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Research Article

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Abstract

Toward sustainable development, transformation of the business model is crucial. Static tools like the Business Model Canvas cannot capture real-world complexity, and simulation-based methods remain validated only in technology-sector contexts, unexamined in resource-constrained developing economies. Using the Simulatable Business Model Description Framework, the transformation of the conceptual model was constructed (Step 1) and tested in a system dynamics tool across four investment

scenarios (Step 2): ICT-only, ICT + Agri-Product Agency, ICT + Logistics, and fully integrated. The fully integrated model outperformed all others, generating ~$1.6 million cumulative ROI against $0.9 million invested, ~90% customer share, and adoption by 16,000 farmers and 4,200 restaurant owners, with Pokhara's tourism food supply chain reaching full self-sufficiency within 4.3 years. These results offer a domestically grounded, simulation-validated alternative to labor-export dependency, advancing SDG 1, 8, and 12. This study highlights implications for business model transformation through a Nepalese case, moving beyond binary comparison to modeling the dynamics of the transition from conceptual design to simulated implementation for sustainability.

Keywords: Business Model, Transformation, System Dynamics, Value co-creation, Data-Driven Agricultural system

1. INTRODUCTION

1.1 Background

Sustainable development has evolved since the 1987 Brundtland Report, gaining a production-and-consumption focus through the 2002 Johannesburg Plan and culminating in the 2030 Agenda's poverty-eradication and inequality-reduction goals (United Nations, 2015). Yet significant gaps remain in the world's least developed countries; UNCTAD (2026) identifies 44 such nations (down from 46 in 2023) as facing a dual challenge of job creation and poverty-reducing growth. Progress has remained uneven since the adoption of the Sustainable Development Goals (SDGs), though Lucas and Sáenz (2025) find that many are breaking out of long-term stagnation, mirroring the growth patterns developed nations experienced 150 years ago.

Nepal exemplifies this struggle: political discontinuity, an agrarian economy that remains a net food importer, and a growing dependence on remittances — now 26.5% of GDP, the third-highest share globally — alongside a documented human cost of migrant-worker deaths and disabilities. Foreign employment policy has constrained domestic productivity, leaving real GDP growth (4.2%) well short of the 7.1% target for 2029 (Gaspar & Dahal, 2025; World Bank, 2025). Despite an agrarian workforce comprising 62% of the labor force, Nepal continues to import most of its food — underscoring the need for locally rooted enterprise models that convert demographic pressure into productive employment.

1.2 Related Literature and Research Gap

In addition to the research on macro-level solutions, research on poverty reduction and unemployment has moved forward a micro, enterprise-level orientation — from Kakwani and Pernia's (2000) conclusion that poverty reduction requires income redistribution through targeted anti-poverty policy, to Prahalad's (2004) Bottom-of-the-Pyramid (BoP) model, which reframes low-income populations as viable markets and co-creators of value rather than as aid recipients. London and Hart (2004) similarly call for policy tailored specifically to low-income populations. Yunus (2007) operationalized the social business framework through Grameen Bank's microcredit and microlending model, distinguishing two types: Type I businesses pursue social objectives exclusively, producing goods and services for the direct benefit of the poor, while Type II businesses connect profitable enterprise to higher-value markets, channeling profit directly to grassroots-level workers. This approach directly targets the bottom of the pyramid, addressing poverty and unemployment simultaneously. Porter and Kramer (2011) introduced the shared-value approach, urging existing companies to redefine their purpose as "creating shared value" generating economic value in ways that simultaneously address societal challenges, rather than optimizing short-term financial performance while overlooking unmet market needs and long-term sustainability. Businesses thus remain key economic drivers, whether through transforming existing business models or creating new ones — yet such transformation remains methodologically unprecedented and challenging in practice.

The Business Model Canvas, which has nine building blocks to describe specific business models, was developed by Osterwalder and Pigneur (2010), and this approach has become a standard conceptual framework for creating or restructuring business models. As a study applying business model canvas for creating a new business concept in Nepal context, Chaudhary and Okada (2024a, 2024b) established the empirical foundation: a PESTLE, SWOT, and 3C analysis of Nepal's agriculture and tourism sectors (focused on Dang and Pokhara) identified strong latent potential — including high mobile penetration and a favorable education base — that is undermined by a fragmented demand-supply chain between farmers and tourists and proposed an ICT-enabled Business Model Canvas description linking the two. However, that paper stopped at the conceptual stage: the To-Be model was proposed but never tested for operational feasibility.

The description on canvas captures a business model only as a single snapshot. It cannot represent how that model would behave under real-world feedback, delay, or nonlinear dynamics once implemented (Foss & Saebi, 2017; Peñarroya-Farell et al., 2021).

Methods to move beyond static canvases exist and are methodologically mature, but validated entirely in formal, technology-sector contexts. Di Valentin et al. (2012) show KPIs as decision triggers for model adaptation; Bock et al. (2021) use neural network analysis to simulate business model change; Velandia et al. (2024) apply Design Science Research to derive transformation patterns.

This structural limit — the inability of static canvases to capture feedback, delay, and nonlinear dynamics has not yet been resolved for a resource-constrained, developing-economy context. Simulation-based transformation methods capable of resolving it remain validated exclusively in formal, technology-sector settings; to the best of the authors' knowledge, they have not yet been applied to a setting such as Nepal's agriculture-tourism sector. Consequently, whether a Nepal-specific To-Be business model — the kind already conceptually developed in Chaudhary et al. (2024a, 2024b) — is dynamically feasible remains unexamined.

1.3 Study Aim

This study dynamic-testing the To-Be business model conceptually developed in Chaudhary et al. (2024a, 2024b) by applying the framework for building a simulation-experimentation environment for business model transformation, developed by Okada et al. (2022). The aim is to determine whether a business model addressing Nepal's SDG-linked unemployment and poverty challenges — developed across this research line — is dynamically feasible.

2. METHODOLOGY

This study builds on two prior stages of work. First one is Chaudhary and Okada (2024a) (2024b) characterized Nepal's agriculture and tourism sectors through four analytical phases (see section 2.1). It proposed an ICT-enabled Business Model Canvas description in Nepal context. Another one is a series of studies on business model transformation simulation methods (see section 2.2) by Kimata et al. (2020), Okada et al. (2020), and Takano et al. (2022). This study takes the proposed To-Be business model as its starting point, constructing a business simulation model using business model simulation methods, and conducting simulations experiments.

(1) **Constructing a Business Simulation Model Using Business Model Transformation Simulation Method**

Using business model transformation simulation methods, especially the "simulatable business model description framework" proposed by Kimata et al. (2022), we construct a business simulation model corresponding to the new business model proposed.

(2) **Simulation Experiments Using the Constructed Business Simulation Model**

Simulation experiments are conducted using the business simulation model constructed in Step 1 to dynamically test the feasibility of the proposed new business model.

2.1 Proposed New Business Model Connecting Agri-business and Tourism Business

This study builds on two prior stages of work. First, Chaudhary and Okada (2024a) characterized Nepal's agriculture and tourism sectors through four analytical phases. The first phase, macro-environmental scanning, used Aguilar's (1967) PESTEL analysis — covering political, economic, social, technological, legal, and environmental factors — to provide a comprehensive view of the external business environment and the prevailing trends relevant to strategic planning for Nepal. The second phase, strategic synthesis, applied Humphrey's (2005) SWOT analysis to examine strengths, weaknesses, opportunities, and threats within the business environment; to explore these findings in greater depth, two sites were observed, comparing local trends across four factors — agriculture, smartphone usage, internet access, and literacy. The third phase, market and competitive positioning, used Ohmae's (1982) 3C analysis — customers, companies, and competitors — to clarify the business model and understand the market environment. Finally, Osterwalder and Pigneur's (2010) Business Model Canvas served as a framework for visualizing, evaluating, and operationalizing the resulting business model. Based on the above, Chaudhary et al. (2024b) developed these findings into a To-Be business model through a zero-base-thinking methodology — expanding the study scope, identifying critical issues through situational analysis and forecasting, and integrating these into a comprehensive solution — resulting in the business model canvas and farmer–tourist demand-supply linking structure shown in Fig. 1.

