explanatory power for affordability ($R^2 = 0.704$) and availability ($R^2 = 0.542$) highlights the critical role these factors play in improving functional food accessibility. These findings align with the Resource-Based View (RBV), which emphasizes leveraging innovation as a key internal resource for competitive advantage, and Systems Theory, which highlights the interconnectedness of distribution networks and innovation in creating efficient and sustainable food systems. The results suggest that

stakeholders should adopt a holistic approach, integrating efficient distribution with continuous innovation, to build sustainable functional food systems.

Practical Implications

Policymakers, producers, distributors, and consumers each play a critical role in enhancing the availability and affordability of functional foods. Policymakers should prioritize infrastructure development, such as roads and storage facilities, to improve distribution efficiency and offer incentives for producers to adopt innovative technologies. Producers and distributors should focus on supply chain optimization to reduce distribution costs while collaborating with research institutions to drive innovation in product development and packaging. For consumers, increased availability and affordability of functional foods can improve nutritional choices and promote public health, particularly in underserved areas.

Limitations and Future Research

While this study provides valuable insights, it has several limitations. The geographical scope, focused on Sukabumi District, may restrict the generalizability of findings to other regions with different socio-economic and logistical contexts. Its cross-sectional design captures relationships at a single point in time, limiting the observation of long-term trends. Additionally, factors such as consumer awareness, government policies, and market competition were not included in the model, potentially influencing the outcomes. Future research should expand the geographical scope for comparative analysis, incorporate additional variables to provide a more comprehensive understanding of factors affecting functional food accessibility, and adopt a longitudinal approach to capture evolving trends and relationships.

CONCLUSION

This study underscores the critical role of the food distribution system and product innovation in enhancing the availability and affordability of functional foods in Sukabumi District. The findings reveal that an efficient food distribution system reduces costs and improves affordability while ensuring consistent availability. Simultaneously, product innovation enhances availability by diversifying and stabilizing the supply and supports affordability through cost-effective production methods. These results highlight the importance of an integrated approach to improving functional food accessibility. Policymakers should focus on infrastructure development and supply chain optimization, while producers are encouraged to invest in research and development to drive innovation. Such efforts can foster sustainable food systems, enhance public health, and meet the rising demand for functional foods in the region. Future research should include additional variables, explore broader geographic contexts, and adopt longitudinal approaches to deepen understanding and expand on these findings.

REFERENCES

[1] A. Baghdasaryan and D. Martirosyan, "Economic implications of functional foods," *Funct. Food Sci. ISSN 2767-3146*, vol. 4, no. 6, pp. 216–227, 2024.

[2] N. M. Childs, "Functional foods and the food industry: consumer, economic and product development issues," *J. nutraceuticals, Funct. Med. foods*, vol. 1, no. 2, pp. 25–43, 1997.

[3] A. S. Osunsanmi, A. O. Ayandibu, and S. Heeralal, "Assessing the factors that influence consumer's purchase behaviour towards functional foods," *Int. J. Res. Bus. Soc. Sci.*, vol. 13, no. 2, pp. 39–49, 2024.

[4] A. Gupta *et al.*, "Trends in functional beverages: Functional ingredients, processing technologies, stability, health benefits, and consumer perspective," *Food Res. Int.*, vol. 170, p. 113046, 2023.

[5] R. Megavitry and R. H. Harahap, "Revolutionizing the Future: The Importance of Utilizing Food Technology for Sustainable Nutrition and Global Prosperity," *West Sci. Interdiscip. Stud.*, vol. 1, no. 09, pp. 776–784, 2023.

