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Original Article

Innovation Diffusion in the Bakery Industry of Indore: Patterns, Drivers, Barriers and the Role of Networks and Suppliers

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Abstract

Introduction: Small and medium bakery enterprises in Indore operate between traditional family production and modern café, patisserie, and online formats. This study examined how equipment, ingredient, and digital innovations diffuse across small, medium, and premium bakeries and how suppliers, peers, and training actors influence adoption. **Methods**: A cross-sectional mixed-methods design was used. Quantitative data were collected from 90 bakery owners or managers, with equal allocation across small, medium, and premium outlets. Qualitative evidence was obtained from 15 semi-structured interviews with owners, suppliers, trainers, and advisory actors. Descriptive statistics, Pearson chi-square tests, and thematic analysis were interpreted through the Diffusion of Innovations and Technology-Organization-Environment frameworks. **Results**: Premium bakeries recorded the highest overall innovation index (80), followed by medium bakeries (57) and small bakeries (36). Digital tools were adopted more widely because they were relatively affordable, visible to customers, and easy to trial. Bakery category was significantly associated with the reported drivers and barriers. Equipment and ingredient innovation was constrained by capital cost, skill gaps, supply inconsistency, and uncertainty about returns, particularly among small bakeries. Supplier demonstrations and peer observation were the strongest diffusion channels. **Conclusion**: Innovation diffusion in Indore's bakery sector is uneven, socially mediated, and shaped by organizational readiness. Inclusive modernization requires practical demonstrations, affordable trials, supplier support, and locally relevant training for smaller bakeries.

***Keywords**: Bakery Sector; Diffusion of Innovation; Digital Transformation; Food Smes; Indore; Mixed Methods; Supplier Networks; Technology Adoption*

Introduction

The Indian urban bakery market has expanded beyond bread, biscuits, and rusks to include cakes, pastries, artisan breads, health-oriented products, customized celebration items, and online ordering. Most bakeries continue to operate as small and medium-sized enterprises (SMEs), in which owners or managers make investment, production, and marketing decisions with limited formal research capacity. Earlier innovation studies indicate that small firms often adopt change selectively because adoption depends on perceived benefits, managerial orientation, firm resources, and external support

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(Damanpour, 1991; Frambach & Schillewaert, 2002; Venkatesh *et al.,* 2003). In the food sector, digital quality systems, automation, and Industry 4.0 tools have also increased pressure on smaller firms to modernize while maintaining product quality and safety (Bisht *et al.,* 2025; Melesse & Orrù, 2025).

Indore is an appropriate empirical setting because it combines a large urban and peri-urban food market with a visible bakery and confectionery base. The district administration reports a population of 3,276,697 for Indore district, indicating a sizeable local market (District Administration Indore, 2026). Madhya Pradesh also has an important food-processing base, and the Ministry of Food Processing Industries (2025) identifies food processing as a major employment-generating industry in India. A recent local report identified at least 100 confectionery businesses and a growing cluster of producers in Rau-Rangwasa, further supporting the relevance of studying small food enterprises in the city (Sharma, 2026).

The local setting is also relevant because Indore contains both traditional retail bakeries and brand-oriented premium outlets. This mixture allows comparison among firms operating in close geographic proximity but facing different expectations regarding presentation, product novelty, visible hygiene, speed of service, and digital engagement. Diffusion may occur through observation across these categories. A small bakery owner may notice a premium outlet's packaging or online menu, but the decision to imitate that practice depends on cost, supplier access, and perceived customer willingness to pay.

The central problem is uneven innovation adoption. Premium bakeries often experiment first with modern display systems, specialty ingredients, online ordering, social media promotion, and supplier-led demonstrations. Smaller bakeries may also wish to modernize, but adoption is slowed by limited capital, uncertain returns, staff turnover, weak supplier relationships, and concern about operational disruption. This situation creates a segmented system in which better-resourced bakeries receive greater supplier attention and market visibility, while smaller units remain cautious. The study therefore examines how innovation spreads through a city-level food ecosystem in which owners observe peers, suppliers act as knowledge intermediaries, and training institutions support capability development.

This unevenness is important because innovation in bakeries is not solely a technical issue. An owner must judge whether a new oven, ingredient, display counter, payment method, or promotional channel fits existing recipes, labor routines, shop space, price expectations, and customer preferences. A low-cost digital practice can often be adopted or abandoned with limited loss, whereas an equipment purchase can affect debt, electricity use, maintenance, staff training, and daily production schedules. Ingredient innovation may similarly require reliable supply, recipe standardization, and customer education. The study therefore treats innovation diffusion as a practical business process in which perceived benefits are balanced against affordability, operational disruption, and social proof from trusted actors.

Rogers' Diffusion of Innovations theory helps explain these differences because bakery owners are more likely to adopt innovations that appear advantageous, compatible with daily work, relatively simple, trialable, and observable (Rogers, 2003; Kapoor *et al.,* 2014). In this study, organizational influences include owner attitudes, capital, employee capability, and operational readiness, whereas environmental influences include suppliers, competitors, customers, and training support.

This study extends the SME innovation literature in three ways. First, it compares the pace of innovation adoption among small, medium, and premium bakeries operating within the same city. Second, it distinguishes among equipment, ingredient, and digital innovation, showing that digital practices diffuse more rapidly because they are visible and relatively inexpensive to trial. Third, it examines how suppliers, peers, and trainers function as practical knowledge brokers that can reduce uncertainty, particularly for smaller bakeries. The study's originality lies in combining the DOI and TOE frameworks with evidence on local networks, adoption barriers, and mixed-methods findings from a tier-2 Indian food-service market. It addresses four research questions: (i) Which bakery categories are early adopters in Indore? (ii) Which equipment, ingredient, and digital innovations are most readily adopted? (iii) Which barriers

differ across bakery categories? and (iv) How do suppliers, peers, and training institutions shape diffusion?

National food-processing data and broad SME studies do not fully capture how bakery owners move from awareness to trial and routine adoption. By focusing on one city, this study addresses that local evidence gap and examines day-to-day diffusion through supplier visits, peer examples, customer requests, and training.

Methodology

Research Design

This study employed a cross-sectional mixed-methods design to provide comparative breadth and contextual depth (Creswell & Plano Clark, 2018; Fetters *et al.,* 2013). The cross-sectional design was appropriate because innovation adoption patterns were examined at one point in time rather than as changes or causal relationships over time (Sedgwick, 2014). The survey measured adoption levels, drivers, and barriers across bakery categories, while interviews explored owners', suppliers', and trainers' perceptions of innovation, risk, and support. Field observations provided additional contextual evidence about bakery operations and innovation practices. Quantitative and qualitative evidence was integrated and interpreted through the Diffusion of Innovations (DOI) and Technology-Organization-Environment (TOE) frameworks.