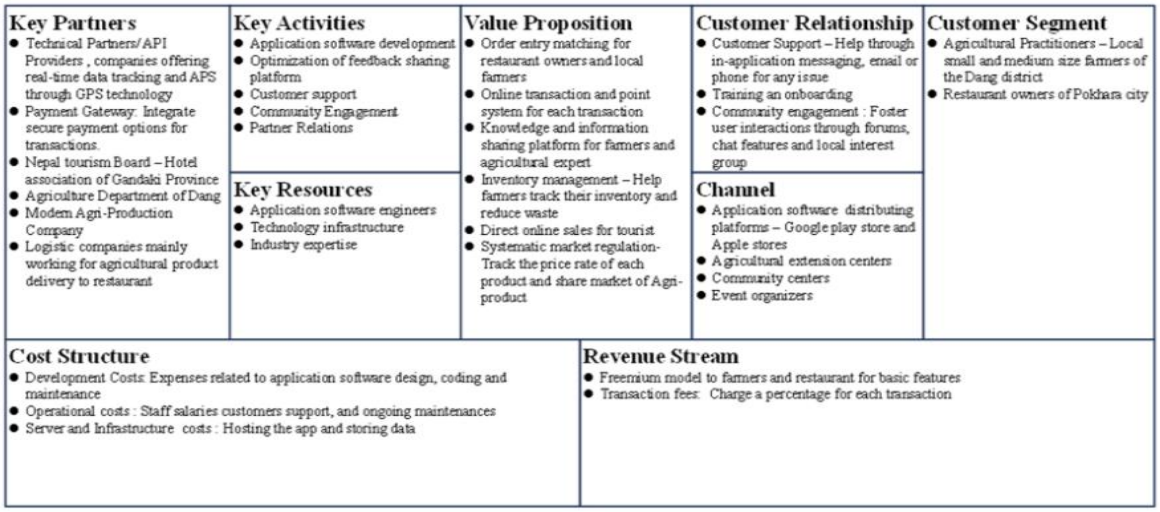


Fig. 1. Proposed Agri-Business Business Model for Nepal (derived from Chaudhary and Okada 2024a)

2.2 Business Model Transformation Simulation Method

In this section, we briefly explain Business Model Transformation Simulation Method.

2.2.1 Concept of Business Model Transformation Simulation

Figure 2 illustrates the concept of business model transformation simulation, proposed by Okada et.al. (2020). In the first step, we examine the "To-Be" business model and use the Business Model Canvas to describe it qualitatively. In the second step, we construct a simulation model using system dynamics techniques to reproduce the performance of the "As-Is" business model. In Step 3, we add the mechanisms that underpin the "To-Be" business model to the simulation model. We consider these added mechanisms to be those that existed within the business environment but had not manifested because they went unnoticed. In the simulation experiments, by activating these mechanisms, we elucidate the dynamic behavior of the transformation process from the As-Is business model to the To-Be business model. While the simulation results cannot be expected to have the same precision as a physical simulation based on universal laws of physics, they are still valuable when compared to static analyses. Through these simulation experiments, we derive a more realistic business model transformation process and seek to build consensus among stakeholders.

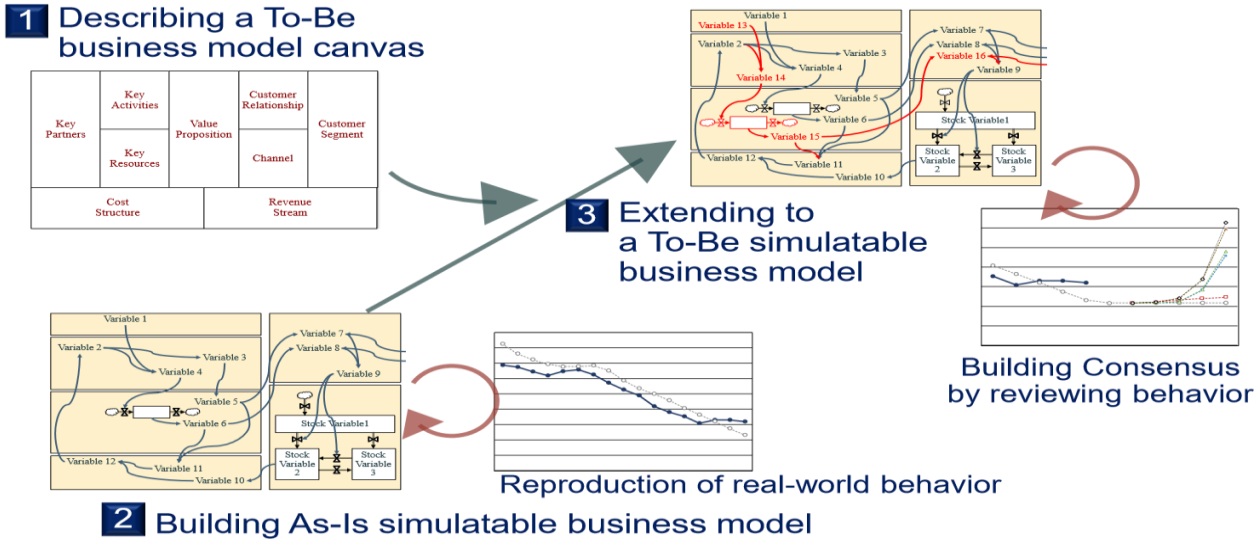


Fig. 2. The Okada Laboratory framework for Business Model (adopted from Kimata et al., 2022)

2.2.2 System Dynamic Simulation

In this subsection, we briefly explain the system dynamics method used to construct simulation models. System dynamics, developed by Forrester at MIT in the late 1950s, is a simulation method that graphically represents a system's structure using stock-flow diagrams, with mathematical functions defining how each variable's value is calculated. The notation used in stock-flow diagrams is explained concisely below:

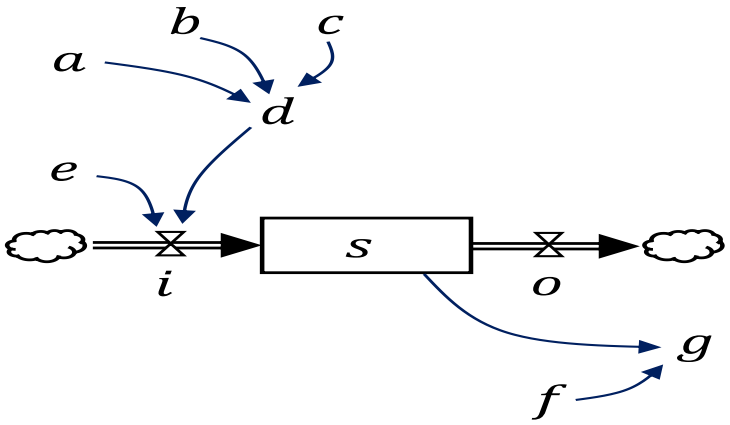


Fig. 3. Simple example of stock-flow diagram

Figure 3 shows an example of a simple stock-flow diagram. The letters in the figure represent variable names. The arrows between variables indicate the direction of causality, and the variable at the end of the arrow is calculated from the variable at the beginning of the arrow, with the calculation method defined as a function. For example, the value of variable d at time t is calculated from the values of variables a, b, and c using a function Fd defined as $d_t = F_d(a_t, b_t, c_t)$. Variables enclosed in rectangles (symbols indicating tanks), such as variable s, are called stock variables. Variables i and o associated with flows (symbols indicating valves on pipes) connected to stock variables are called flow variables. Furthermore, the value of the stock variable s at time t is calculated by a function F_s such as $s_t = s_{t-1} + i_t - o_t = s_0 + \int_{\tau=1}^{t}(i_\tau - o_\tau)\, d\tau$ from the values of the flow variables connected to its initial value. The values of stock variables correspond to the accumulation of flow variable values, enabling the representation of mechanisms involving time delays. It is possible to calculate the values of other variables (e.g., variable g) from the values of stock variables, but it is not possible to change the values of stock variables without mediating flow variables.

2.3 Formulation of Simulation Experiments Using the Constructed Business Simulation Model

Simulation experiments, which are scenario analysis, will be conducted using the constructed simulation model in a system dynamics tool (Vensim DSS 9.2.4×64) over a −12 to 120-month period to verify the proposed model's effectiveness. The −12-month phase represents preparatory investment and infrastructure development preceding the model's operational, value-creating phase.