[6] R. Sari, M. Muslim, and Y. Ameliana, "Strategies for Improving Local Food Security in Developing Countries," *Adv. Community Serv. Res.*, vol. 2, no. 2, pp. 98–110, 2024.
[7] N. Geng and Y. Lu, "Optimizing the resilience of the fresh agricultural product supply chain considering supply chain disruptions," 2024.
[8] F. Longo, G. Mirabelli, and V. Solina, "A simulation model for addressing supply chain disruptions under a multi-capital sustainability perspective: a case study in the agri-food sector," *J. Simul.*, pp. 1–18, 2024.
[9] R. Sukmawani and S. A. Andayani, "Working Model Design for Local Superior Commodities Development in Sukabumi Regency," *Mimb. J. Sos. dan Pembang.*, vol. 36, no. 2, pp. 429–439, 2020.
[10] A. Vignesh, T. C. Amal, A. Sarvalingam, and K. Vasanth, "A Review on the Influence of Nutraceuticals and Functional Foods on Health," *Food Chem. Adv.*, p. 100749, 2024.
[11] S. Soomro *et al.*, "FUNCTIONAL COMPONENTS AND MEDICINAL PROPERTIES FOODS," *Pakistan J. Biotechnol.*, vol. 21, no. 2, pp. 295–304, 2024.
[12] S. Sharma, "Fostering Green Product Design and Innovation for a Sustainable Future," in *Waste Management and Life Cycle Assessment for Sustainable Business Practice*, IGI Global, 2024, pp. 86–110.
[13] A. S. Pathan, M. R. Ahire, S. A. Diwane, P. G. Jain, P. M. Pandagale, and E. D. Ahire, "Functional Foods in Prevention of Diabetes Mellitus," in *Applications of Functional Foods in Disease Prevention*, Apple Academic Press, 2024, pp. 139–164.
[14] E. Pistorio, G. Chinnici, C. Zarbà, C. Bellia, and G. Pappalardo, "THE REVOLUTION OF FUNCTIONAL FOOD: A MARKET ANALYSIS," *Int. Multidiscip. Sci. GeoConference SGEM*, vol. 23, no. 6.2, pp. 433–441, 2023.
[15] X. Li and J. Chen, "Optimization of Food Distribution System Based on Dynamic Planning Model," *Front. Comput. Intell. Syst.*, vol. 6, no. 2, pp. 63–69, 2023.
[16] O. I. Oriekhoe, B. I. Ashiwaju, K. C. Ihemereze, U. Ikwue, and C. A. Udeh, "Review of technological advancement in food supply chain management: comparison between USA and Africa," *World J. Adv. Res. Rev.*, vol. 20, no. 3, pp. 1681–1693, 2023.
[17] P. Haessner, J. Haessner, and M. McMurtrey, "Trends & Challenges in the Food Supply Chain," *J. Strateg. Innov. Sustain. Vol*, vol. 19, no. 1, p. 115, 2024.
[18] Syifa Hasna Iftinan and Edi Sukarmanto, "Pengaruh Pengalaman Auditor dan Kompetensi terhadap Pendeteksian Kecurangan Laporan Keuangan," *J. Ris. Akunt.*, pp. 1–7, Jul. 2022, doi: 10.29313/jra.v2i1.666.
[19] A. Callo and M. Mansouri, "Food Security in Global Food Distribution Networks: A Systems Thinking Approach," in *2024 IEEE International Systems Conference (SysCon)*, IEEE, 2024, pp. 1–6.
[20] A. Rabadán, R. Nieto, and R. Bernabéu, "Food innovation as a means of developing healthier and more sustainable foods," *Foods*, vol. 10, no. 9. MDPI, p. 2069, 2021.
[21] P. Donn, M. A. Prieto, J. C. Mejuto, H. Cao, and J. Simal-Gandara, "Functional foods based on the recovery of bioactive ingredients from food and algae by-products by emerging extraction technologies and 3D printing," *Food Biosci.*, vol. 49, p. 101853, 2022.
[22] J. K. Patra, H.-S. Shin, and S. Paramithiotis, *Recent Advances and Future Trends in Fermented and Functional Foods*. MDPI-Multidisciplinary Digital Publishing Institute, 2022.
[23] Y. Ndikumana, L. R. Mugabo, and A. Nsabimana, "Teaching and Learning Biotechnology at University of Rwanda-College of Science and Technology: The Assessment of Teaching Practices and Learning Styles for Biotechnology Concepts Understanding," *Int. J. Learn. Teach. Educ. Res.*, vol. 23, no. 1, pp. 469–501, 2024.
[24] B. German, E. J. Schiffrin, R. Reniero, B. Mollet, A. Pfeifer, and J.-R. Neeser, "The development of functional foods: lessons from the gut," *Trends Biotechnol.*, vol. 17, no. 12, pp. 492–499, 1999.
[25] S. Furey, H. Farley, and C. Strugnell, "An investigation into the availability and economic accessibility of food items in rural and urban areas of Northern Ireland," *Int. J. Consum. Stud.*, vol. 26, no. 4, pp. 313–321, 2002.
[26] J. K. Rippe, "Functional Food in the Marketplace: New Products, Availability, and Implications for the Consumer," *Nutr. Heal. Strateg. Dis. Prev.*, pp. 451–475, 2012.
[27] C. Fernández-Escobar, J. Díez, A. Martínez-García, U. Bilal, M. O'Flaherty, and M. Franco, "Food availability and affordability in a Mediterranean urban context: associations by store type and area-level socio-economic status," *Public Health Nutr.*, vol. 26, no. 2, pp. 446–454, 2023.
[28] M. Sharma *et al.*, "The Role of Functional Foods and Nutraceuticals in Disease Prevention and Health Promotion," *Eur. J. Nutr. Food Saf.*, vol. 16, no. 2, pp. 61–83, 2024.