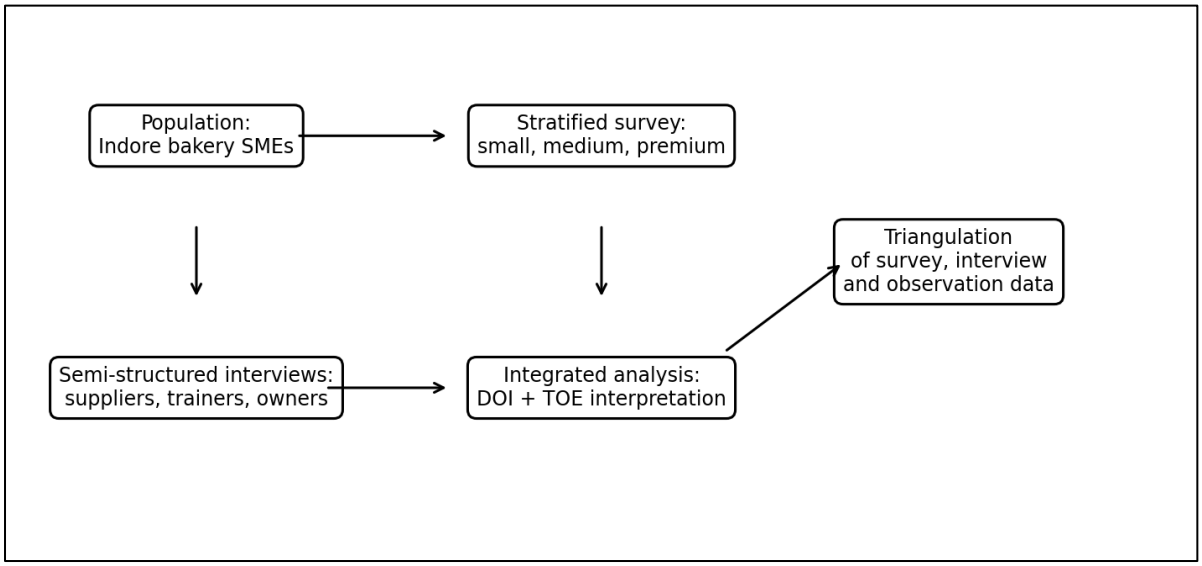

Figure 1: Study Design and Analytical Flow

Figure 1 presents the mixed-methods research process and shows how survey data, field observations, and qualitative interviews were integrated and interpreted through the DOI and TOE frameworks.

Study Area and Target Population

The study was conducted in Indore, Madhya Pradesh. The target population comprised bakeries that produced and sold baked goods, including small family-run bakeries, medium commercial bakeries, and premium café or patisserie formats. Qualitative participants included equipment and ingredient suppliers, trainers, and advisory actors involved in bakery technology, demonstrations, skills training, or consultancy.

The three bakery categories were treated as analytical strata rather than rigid administrative classifications. In practice, the boundary between small and medium bakeries may be gradual because some neighborhood units use selected modern tools, while some commercial units retain labor-intensive practices. Classification therefore combined observable business formats with operational indicators. This approach enabled comparison without assuming that all bakeries of the same size behaved identically and allowed premium outlets to be analyzed separately because their customer expectations,

display standards, ingredient choices, and online visibility differed from those of conventional commercial bakeries.

Sampling Strategy and Stratification Procedure

A stratified sampling approach was used in the quantitative phase to ensure representation of distinct bakery categories rather than treating all outlets as a homogeneous population (Lohr, 2021). The sampling frame was divided into small, medium, and premium bakeries. Classification criteria included business scale, production process, product type and variety, seating arrangement, production equipment, target market, and online presence.

Equal allocation was used, with a target of 30 respondents in each stratum. When a selected unit was unavailable or ineligible, another unit from the same stratum was approached. This procedure maintained the comparative structure and ensured equal representation of small, medium, and premium formats. Table 1 presents the classification criteria and respondent distribution.

Table 1: Sampling, Classification, and Measurement Structure

Bakery category	Operational classification criteria	Respondents (n)
Small bakeries	Neighborhood or family-run units; limited equipment; narrow product range; limited digital activity	30
Medium bakeries	Commercial units with regular staff, broader product range, moderate equipment use and some digital activity	30
Premium bakeries	Café, patisserie or brand-oriented outlets with advanced display, higher-value products and active digital presence	30
Total	Stratified quantitative sample of bakery owners/managers or decision-makers	90

Table 1 presents the operational classification criteria and the equal respondent allocation across the three bakery categories.

Inclusion and Exclusion Criteria

Respondents were eligible when the bakery was located in Indore, produced its own bakery products, and the respondent was an owner, manager, or other decision-maker familiar with investment, production, supply, and digital practices. Only adults aged 18 years or older were included. Closed units, outlets outside Indore, and resellers of third-party bakery products were excluded. Qualitative participants were eligible when they had direct professional experience with bakery equipment, ingredients, training, demonstrations, or advisory support.

Survey Instrument and Questionnaire Administration

The survey contained seven sections: respondent and business profile, equipment adoption, ingredient innovation, digital innovation, perceived drivers, perceived barriers, and adoption support. Items covered modern ovens, mixers, display and packaging systems, specialty ingredients, healthier product variants, digital payments, social media, online ordering, customer demand, supplier influence, capital cost, staff skills, supply consistency, and risk aversion.

Most attitudinal items used a five-point Likert scale ranging from 1 (very low/not important) to 5 (very high/essential), according to the item wording. Field administration took place over ten weeks between January and March 2026. Questionnaires were completed during field visits, with digital follow-up only when preferred by respondents.

Qualitative Component

The qualitative component comprised 15 semi-structured interviews with bakery owners or managers, ingredient and equipment suppliers, trainers, and advisory actors. Interview questions explored visible innovations, early adopters, confidence in trying new products or machines, barriers, supplier support,

peer influence, and training needs. Participants were selected purposively because they could explain practical adoption processes within the local bakery ecosystem.

The interviews complemented rather than duplicated the survey. Survey responses indicated whether respondents perceived a driver or barrier as important, while interviews explored why those perceptions arose. For example, a high rating for-capital cost could reflect equipment prices, reluctance to borrow, uncertainty about electricity costs, or concern about whether staff could operate the equipment. Supplier support could involve a one-time demonstration, credit facilities, troubleshooting, or continuing technical advice. These contextual meanings helped interpret the numerical adoption patterns.

Each interview lasted approximately 25-45 minutes. Notes were taken with participant consent, and detailed field notes were prepared immediately after interviews when audio recording was not permitted. Interviews were conducted by members of the research team familiar with the bakery context.