3. Results of Step 1: Constructing a Business Simulation Model Using System Dynamics Methods

Since its inception, system dynamics has been applied across a diverse range of disciplines, gaining widespread recognition within the business domain through Sterman's (2000) seminal work. Building on this foundation, Kimata et al. (2020) developed, from extensive practical experience, the "Simulatable Business Model Description Framework" designed to facilitate and streamline the construction of simulation models, the proposed "To-Be" business model for Nepal is constructed and shown in the figure below:

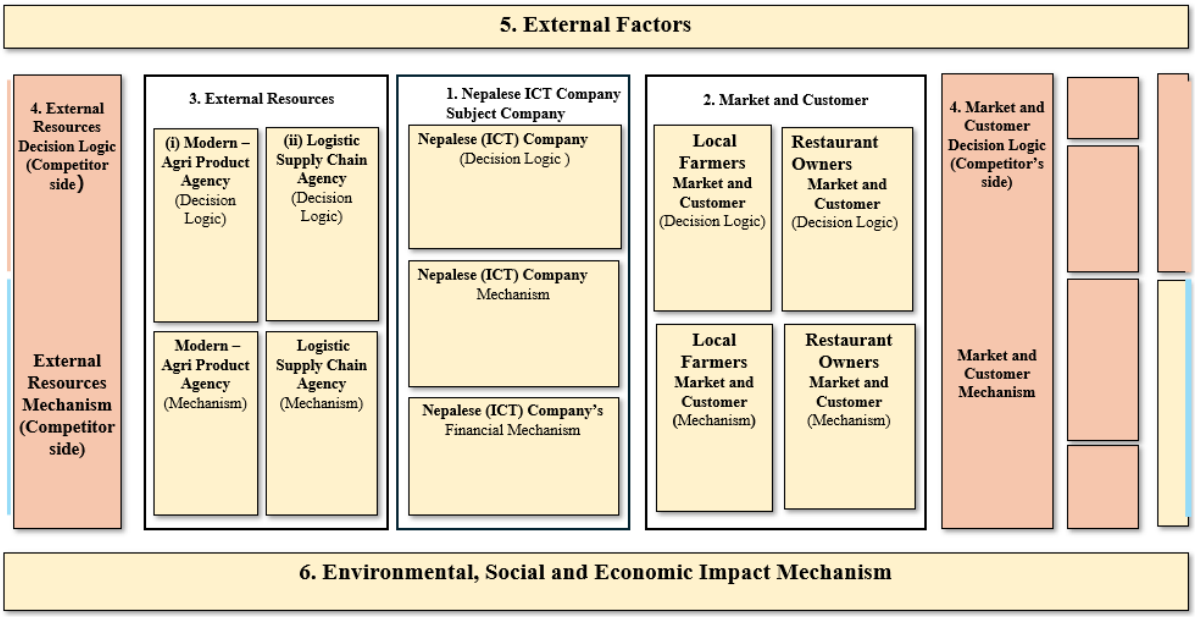


Fig. 5. Business Model Framework for Nepalese ICT Company based on Kimata Framework

Figure 5 presents the Business Model Framework for a Nepalese ICT Company, adapting Kimata et al.'s framework to Nepal's agribusiness-tourism-ICT context as follows: (1) the Subject Company refers to the Nepalese ICT company, which competes with (4) Competitors in targeting (2) the Nepalese Market and Customers, defined as local farmers and restaurant owners, while drawing on (3) External Resources, comprising (i) the Modern Agri-Product Agency and (ii) the Logistics Supply Chain Agency. (5) External Factors capture the external influences and impacts exerted on the model by both the Subject Company and its competitors. Sub-models (1) and (4) are further integrated into dedicated sections delineating the decision-making logic governing customer acquisition and resource allocation. The model also integrates the proposed system's social and environmental impacts arising from its economic outcomes.

3.1 Subject Company's Decision Logic and Mechanism

The proposed "To-Be" model treats the ICT company as sufficiently capitalized to engage in strategic partnerships, technology transfer, and long-term investment in Nepal's digital economy, serving local communities. Figure 6 shows cumulative ICT capital investment for acquiring the "Platform Matching System" capability. Following system dynamics theory, stocks (accumulations) and flows (rates of change) are distinguished: Stock (1) represents accumulated technical infrastructure, driven by monthly ICT development investment; Stocks (2) and (3) are inventory buffers accumulating upstream food-availability data from farmers and downstream food-demand data from restaurant owners (via POS records), measured in tons/month following start-flag activation.

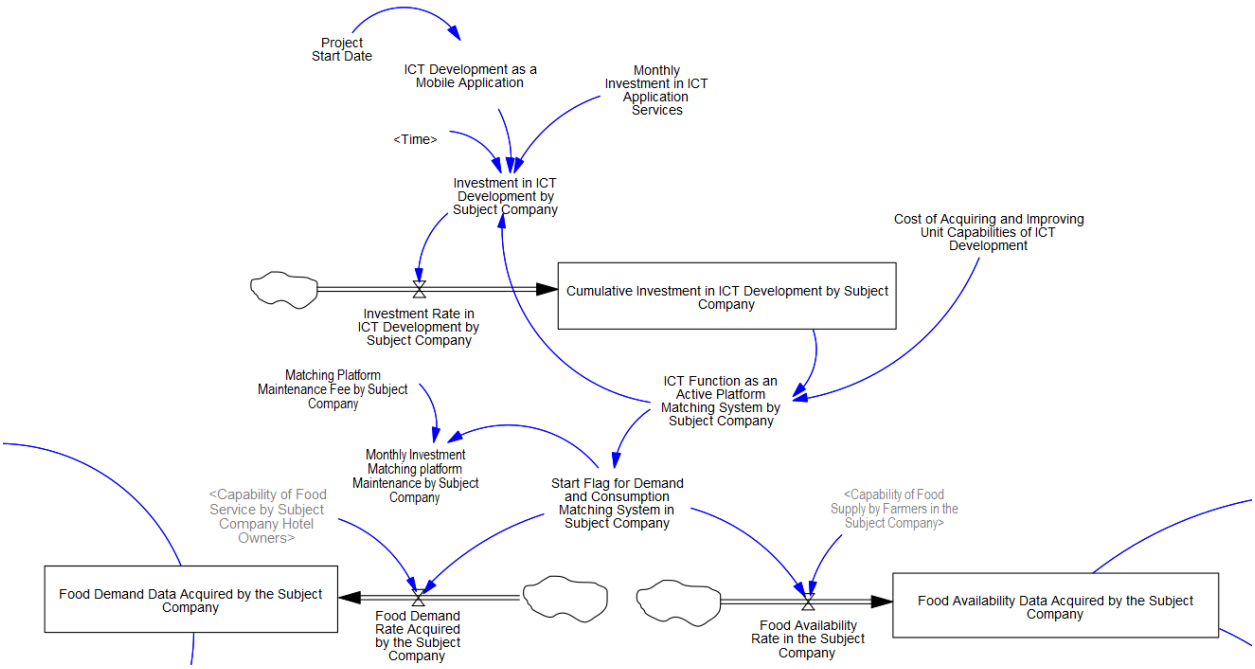


Fig. 6. Simulation Modeling for Project investment by Nepalese ICT Corporation

3.2 External Resources' Decision Logic and Mechanism

To enhance its competitiveness and market attractiveness, the subject ICT company has elected to form strategic alliances with Modern Agri-Production Agency and Logistic Supply Chain. The company treats project implementation as both a business activity and a learning vehicle — simultaneously delivering value to customers while building the internal ICT competencies required to sustain and grow these partnerships over time.

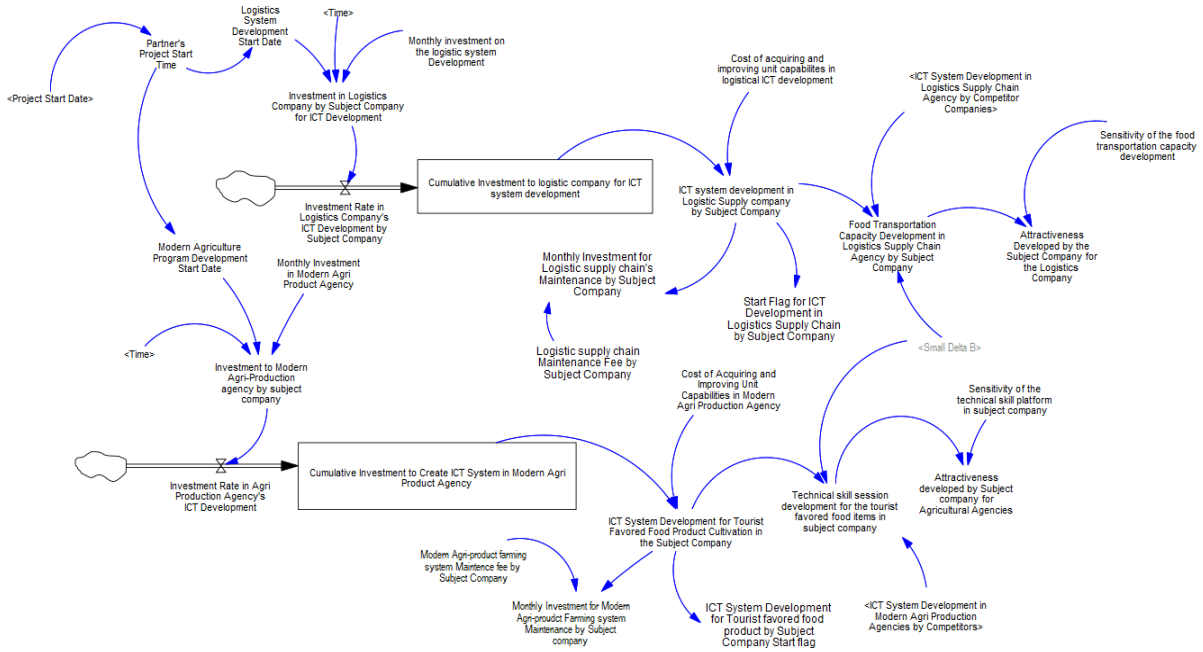


Fig. 7 Project investment based on collaboration with partner company

The Subject Company allocates monthly investment to acquire ICT functions: technical skills development for tourist-favored Nepalese cuisine (Modern Agri-Product agency) and food transportation capacity with on-time delivery (logistic supply chain agencies), accumulating capabilities over time. Competitiveness is assessed across axes tied to customer segments, benchmarked against competitors, assuming earlier capability acquisition yields superior position. Overall competitiveness (weighted average) is log-transformed, summed, and averaged; a customer appeal value (0–1), via sigmoid function, reflects attractiveness. Based on attractiveness, the Subject Company and competitors compete for a pool of 20 agency collaborations, with "shifting time" and "average shifting period" parameters introducing lag between attractiveness changes and resulting agency-support shifts.

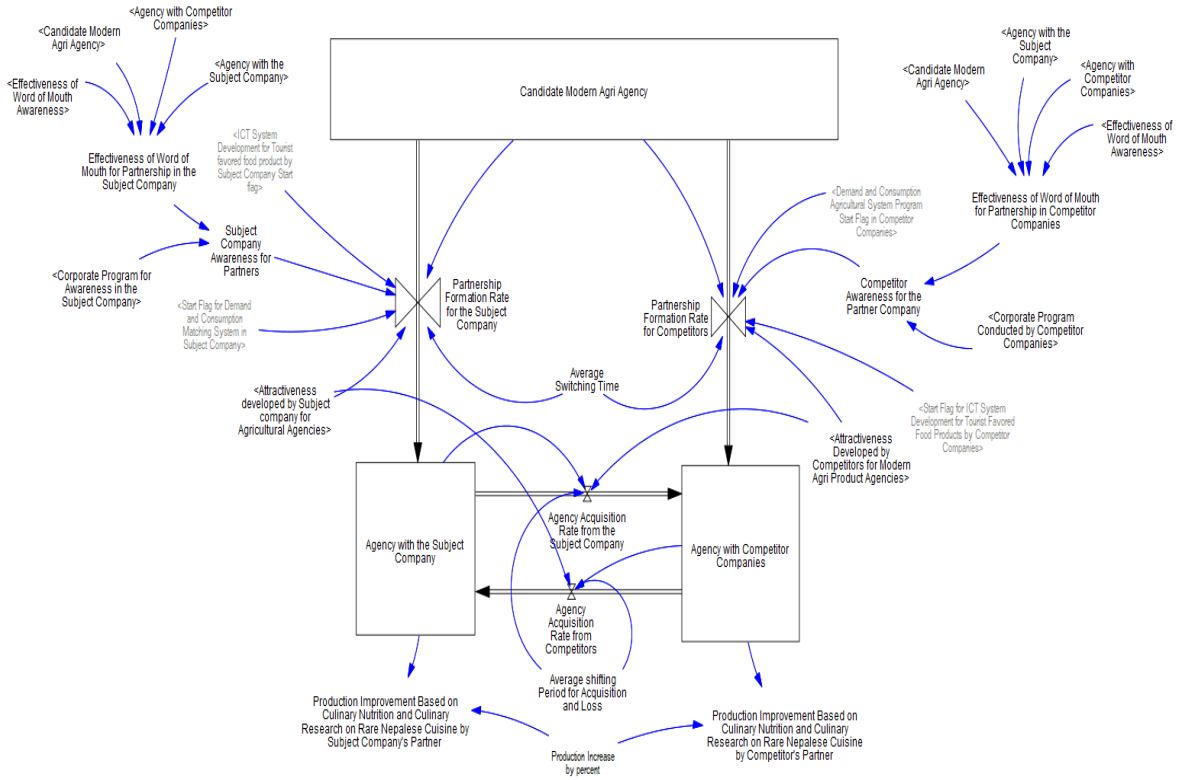


Fig. 8 External Resources Mechanism for Partner acquisition

A similar mechanism applies to the pool of 10 Logistic Supply Chain Agencies willing to support timely delivery competitiveness for both the subject company and its competitors. Through these partnerships, delivery capacity — measured in metric tons per month for premium service offerings — is acquired. This capacity captures the operational execution capability behind tourist-oriented specialty agricultural products.

3.3 Decision Logic and Mechanism of Market and Customers

3.3.1 Subject Company Awareness Strategy

Brand-based competitive advantage emerges from accumulated monthly investment in advertising, combined with word-of-mouth effectiveness — modeled using a Bass diffusion model, with effectiveness capped at 1 (100%). Market penetration is calculated as the proportion of farmers who have adopted any freemium service — from either the Subject Company or its competitors — out of the total addressable market. When few farmers use the freemium service, word-of-mouth is less effective, as fewer people are discussing it in the early stages; as adoption increases, word-of-mouth effectiveness rises due to network effects. A similar awareness strategy applies to restaurant owners and partnerships.

3.3.2 Market and Customer Mechanism: Technology Diffusion Among Local Farmers

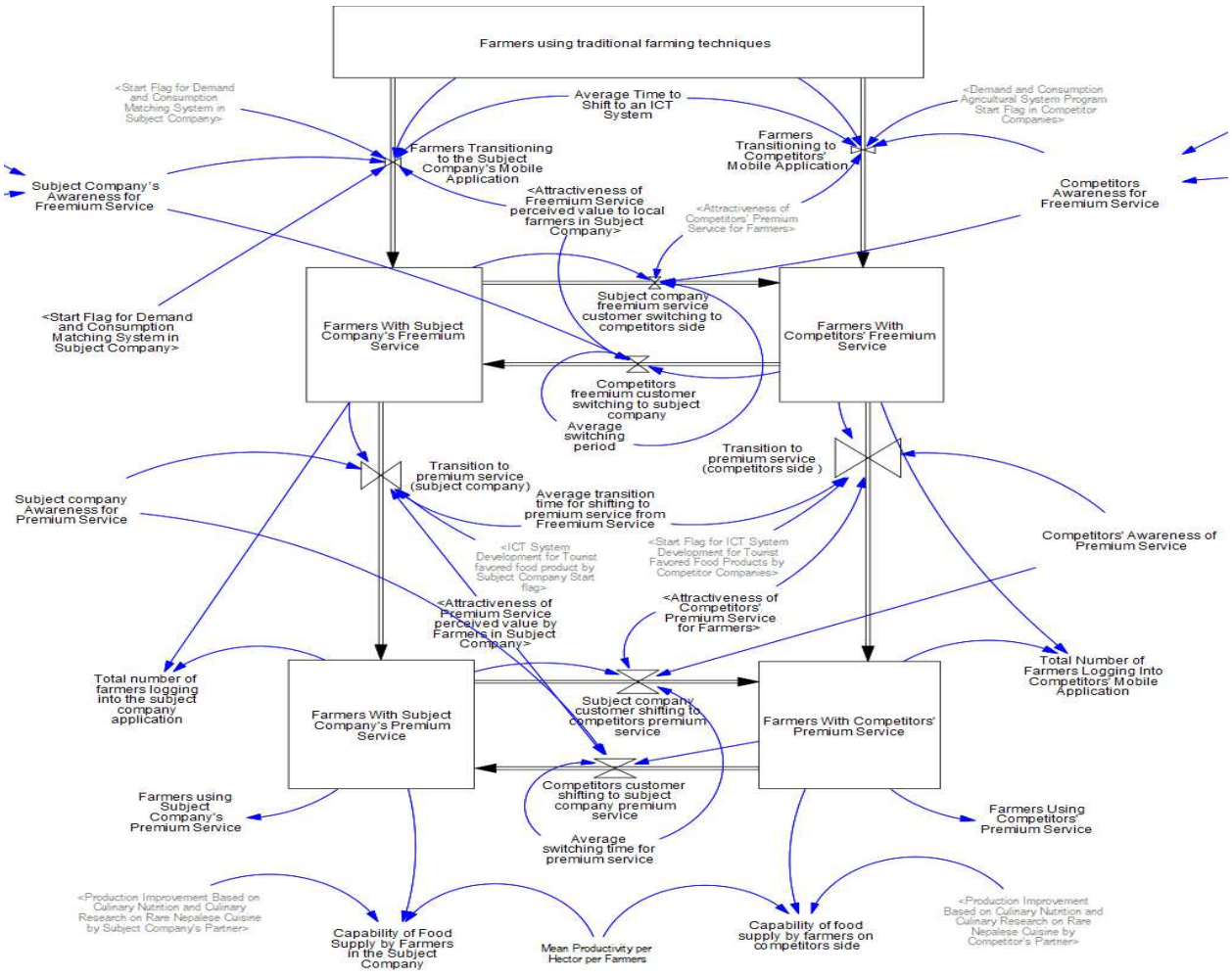


Fig. 9. Diffusion Model of Technology Adoption Among Local Farmers: Subject Company Versus Competitor Uptake