Table 2: Qualitative Participant Profile

Respondent Group	Number of Interviews	Main Purpose of Inclusion
Bakery owners/managers	6	To understand direct adoption decisions, perceived risks and operational constraints
Ingredient/equipment suppliers	5	To understand demonstrations, after-sales support, credit terms and supplier-led diffusion
Trainers/advisory actors	4	To understand skill development, institutional support and capability gaps
Total	15	To triangulate survey patterns with ecosystem-level explanations

Table 2 presents the qualitative participant profile. Including different participant groups strengthened triangulation by enabling adoption patterns to be examined from both firm-level and ecosystem-level perspectives.

The study followed informed-consent and confidentiality principles. Participation was voluntary, and respondents were informed that they could skip questions or withdraw. No minors were included. Personal and business identities were not disclosed, and findings were reported in aggregate or pseudonymized form.

Literature Review

Innovation Adoption in SMEs and Food-Sector Businesses

Managerial perceptions, risk tolerance, learning mechanisms, and supportive environments shape innovation adoption in SMEs. Because small firms usually have limited internal research and development capacity, they rely heavily on external knowledge from suppliers, customers, peers, and training institutions. In food SMEs, innovation also requires operational adjustments in production, storage, hygiene, and quality assurance rather than only visible product changes (Damanpour, 1991; Frambach & Schillewaert, 2002; Venkatesh *et al.,* 2003).

Recent food and agri-food research emphasizes digitalization, traceability, production control, and quality assurance. Adoption remains uneven when inter-firm supply chains, digital traceability, and automated analysis require new skills and investment (Hassoun *et al.,* 2023; Martínez-Peláez *et al.,* 2024; Vahdanjoo *et al.,* 2025). Bakery innovation is distinctive because it ranges from low-cost digital promotion to expensive equipment, specialty ingredients, and food-safety practices (Bisht *et al.,* 2025; Melesse & Orrù, 2025).

The bakery sector offers a useful lens because several forms of innovation occur simultaneously. Product innovation includes new flavors, healthier ingredients, premium fillings, and customized celebration products. Process innovation includes improved ovens, mixers, proofers, packaging tools, and temperature-control systems. Marketing innovation includes social media, online ordering, digital payments, and delivery-platform visibility. These forms do not diffuse at the same rate. A firm may adopt digital promotion quickly but postpone a proofer or display system for years; treating bakery innovation

as a single adoption decision would therefore obscure important differences between low-risk and high-risk innovations.

Rogers' Diffusion of Innovations Theory

Rogers' Diffusion of Innovations theory explains how an idea, practice, or technology moves through a social system over time (Rogers, 2003). Its five perceived attributes are relative advantage, compatibility, complexity, trialability, and observability. In bakery settings, an innovation is attractive when it improves sales, product quality, customer reach, or reputation; fits existing skills and recipes; is not difficult to operate; can be tested on a small scale; and produces visible results.

The DOI framework helps explain the preference for digital innovations over equipment or ingredient changes. Digital payments, WhatsApp ordering, and social media promotion are relatively inexpensive, reversible, and visible to customers. By contrast, ovens, mixers, proofers, and specialty ingredients often require capital, training, and reliable suppliers, thereby reducing trialability and increasing perceived risk.

Technology-Organization-Environment Framework

The TOE framework proposes that technology adoption is shaped by technological, organizational, and environmental contexts (Tornatzky & Fleischer, 1990; Baker, 2011). The technological context includes cost, complexity, and compatibility; the organizational context includes firm size, financial capacity, owner attitudes, staff skills, and readiness; and the environmental context includes competition, suppliers, customer pressure, institutional support, and regulation.

This study combines the DOI and TOE frameworks to explain innovation adoption across bakery categories. DOI explains how owners perceive specific innovations, whereas TOE explains why the same innovation may be evaluated differently across organizational settings. For example, a premium bakery may view a modern oven as compatible and profitable, while a small bakery may view it as expensive, risky, and difficult to maintain.

Networks, Suppliers, and Training Institutions as Diffusion Channels

Innovation among SMEs is also socially mediated. Suppliers can reduce uncertainty through demonstrations, credit terms, after-sales service, and technical advice. Peer observation helps owners assess whether a practice works in a comparable business, while training institutions support skills development and help translate new equipment or ingredients into routine practice (Greenhalgh *et al.,* 2004; Alawamleh *et al.,* 2022).

These channels may not benefit all firms equally. Suppliers may prioritize premium outlets with greater purchasing capacity, while smaller bakeries may receive less demonstration support. Training institutions may provide broad hospitality training without addressing the everyday constraints of local bakeries. Unless support is targeted toward smaller units, this gap can widen uneven diffusion.

The local network perspective is therefore central to the study. In many small businesses, adoption knowledge comes less from formal manuals or consultancy reports than from observing a supplier demonstrate a machine, seeing a competitor's counter display, hearing another owner's experience, or attending a short training session. Owners may trust such information because it is practical, context-specific, and connected to visible outcomes. However, network-based learning can also reproduce inequality: owners with stronger supplier relationships, higher purchase volumes, or more visible outlets may encounter innovation earlier and more frequently than smaller neighborhood bakeries.

Table 3: Measurement Framework by Bakery Category

Bakery Category	Core Adoption Measures	Driver/Barrier Measures
Small Bakeries	Equipment, ingredient and digital adoption items on five-point scales	Capital cost, skills, supply inconsistency, risk, customer demand, and supplier influence
Medium Bakeries	Same measures used for comparison across strata	The same driver and barrier measures were used for comparison across categories
Premium Bakeries	Same measures used for comparison across strata	The same driver and barrier measures were used for comparison across categories

Table 3 summarizes the adoption measures and the driver and barrier variables applied consistently across small, medium, and premium bakery categories.

Research Gap and Conceptual Linkage

Most research on SME digital transformation and food-sector modernization examines broad sectors or national settings. Fewer studies explain how innovation travels within a single city-level food ecosystem. This study addresses that gap by linking adoption patterns, barriers, and diffusion channels across small, medium, and premium bakeries in Indore.

Digital adoption was expected to exhibit high observability and low trial cost; equipment adoption to depend more strongly on capital and capability; ingredient innovation to depend on compatibility with recipes and customer preferences; and barriers to reflect both complexity and organizational constraints. This integrated framing guided instrument design and interpretation.