Figure 9 illustrates local farmers' customer movement via a stock-flow diagram, modeling farmers using traditional farming techniques as potential customers within a single stock. Of the 193,697 people engaged in agriculture per the Nepal Population and Housing Census (2021), 30,000 are considered potential farmers. Upon activation of the matching system's start flag, farmers first subscribe to the free Fundamental Tier (freemium service); "Farmers with the Subject Company's Premium Service" then constitutes the Differentiated Tier, activated once tourist-favored food product data accumulates. This premium service connects farmers to tourism-driven demand by curating tourist-favorite products and guiding producers through technical skills training, packaging, and quality control, supported by market data, capacity planning, and on-time delivery.

3.3.3 Market and Customer Mechanism: Technology Diffusion Among Restaurant Owners

Figure 10 depicts the stock-flow diagram modeling competitive dynamics for restaurant owners in Pokhara who use traditional shopping and imported goods. Per the Nepal Population and Housing Census (2021), 13,460 people in Kaski District, Pokhara Metropolitan City, are engaged in accommodation and food service; 5,000 are assumed to subscribe following start-flag activation. Freemium Service offers real-time food availability data free of charge — an information-acquisition strategy, not pricing strategy. The Premium Service targets freemium subscribers seeking high-end products with delivery. A key strength is integrating local and tourist-demanded food data with timely delivery via the mobile application.

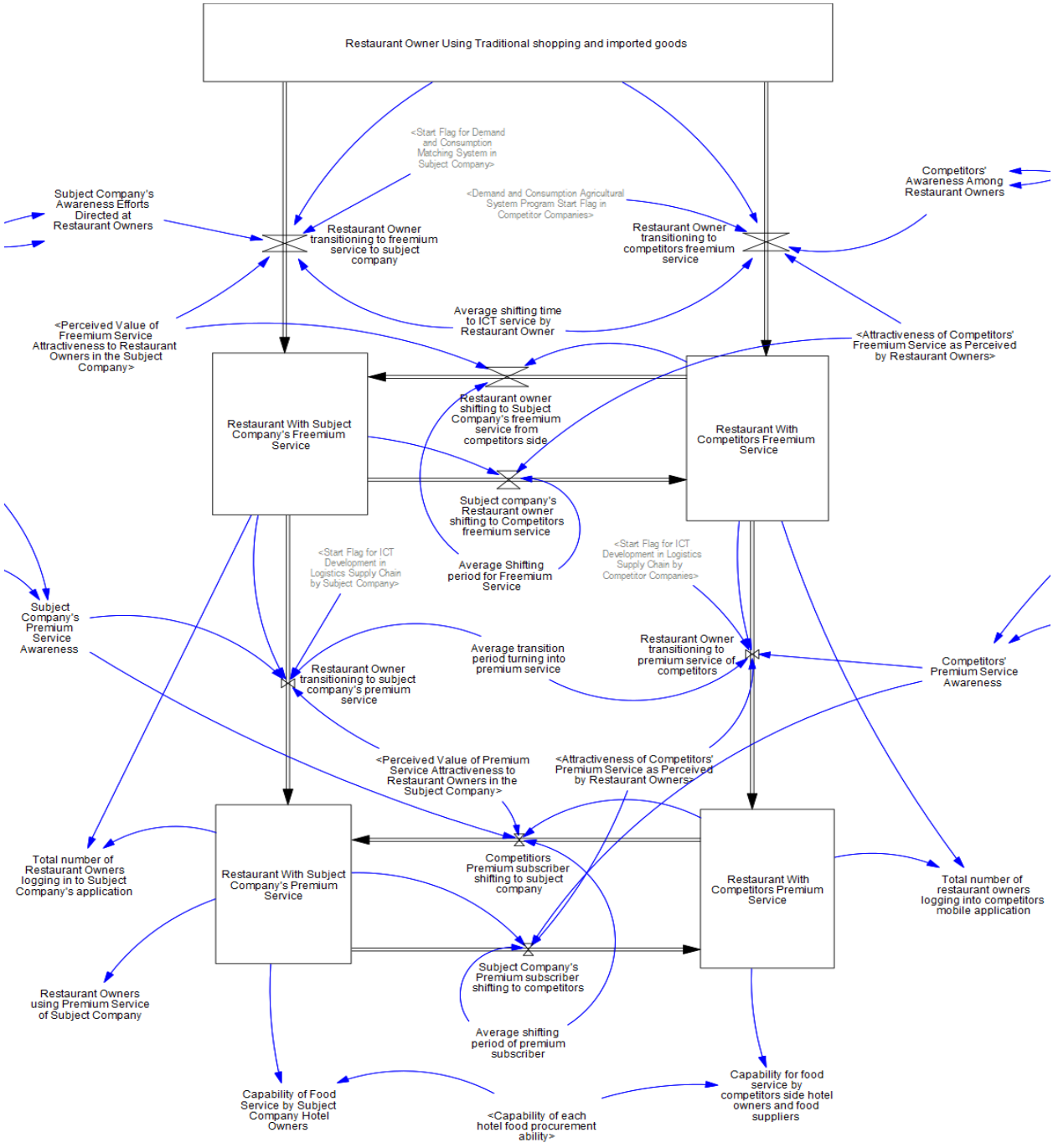


Fig. 10. Diffusion Model of Technology Adoption Among Restaurant Owners: Subject Company Versus Competitor Uptake

Premium conversion is controlled by the "Freemium Customer Transitioning to Premium Service" parameter for each side, while cross-platform switching at the premium level is governed by "Average Switching Time." Adoption is driven by the Subject Company's awareness (freemium and premium) and attractiveness to restaurant owners. As the market matures, competitors introduce similar services, with equivalent systems modeling competitive tension. Monetization follows the free-to-paid conversion path. Overall, the diagram models a two-sided competitive market with switching driven by relative attractiveness and awareness.

4. Result of Step 2: Outcomes of Simulation Experiments

4.1 Farmer side Technology Adoption based on Different Investment Strategy

Two scenarios have been experimented: Scenario A = Investment in ICT System only; Scenario B = Investment on ICT and Modern Agri-Product Agency.

Scenario A involves investment in ICT alone, delivering ICT-enabled supply-demand matching through a mobile application; within this model, the freemium tier — offered free of charge — serves as the fundamental customer acquisition mechanism. Scenario B, by contrast, extends this investment to include collaboration with the Modern Agri-Product Agency (Section 4.2), acquiring the integrated capability to provide technical skills and farming techniques for tourist-favored food and rare cuisine. This expanded offering is classified as the premium tier, charged monthly through a subscription model.

The potential pool of farmers using traditional methods is assumed to be 30,000. Under this condition, the Subject Company's ICT capability acquisition and "start flag" activation begin at month 12, whereas the competitors' start flag activates at month 36, reflecting an imitation time lag. Upon activation of their respective start flags, both the Subject Company and its competitors begin delivering their services within the simulation model.