Table 4: Conceptual Linkage among Variables, DOI, and TOE

Study variable	DOI interpretation	TOE interpretation
Digital innovation adoption	High relative advantage, high observability and low trial cost	Technological affordability and environmental customer pressure
Equipment adoption	Higher relative advantage but lower trialability and higher complexity	Technological cost and organizational readiness
Ingredient innovation	Compatibility with recipes and customer taste determines adoption	Supplier availability and workforce capability
Competitive pressure	Observable success of competitors encourages adoption	Environmental pressure from nearby premium outlets
Customer demand	Relative advantage is clearer when customers request new products	Environmental demand shapes managerial priorities
Innovation barriers	Complexity and low trialability discourage adoption	Organizational resource constraints and weak support systems

Table 4 connects the study variables with the DOI and TOE frameworks and shows how adoption, competitive pressure, customer demand, and barriers were interpreted conceptually.

Data Analysis

Survey data were organized in Microsoft Excel and analyzed in IBM SPSS Statistics. Descriptive statistics summarized normalized adoption scores and the proportions of respondents reporting each

driver or barrier as high. For inferential analysis, driver and barrier responses were treated as binary categorical variables (high versus not high) according to the survey coding, and Pearson chi-square tests of independence were used to compare the three bakery categories. Statistical significance was assessed at $\alpha = 0.05$. Because the study was cross-sectional and city-specific, the findings were interpreted as exploratory associations rather than causal effects.

For each adoption domain, item scores were summed, divided by the maximum possible score, and multiplied by 100 to create a normalized index ranging from 0 to 100. The overall innovation index was calculated as the arithmetic mean of the equipment, ingredient, and digital indices. These indices were used as descriptive benchmarks and not for causal modeling.

Interview and field notes were analyzed using principles of reflexive thematic analysis (Braun & Clarke, 2021). Statements concerning adoption, risk, supplier support, customer demand, skills, and training were coded, grouped into themes, and interpreted alongside the survey results and the DOI-TOE framework.

Table 5: Summary of Research Constructs, Indicators, and Measurement Scales

Construct	Number of Items	Example Indicators	Scale
Digital innovation adoption	6	Digital payments, social media, online ordering, customer database use, digital promotion, delivery platform use	5-point Likert scale; normalized index (0-100)
Equipment adoption	5	Modern ovens, mixers, display systems, temperature control, packaging tools	5-point Likert scale; normalized index (0-100)
Ingredient innovation	5	Specialty flour, healthier ingredients, premium fillings, preservative alternatives, product diversification	5-point Likert scale; normalized index (0-100)
Competitive pressure	4	Competitor modernization, pricing pressure, product imitation, customer comparison	5-point Likert scale; categorized for chi-square analysis
Customer demand	4	Health-oriented demand, customization, premium presentation, convenience expectations	5-point Likert scale; categorized for chi-square analysis
Innovation barriers	8	Capital cost, staff skills, maintenance, supply inconsistency, uncertain ROI, risk aversion, space limits, training access	5-point Likert scale; categorized for chi-square analysis

Table 5 summarizes the principal constructs, number of items, representative indicators, and measurement scales. Digital innovation adoption was measured with six items, while equipment adoption and ingredient innovation were each measured with five items. Competitive pressure and customer demand were measured with four items each, and innovation barriers with eight items. All constructs used five-point Likert scales; adoption-related constructs were additionally converted into normalized indices.

The first section of the instrument recorded respondent and business characteristics, including role, years of operation, number of employees, bakery type, product variety, customer type, and digital presence. The second section assessed adoption of production equipment, ingredients, and digital tools, including ovens, mixers, proofers, display systems, packaging, temperature control, specialty flour, healthier ingredients, digital payments, social media, online ordering, and customer-feedback tools. The third section assessed innovation drivers and barriers, including competitive pressure, demand for

healthier products, efficiency, supplier promotion, capital cost, maintenance difficulty, skill gaps, risk-averse behavior, supply uncertainty, and limited training. The interview guide explored visible innovations, early adopters, supplier support, peer influence, training gaps, and willingness to experiment with new products or machines. This structure supported integration of survey and interview evidence.

Results

Respondent and Business Profile

The quantitative sample comprised adult owners and managers directly involved in investment and operational decisions. Small bakeries were predominantly neighborhood or family-managed units; medium bakeries had more regular staff and wider product ranges; and premium bakeries had stronger brand, café, or patisserie characteristics. Digital visibility and exposure to formal training increased from small to premium formats. The qualitative sample included participants from both the demand and supply sides of the bakery ecosystem.

Innovation adoption should be interpreted in relation to business format. A small neighborhood bakery may depend on family labor and repeat local customers and may therefore be cautious about expensive experimentation. A medium bakery may have a wider product range and a greater need for process consistency, making selected equipment and packaging upgrades attractive. A premium outlet may compete through presentation, novelty, customization, and digital engagement, making innovation part of its market identity. These differences help explain the uneven distribution of adoption among firms operating in the same city.

Table 6: Descriptive Profile of Bakery Categories

Characteristic	Small Bakeries	Medium Bakeries	Premium Bakeries
Respondents surveyed	30	30	30
Typical respondent role	Owner/Family Manager	Owner/operations manager	Owner/Manager/Brand Manager
Dominant business format	Neighborhood Bakery	Commercial bakery outlet	Café/Patisserie or Premium Outlet
Digital visibility	Low to Moderate	Moderate	High
Formal training exposure	Limited	Moderate	Relatively Higher

Table 6 provides descriptive context for interpreting the findings. Differences in ownership structure, business format, digital visibility, and training exposure should be considered alongside the observed adoption patterns.

Early-Adopter Profile

Early adopters were mainly premium and medium bakeries located in commercially visible areas. They had wider product ranges, stronger supplier relationships, greater interest in specialty ingredients, and more confidence in social media marketing. Their innovations included improved display systems, premium packaging, selective equipment modernization, new product lines, and digital promotion.

Small bakeries were not outside the innovation system; rather, their adoption was narrower and more pragmatic. They readily used tools that supported orders, payments, and customer communication when these required limited training or fixed investment. Production-related innovations were assessed more cautiously because they could affect product consistency, energy use, repair dependence, and cash flow. The findings therefore distinguish openness to innovation from the capacity to absorb it. Small bakeries may recognize the value of modernization while remaining constrained by risk and limited resources.

Table 7: Innovation Adoption Index by Bakery Type (Normalized Scores, 0-100)

Bakery type	Equipment Index	Ingredient Index	Digital Index	Overall Index
Small	34	29	46	36
Medium	58	51	63	57
Premium	81	74	86	80

Table 7 shows a clear adoption gradient from small to premium bakeries. The largest overall difference was between premium and small bakeries, indicating segmented modernization within the same city market.