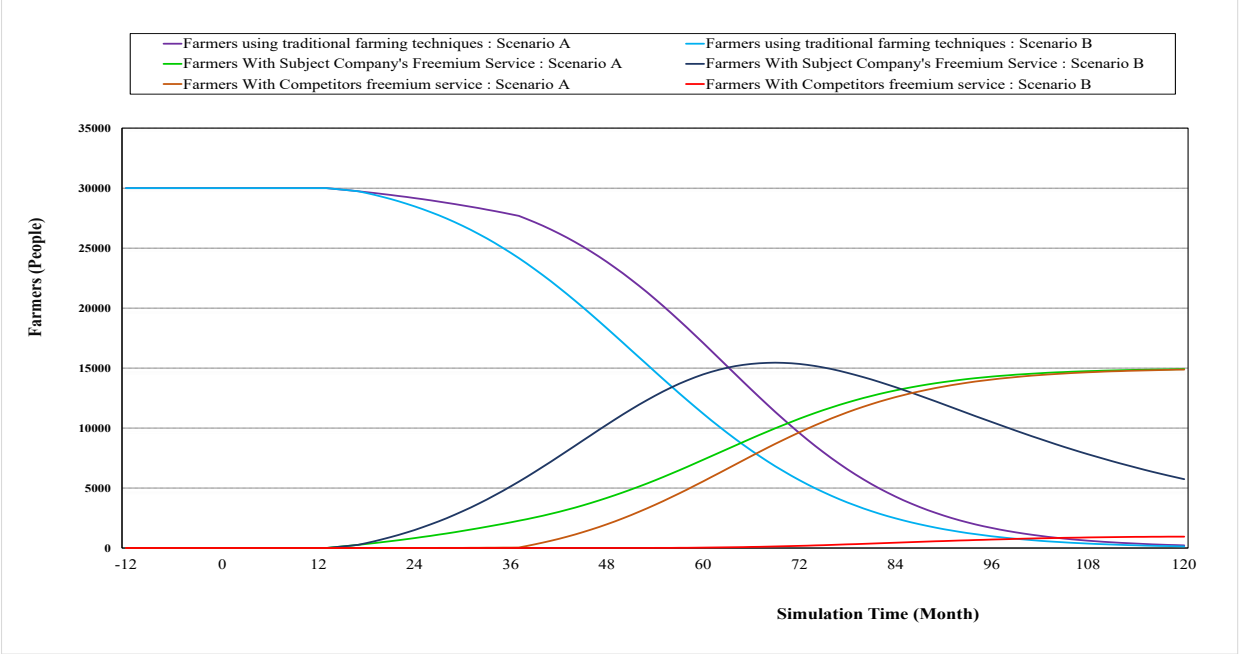


Fig.11. Freemium-based Matching service Adopting Rate by Local Farmers (Subject Comapy vs Competitor)

- **Scenarion A: (Purple / Green/ Orange)**

  As the freemium adoption rate from the Subject Company (green) and competitors (orange) kicks in, the potential farmers (purple) begin to gradually decline. The convergence is roughly 15,000 by month 120, reflecting the slower movement of traditional farming, alongside high competition for farmer acquisition between the Subject Company and its competitors, as the service is free."

- **Scenario B**: **(Blue /Dark navy / Red*)***

  In this scenario, traditional farming collapses fast, and the Subject Company's freemium service (dark navy) wins decisively, peaking at around 15,000 farmers near month 70 — well ahead of the competitor (red), which barely registers 1,000 by month 120. Head-to-head competition persists even though the competitor's ICT system launches three years after the Subject Company's, though freemium customer acquisition drops significantly once the Subject Company activates the integrated service. The freemium tier wins faster and harder due to richer earlier matching data, then declines after its month-70 peak, representing farmers shifting from freemium to the paid premium tier as information asymmetry resolves.

4.2 Matching service adoption by Local farmers based on freemium and premium service with different investments

This chart isolates exactly two stocks that matter for the Subject Company model and removes competitor and traditional-user noise. This is the two-stage adoption pipeline, illustrating the fundamental trade-off in the freemium-to-premium conversion strategy. The red line 'Premium Service: Scenario A' sits flat for all 120 months because nobody upgrades from freemium to premium, as the premium service is not activated in Scenario A.

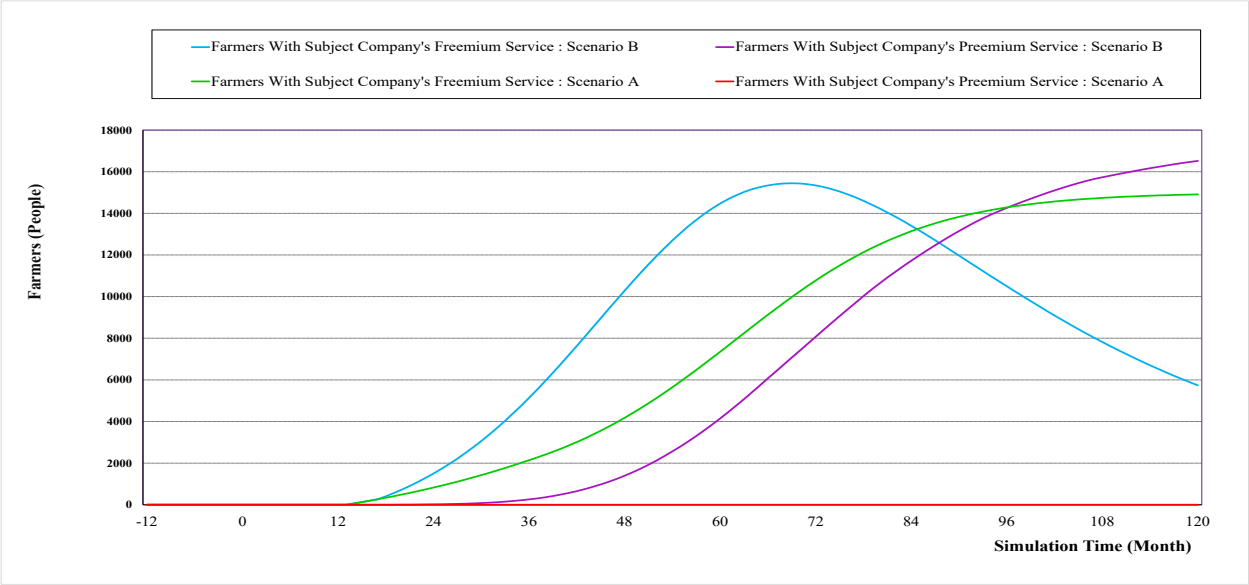


Fig. 12. Freemium and Premium Matching service Adopting Rate by Local Farmers

Scenario B is entirely different from Scenario A. The blue curve rises faster than the green curve, peaks around month 70–72 at 15,000 farmers and then declines steadily to about 5,000 by month 120. Meanwhile, the purple premium curve gradually increases until around month 36, then begins a slow climb because the competitor's premium service is also activated in the model, though not shown in the graph. Even so, the premium service of the Subject Company keeps attracting premium users and comfortably holds the highest value at 16,500 by month 120.

4.3 Matching service adoption by Restaurant Owners based on freemium and premium service with different investments

Two scenarios have been experimented with restaurant owners: Scenario A = Investment in ICT System only; Scenario C = Investment on ICT and the Logistic Supply Chain.

As explained on the farmer's side, Scenario A involves investment in the ICT system alone, delivering the food-availability matching service to restaurant owners via a mobile application, free of charge. By contrast, information on tourist-favored food and rare cuisine, combined with on-time delivery service, is integrated into the premium tier, reflecting Scenario C.

The potential pool of restaurant owners currently importing food is assumed to be 5,000.

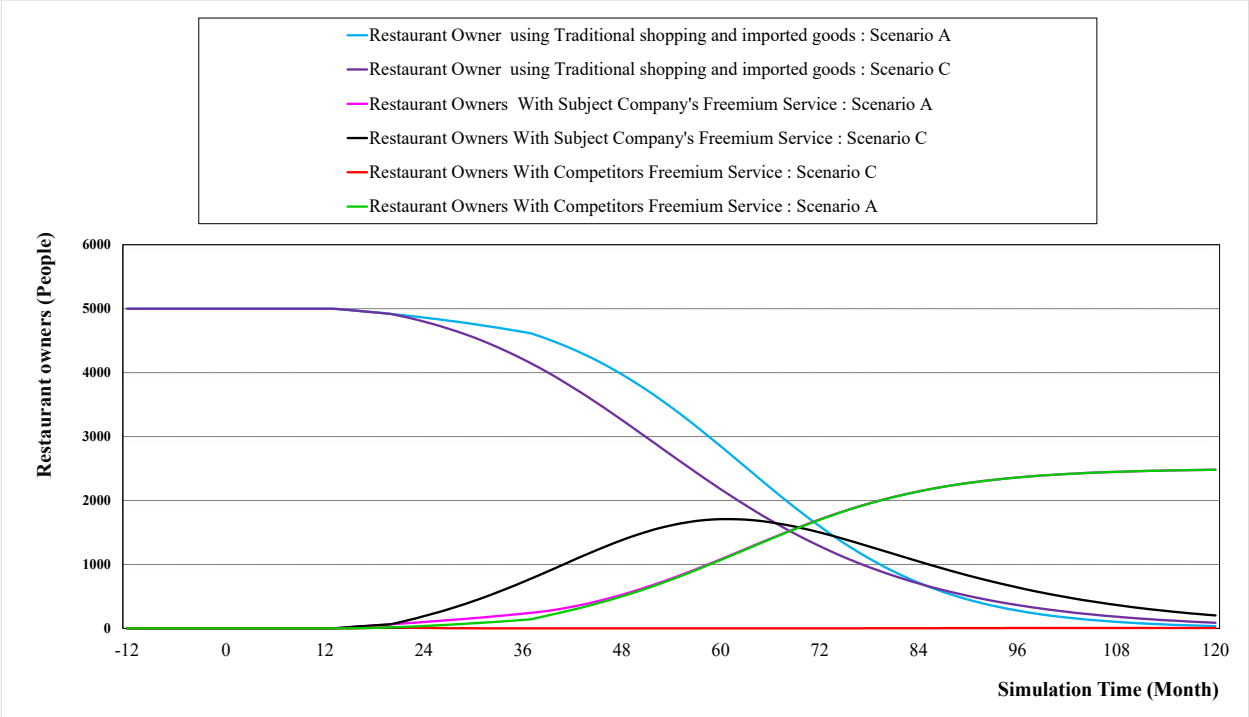


Fig. 13 Freemium-based Matching service Adopting Rate by Restaurant Owners (Subject Comapy vs Competitor)