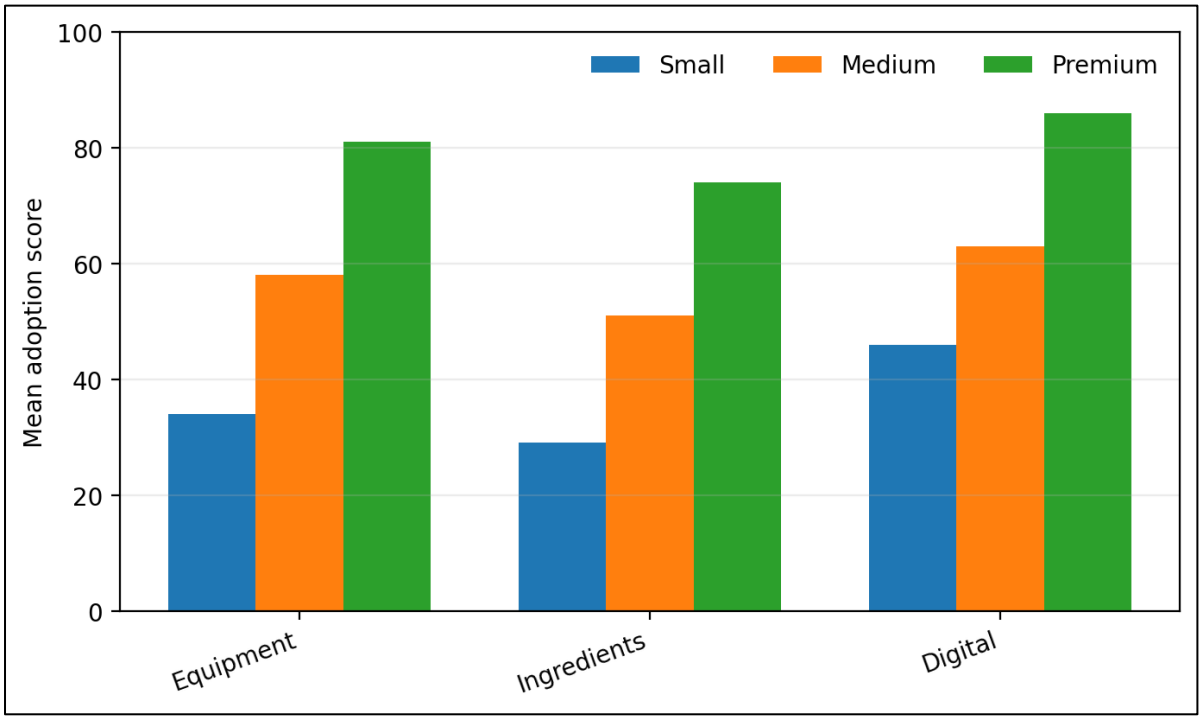

Figure 2: Comparative Innovation Adoption by Bakery Type

Figure 2 compares equipment, ingredient, and digital innovation indices across the three bakery categories. Digital innovation had the highest score in every category, while premium bakeries consistently recorded higher scores than medium and small bakeries.

The figure confirms the pattern shown in Table 7: digital innovation was the most widely adopted domain, and premium bakeries recorded higher equipment, ingredient, and digital adoption indices than the other categories.

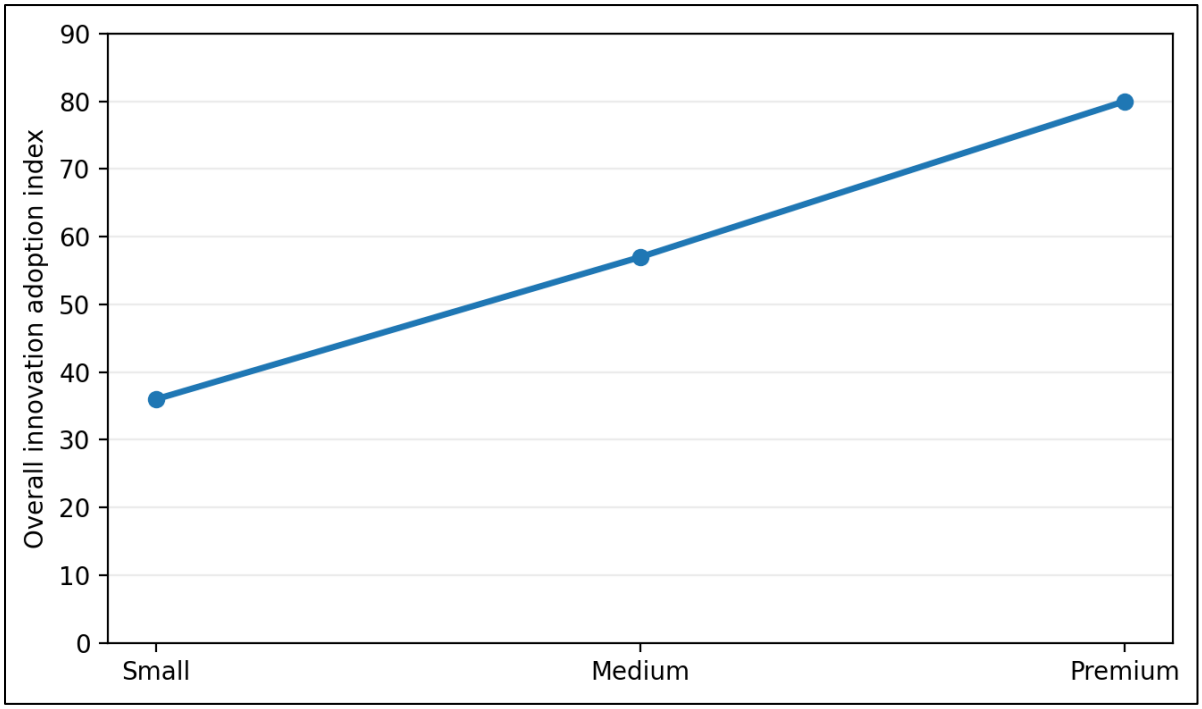

Figure 3: Overall Innovation Adoption Gradient

Figure 3 illustrates the overall innovation adoption gradient, with premium bakeries recording the highest index, followed by medium and small bakeries. The descriptive pattern shows progressively higher adoption-index scores from small to medium and premium bakeries. These differences may reflect variation in organizational resources, market visibility, and operational capacity, although these factors were not tested as predictors of the adoption indices. Small bakeries adopted innovation more selectively, favoring relatively affordable digital tools such as digital payments and WhatsApp ordering over equipment or ingredient changes that could disrupt production.

Reported Drivers of Innovation

Efficiency and cost savings were the most frequently reported drivers across bakery categories. Customer health demand, supplier promotion, and competitive pressure were reported increasingly from small to premium bakeries, suggesting that more visible and better-resourced firms were better positioned to recognize market opportunities and respond to customer expectations.

Supplier promotion was least common among small bakeries and became more prominent in medium and premium formats. Suppliers may therefore concentrate their efforts on firms with greater purchasing capacity or stronger prospects for repeat orders. Customer health demand also increased by bakery category, suggesting that premium customers more frequently requested healthier ingredients, premium presentation, or customized products. Competitive pressure was stronger where customers could readily compare product variety, packaging, and ambience across visible outlets.

Table 8: Reported Drivers of Innovation by Bakery Type, n (%)

Driver	Small, n (%)	Medium, n (%)	Premium, n (%)
Competitive pressure	13 (43.3)	20 (66.7)	25 (83.3)
Customer health demand	12 (40.0)	18 (60.0)	24 (80.0)
Efficiency and cost savings	17 (56.7)	22 (73.3)	26 (86.7)
Supplier promotion	8 (26.7)	15 (50.0)	21 (70.0)

Table 8 reports the number and percentage of respondents in each category who rated each driver as high (n = 30 per category). All drivers increased from small to premium bakeries. Efficiency and cost

savings were the most frequently reported driver in each category, while supplier promotion was the least frequently reported.

Pearson chi-square tests indicated significant associations between bakery category and competitive pressure, χ^2 (2, N = 90) = 10.57, p = 0.005; customer health demand, χ^2 (2, N = 90) = 10.00, p = 0.007; efficiency and cost savings, χ^2 (2, N = 90) = 6.76, p = 0.034; and supplier promotion, χ^2 (2, N = 90) = 11.29, p = 0.004. Descriptively, each driver was reported more frequently by premium bakeries than by medium or small bakeries.

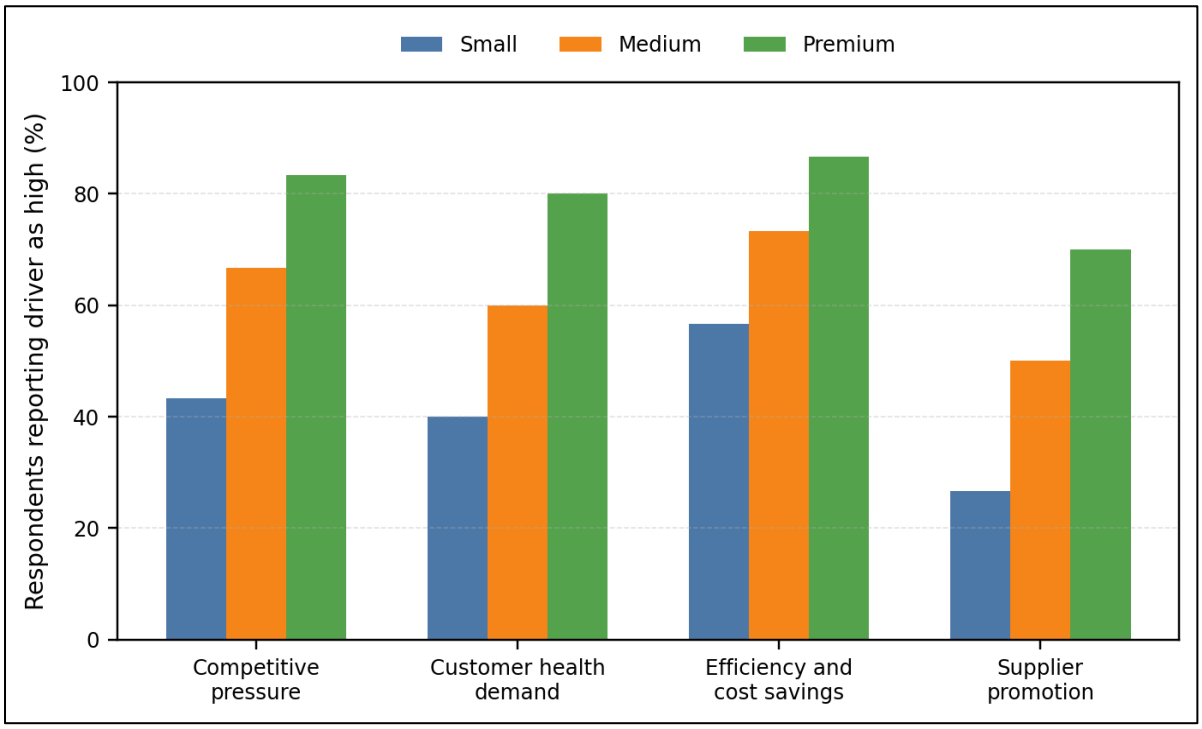

Figure 4: Reported Drivers across Bakery Types

Figure 4 shows the increasing frequency of competitive pressure, customer health demand, efficiency and cost savings, and supplier promotion across bakery categories. The pattern suggests that greater resources, customer visibility, and supplier engagement strengthen opportunity recognition and responsiveness to market demand.

Reported Barriers to Diffusion

Barriers were most frequently reported by small bakeries. High capital cost was the leading barrier, followed by risk aversion, skill gaps, and supply inconsistency. Medium bakeries reported moderate constraints, while premium bakeries reported substantially fewer barriers. These patterns indicate that innovation readiness is shaped by financial capacity, workforce capability, and supply reliability.

The barrier findings help explain why adoption may remain slow even when owners are aware of available innovations. A machine may appear useful, but purchase can be delayed by uncertainty about maintenance, staff training, and expected sales gains. Ingredient innovation may similarly be postponed when supply is inconsistent or customers are price-sensitive. These constraints may be cumulative: a bakery facing both capital limitations and skill shortages is likely to find adoption more difficult than one facing only a single constraint.

Table 9: Key Barriers to Innovation Diffusion by Bakery Type, n (%)

Barrier	Small, n (%)	Medium, n (%)	Premium, n (%)
High capital cost	23 (76.7)	16 (53.3)	6 (20.0)
Skill gaps	18 (60.0)	12 (40.0)	5 (16.7)
Supply inconsistency	17 (56.7)	12 (40.0)	7 (23.3)
Risk aversion	19 (63.3)	11 (36.7)	4 (13.3)

Table 9 reports the number and percentage of respondents in each category who rated each barrier as high (n = 30 per category). High capital cost was the most frequently reported barrier among small and medium bakeries. Every barrier declined substantially from small to premium bakeries, indicating that financial capacity, workforce capability, and supply reliability influence innovation readiness.

Pearson chi-square tests indicated significant associations between bakery category and high capital cost, χ^2 (2, N = 90) = 19.47, $p < 0.001$; skill gaps, χ^2 (2, N = 90) = 11.88, $p = 0.003$; supply inconsistency, χ^2 (2, N = 90) = 6.94, $p = 0.031$; and risk aversion, χ^2 (2, N = 90) = 15.98, $p < 0.001$. Descriptively, these barriers were most frequently reported by small bakeries and least frequently reported by premium bakeries.