- **Scenario A : (Blue,Pink,Red)**

Following the activation of the freemium service, traditional restaurants began migrating toward the subject company by the 12th month. By the third year, competitors entered the market, triggering a rapid transition of customers toward both the subject company and its competitors. Given that the service is free, competition intensified significantly — resulting an average rate sustained throughout the 120 months.

- **Scenario C : (Purple, black, Red)**

Following the integrated investment, traditional restaurant owner transitions were 500 higher than under the ICT-investment-only scenario (Scenario A). Freemium service users on the subject company's platform quickly gained momentum, reaching peak acquisition in the 60th month with approximately 800 traditional restaurant users onboard. In contrast, competitors demonstrated significantly lower acquisition rates — negligible when compared to the subject company's performance.

4.4 Matching service adoption by Restaurant Owners based on freemium and premium service with different investments

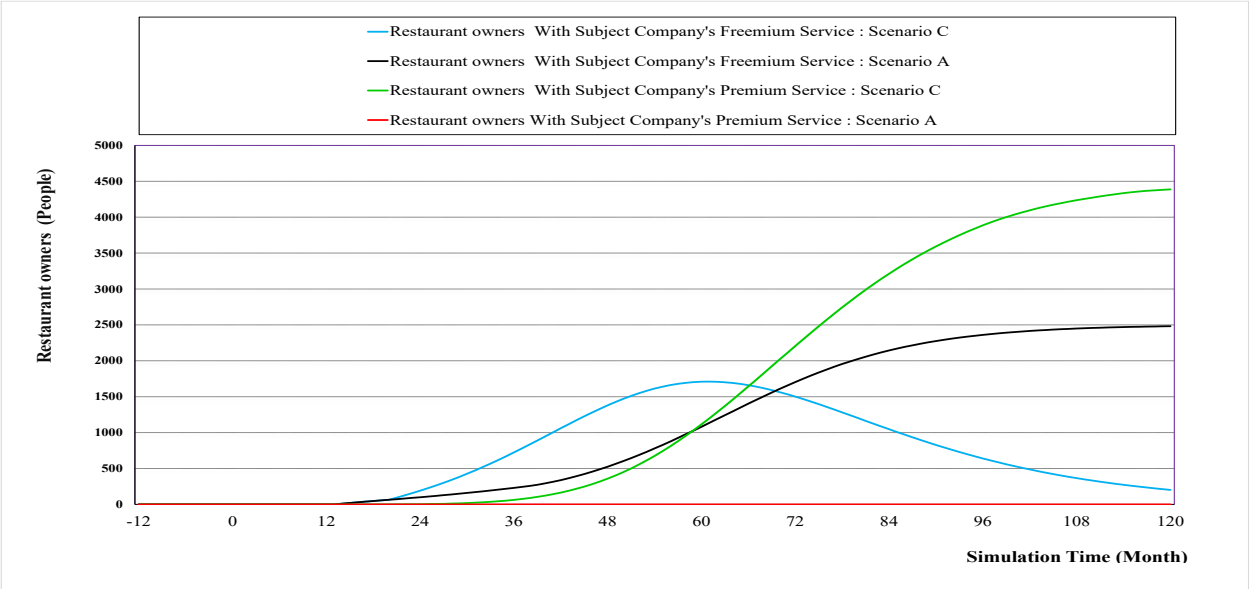


Fig. 14. Freemium and Premium Matching service Adopting Rate by Restaurant Owners

The graph illustrates the simulation of restaurant owner transitions over a 120-month period across four distinct scenarios, comparing the adoption patterns of both Freemium and Premium services under different investment.

- **Scenario C: (Blue Line)**

  Exhibits a classic bell-curve patterns, and the adoption is at approximately 1,800 users around the 60th month. The behavious shows the overshoot and collaspe pattern , suggeting that the users transiton out of the freemium tier- likely upgrading to premium.

- **Scenario A : (Black Line)**

  The adoption follows the similar bell-curve but with a lower and delayed peak of roughly 2200 at 84the month

- **Scenario C : (Green Line)**

  The effect of bell-curved being obeserved on the freemium on scenario C is being clearly transition on the premium tier of scenario C . The growth shows the classic S happed growth to hit the designated target of 5,000 potential restaurant users. Reaching nearly, 4,500 users by the 120th month, shows the successful conversion from freemium to premium driven to integrated services.

- **Scenario A : Red line)**

  Since the premium servie is not activated on the scenario A, there line is flat.

4.5 **Full Life Cycle of Technology Adoption**

Figure 15, illustrates the adoption pathway of local farmers, depicting the complete lifecycle of their engagement with the subject company's model—from initial onboarding through to full integration—once the fully integrated “Scenario D” is activated. This adoption pattern emerges following sustained investment and capability development, with competitive pressure from rival firms factored into the analysis. The corresponding graph has been omitted here to reduce visual congestion.

- **Scenario D: Integrated Investment on ICT + Modern Agri-Product Agency + Logistic Supply Chain**

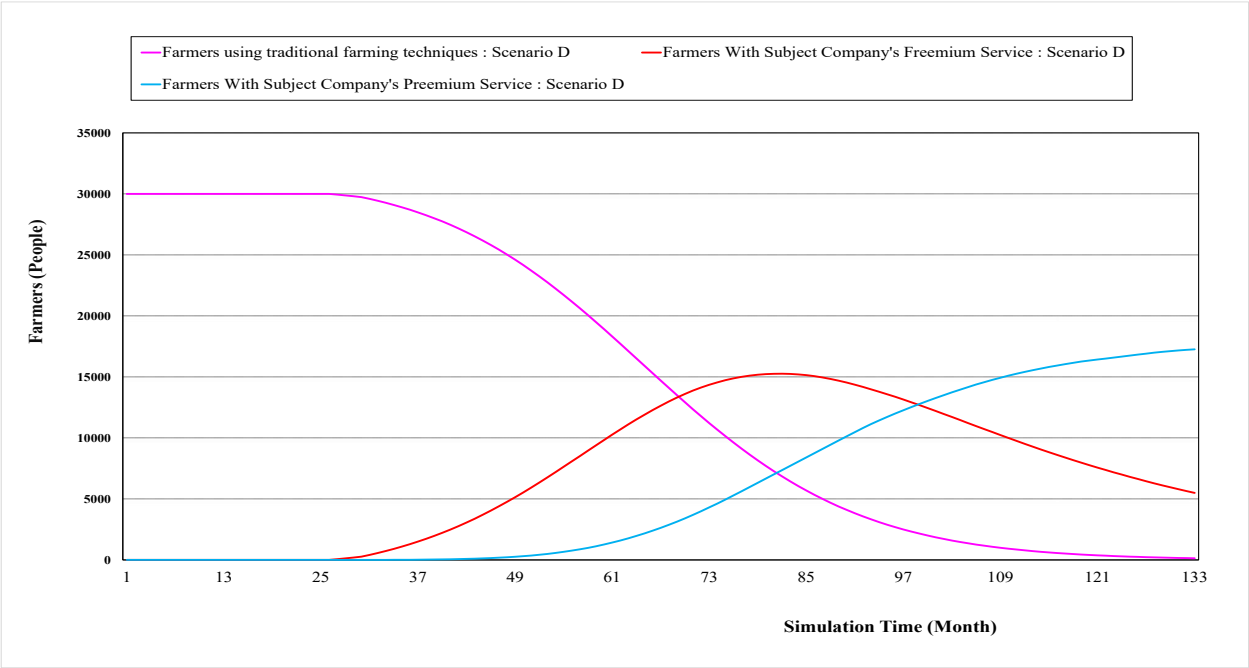


Fig.15. Full Life cycle of the technology adoption of local farmers

Stage One: The Incumbent Baseline (Purple) — Traditional farming holds steady at 30,000, representing a potential market for the first 12–18 months. It then begins eroding, following an S-curve decay pattern, dropping from 30,000 to about 15,000 around months 70–72, and descending toward zero by around months 108–114.