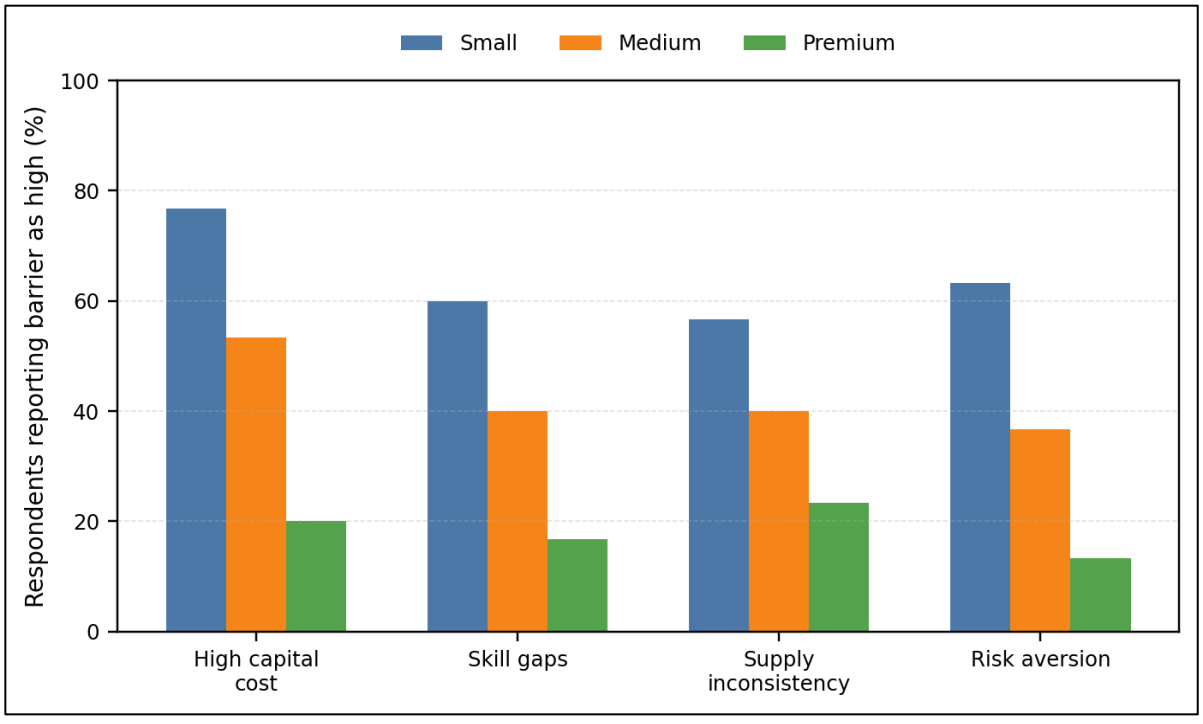

Figure 5: Reported Barriers across Bakery Types

Figure 5 illustrates the inverse barrier gradient across bakery categories. Small bakeries reported the highest levels of financial, skill-related, supply, and risk barriers, whereas premium bakeries reported the lowest levels.

Role of Networks and Institutions

Supplier demonstrations were the strongest influence channel, followed by peer observation and training institutions. Demonstrations reduced uncertainty by allowing owners to observe ingredient performance, equipment operation, and maintenance requirements before making a financial commitment. Peer observation was also important because owners relied on examples from comparable local businesses. Guidance from training institutions was most useful when it was brief, practical, and suited to the daily operational constraints of bakery businesses.

Interview evidence suggested that demonstrations were particularly effective in translating the abstract benefits of innovation into visible, locally relevant outcomes. Owners valued opportunities to observe the performance of ingredients and equipment before making a financial commitment.

Table 10: Influence Channels (Mean Likert Scores)

Channel	Mean score
Supplier demonstrations	4.1
Peer observation	3.8
Training institutions	3.2

Table 10 shows that supplier demonstrations were the strongest influence channel, with a mean score of 4.1, followed by peer observation at 3.8 and training institutions at 3.2. These findings indicate that practical and trusted information sources can reduce uncertainty and support innovation adoption.

Qualitative Themes

Four qualitative themes emerged. First, selective modernization showed that bakeries with stronger market confidence and clearer customer positioning concentrated their innovation efforts on convenience, customer appeal, and product presentation. Second, practical evaluation before adoption showed that owners preferred innovations they could test, observe, and understand through credible demonstrations, aligning with the DOI attributes of trialability and observability.

Third, capability and resource constraints reflected the financial pressure, training gaps, maintenance concerns, and uncertainty about returns experienced particularly by small bakery owners.

Fourth, mediated diffusion highlighted suppliers and peers as practical knowledge intermediaries. Suppliers acted not only as vendors but also as translators of market trends, equipment use, and ingredient possibilities. However, unequal supplier outreach may reinforce segmented modernization when smaller bakeries receive less support.

Table 11: Thematic Structure of Qualitative Findings

Theme	Representative meaning	Link to DOI/TOE
Selective modernization	Owners adopt innovations that clearly match business positioning and customer visibility	Relative advantage and organizational readiness
Practical evaluation	Demonstrations and trials reduce uncertainty	Trialability and observability
Capability constraints	Cost, skills and maintenance slow adoption	Organizational context and technological complexity
Mediated diffusion	Suppliers and peers translate innovation into practical knowledge	Environmental support and social system influence

Table 11 summarizes the four qualitative themes and links each theme to the DOI and TOE frameworks. These themes indicate that innovation adoption is shaped by business positioning, opportunities for practical evaluation, organizational capability, and support from suppliers and peer networks.

Discussion

The findings reveal a segmented and socially mediated pattern of innovation diffusion in Indore's bakery industry. Premium bakeries recorded the highest use of innovative equipment, ingredients, and digital technology, while small bakeries recorded the lowest. Research on SME digitalization similarly indicates that adoption depends not only on technology availability but also on managerial capacity, organizational readiness, and resources (Kallmuenzer *et al.,* 2025; Kahveci, 2025). This study demonstrates the same mechanism within a localized bakery ecosystem rather than a broad industrial sample.

Descriptive adoption indices differed across bakery categories, with premium bakeries recording the highest scores, followed by medium and small bakeries. Bakery category was also significantly associated with the reported innovation barriers. Premium bakeries had higher innovation indices and reported fewer barriers. Interview evidence linked this pattern to greater resource capacity, stronger supplier relationships, willingness to experiment, and access to customers receptive to premium products.

The TOE framework provides context for these differences. Premium bakeries are more likely to have financial slack, trained staff, established supplier relationships, and customers willing to pay for premium presentation. Small bakeries face less favorable technological and organizational conditions because maintenance, space, skills, and capital costs can turn innovation into a substantial business risk (Tornatzky & Fleischer, 1990; Baker, 2011). Studies of digital transformation and operational integration in food SMEs report comparable constraints (Gupta & Jagtap, 2024; Marczewska, 2024; Vahdanjoo *et al.*, 2025).

DOI theory helps explain why digital innovations diffused faster than equipment and ingredient innovations. Digital payments, online communication, and social media marketing offer clear relative advantage, low trial cost, and outcomes that are readily visible to customers. Equipment and premium ingredients involve greater complexity, lower reversibility, and less immediately observable returns. Consequently, small bakeries may adopt digital practices first and postpone production-related innovation until the expected benefits become clearer.

The Indore case also shows that modernization is not simply a matter of adopting more tools. The depth, integration, and practical value of digital and production innovation are equally important. Recent studies of food manufacturing and digital adoption similarly argue that firms require coherent support systems rather than isolated technologies to achieve flexibility, sustainability, and performance gains (Hu *et al.,* 2026; Ndiata *et al.,* 2025).

Suppliers are central to this process. Demonstrations and peer observation reduce uncertainty by showing owners how innovations work in practice. This finding aligns with innovation-intermediation research emphasizing the role of external actors in helping SMEs translate unfamiliar technologies into usable routines (Greenhalgh *et al.,* 2004; Alawamleh *et al.,* 2022). However, supplier support is uneven: premium bakeries may receive more demonstrations and credit opportunities, while small bakeries remain outside the strongest learning channels.

These findings also have implications for supplier power. Suppliers can accelerate innovation by offering affordable trials, usage guidance, technical assistance, and post-purchase support, thereby strengthening knowledge transfer and innovation capability within buyer-supplier relationships (Sikombe & Phiri, 2019). They may also unintentionally reinforce unequal diffusion when demonstrations, financial assistance, and credit facilities are directed mainly toward established or high-volume buyers (Selviaridis & Spring, 2022). Smaller bakeries may consequently experience slower exposure to new ingredients and equipment, lower confidence in experimentation, and limited access to troubleshooting. Suppliers therefore function as both market actors and informal knowledge brokers within the bakery ecosystem (Crupi *et al.,* 2020).

The qualitative themes provide contextual explanations for the quantitative patterns, demonstrating the value of integrating qualitative and quantitative evidence (Fetters *et al.,* 2013). Selective modernization, practical evaluation, capability constraints, and mediated diffusion suggest that adoption requires understanding, trust, trial, technological assimilation, and eventual routinization within business operations (de Mattos *et al.,* 2024). Although the cross-sectional design does not establish causality, the findings show descriptive differences in adoption intensity across bakery categories and statistically significant associations between bakery category and the reported drivers and barriers within this urban food-SME ecosystem (Wang & Cheng, 2020).

Taken together, the results suggest that innovation diffusion in Indore is a staged and relational process involving awareness, exploration, adoption, and transformation (Garzoni *et al.,* 2020). Awareness often

begins through market observation, supplier contact, or customer requests. Trial depends on affordability, demonstration, and confidence that errors can be managed, whereas routine adoption requires staff capability, consistent supply, maintenance support, and evidence of improved sales, product quality, or reputation. Disruption at any stage may delay adoption. This phased interpretation explains why visible and relatively accessible digital tools spread more rapidly, while equipment and ingredient innovations remain concentrated among bakeries with stronger financial resources, technological capabilities, skilled employees, and support networks (Melesse & Orrù, 2025).

Implications

Theoretical Implications

Integrating DOI and TOE in a localized food-SME context adds theoretical value. DOI explains how owners evaluate a specific innovation, while TOE explains why those evaluations differ across organizational and environmental settings. Together, the frameworks provide a structured explanation of segmented diffusion within a city-level bakery system.

Managerial Implications

Bakery owners should approach innovation incrementally rather than as a single large investment. Small bakeries can begin with visible and affordable practices such as digital payments, social-media menus, customer-feedback tracking, and small ingredient trials. Medium bakeries can benefit from planned equipment upgrades, staff training, and supplier demonstrations. Premium bakeries should focus on deeper integration of digital, ingredient, and equipment innovations rather than symbolic adoption alone.

Practical and Policy Implications

The findings point to the need for inclusive diffusion mechanisms. Suppliers, bakery associations, training institutions, and policy actors can reduce risk for smaller bakeries through cluster-based demonstrations, shared trial kitchens, equipment-orientation workshops, supplier credit schemes, and locally relevant training modules. Peer-learning events may also help small and medium bakery owners observe innovations under realistic operating conditions.

Limitations

The cross-sectional design permits identification of associations but not causal relationships. Self-reported and perception-based data may have introduced recall and social-desirability bias. The study was limited to bakeries in Indore, and caution is therefore required when generalizing the findings to other metropolitan, semi-urban, or rural settings. Equal allocation across bakery categories supported comparison but did not estimate citywide category prevalence. The relatively small sample and absence of longitudinal data further limit inference. Although the mixed-methods design strengthened contextual interpretation, the statistical findings should be regarded as exploratory and specific to the study area.

Future Research

Future research could extend this work in three directions. Longitudinal studies could trace movement from awareness to trial and routine adoption. Comparative studies across tier-1, tier-2, and smaller cities could assess whether the Indore pattern reflects wider food-SME modernization pathways. Larger samples could also examine relationships between adoption and profitability, waste reduction, customer retention, product quality, and sustainability outcomes.

Conclusion

The Indore bakery sector includes both innovation-ready and resource-constrained firms. Digital tools diffuse most rapidly because they are relatively affordable, visible, and easy to trial, whereas equipment and ingredient innovations require greater finance, skill, and supplier support. Supplier demonstrations, peer observation, and training institutions shape adoption, but their benefits are unevenly distributed. More inclusive modernization will depend on practical trials, locally relevant training, and supplier support that reaches small and medium bakeries as well as premium outlets.

CRediT Authorship Contribution Statement

P.S.S.: Conceptualization, methodology, investigation, formal analysis, writing-original draft, writing-review and editing, and supervision. L.S.J.: Academic guidance, review, validation, and institutional coordination. G.N.: Data curation, field coordination, validation, resources, and writing-review and editing.

AI Assistance Declaration

Generative AI tools were used only to improve language, grammar, clarity, and manuscript organization. All arguments, interpretations, and revisions were reviewed and approved by the authors, who remain fully responsible for the manuscript's content.

Conflict of Interest

There are no conflicting interests, according to the authors.

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