Stage Two: The Funnel (Red) Freemium adoption rises in lockstep with the traditional segment's decline; every farmer leaving "traditional" enters "freemium" on a one-for-one basis in this early window. Freemium users peak at 15,500 around month 70, the point at which the curve intersects the traditional-users line exactly. The subsequent decline does not represent attrition out of the system, but rather a graduation to premium.

Stage Three: The Destination (Blue) Premium users are the ones who will pay the Subject Company — the targeted customers. Premium users remain flat near zero until about month 40, then begin slow growth and climb smoothly all the way to 16,000 by month 120, still trending upward with no sign of having plateaued.

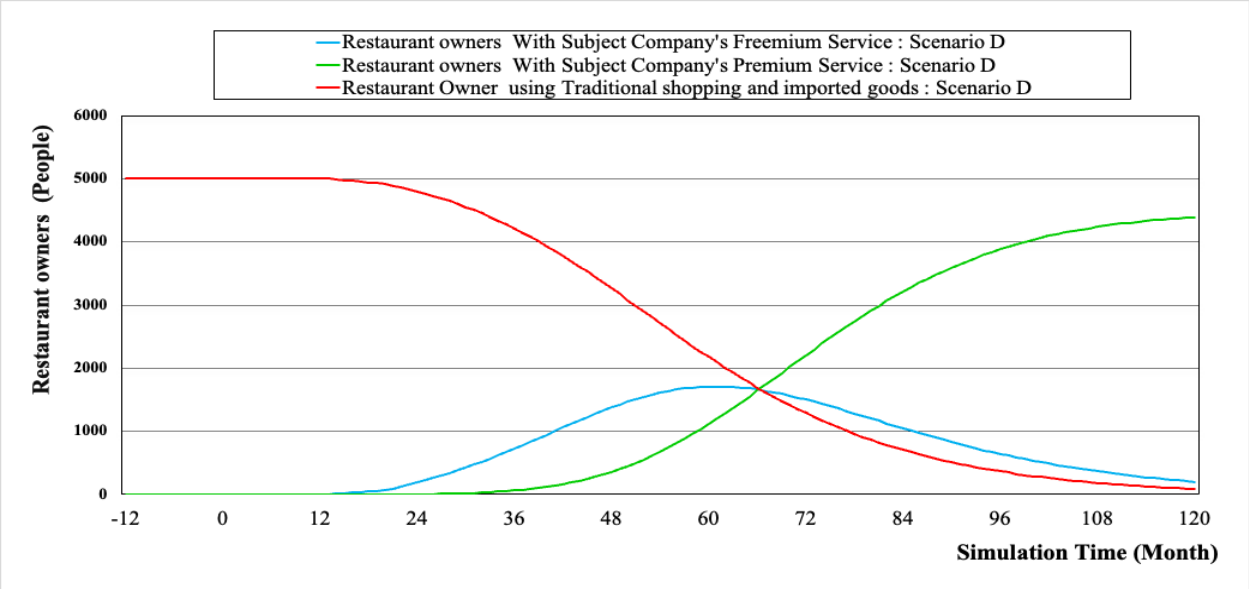


Fig. 16. Full Life cycle of the technology adoption of Restaurant Owners

Stage One — The incumbent baseline (red): With the potential pool of restaurant owners assumed at 5,000, adoption begins quickly following start-flag activation at month 12. A sharp decline follows, representing S-curve decay, with traditional users dropping from 5,000 to approximately 2,000 by month 60.

Stage Two — The funnel (blue): As traditional users decline sharply, freemium adoption rises steadily, reaching approximately 1,800 within three years. Notably, an equilibrium point emerges around month 65, marking the major transition phase among traditional, freemium, and premium users.

Stage Three — The destination (green): Premium conversion takes approximately 18 months to gain traction, after which it accelerates sharply from month 48 onward. By the equilibrium point at month

65, premium users surpass the other two tiers, showing the highest adoption rate. The premium curve approaches near-total dominance, saturating at a maximum of approximately 4,200 customers, while the traditional and freemium curves gradually decline toward zero as the market saturates.

Compared to the farmer's side where the potential adopter pool was 30,000 — the restaurant-owner pool was smaller, at 5,000. Despite competitors entering the market approximately three years later, the Subject Company's early-mover advantage allowed it to capture most of the market before competitive imitation took effect, securing approximately 91% of customer share.

4.6 Internal Investment Mechanism and Return of Investment by the Subject Company

(A) Internal Investment by Subject Company

The figure 17 illustrates the cumulative investment trajectories of the Subject Company across four scenarios (A, B, C, D) over approximately 120 months (10 years), measured in millions of USD. All scenarios originate near zero at month -12 and grow steadily. Scenario A (Red), representing matching service optimization, shows the slowest growth, reaching 0.3 million USD. Scenario C (Blue), reflecting logistic supply chain enhancement, shows moderate growth, reaching 0.5 million USD. Scenario B (Orange), associated with Modern Agri-Production capacity development, achieves above-moderate growth, reaching 0.7 million USD. Scenario D (Green), combining Scenarios A, B, and C, shows the most aggressive growth, reaching the highest cumulative value overall.

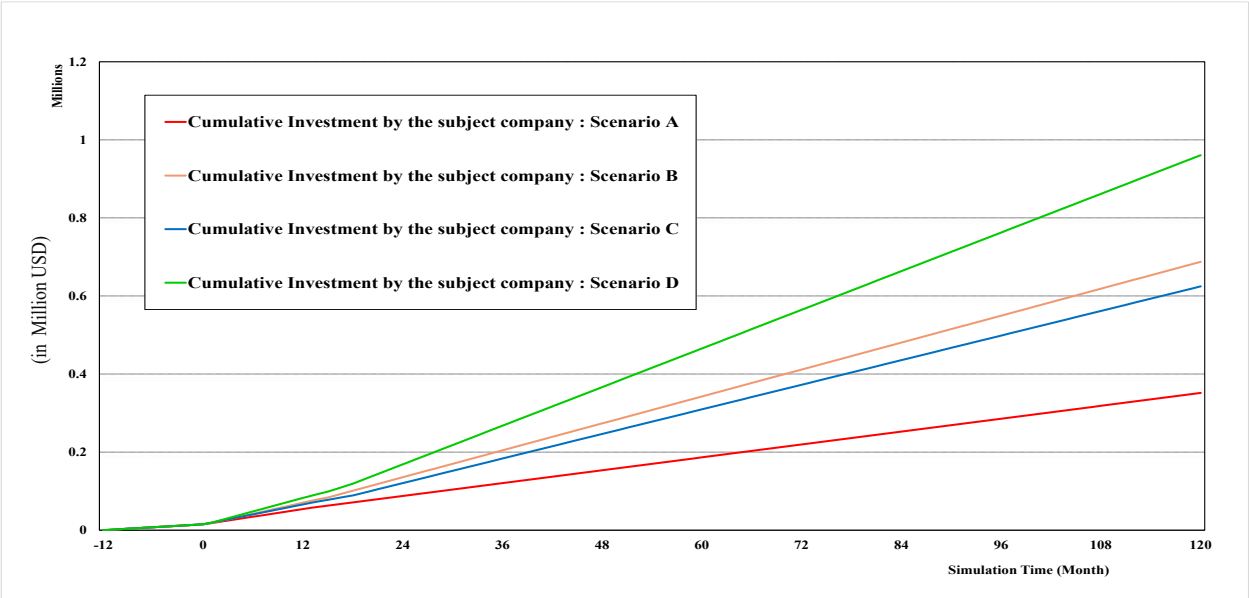


Fig. 17. The cumulative trajectories of the Subject Company across four distinct scenarios (A,B,C and D)

All scenarios follow a linear-to-slightly-curved upward trend, reflecting consistent investment accumulation. The variance across scenarios highlights those different investment strategies that yield significantly different cumulative results over a 10-year period, underscoring the importance of selecting the optimal investment scenario to maximize long-term financial growth.

(B) Return of Investment

Financial Analysis based on the Graph input, shows that the business runs in two users tiers and transaction layer.

Scenario A (Red) shows a negative ROI trajectory while cumulative investment continues rising, reflecting early-phase platform build-out, infrastructure development, and user acquisition — since transaction fees, the primary ROI driver, require matched producer-consumer pairs, and the marketplace remains nascent with free service.

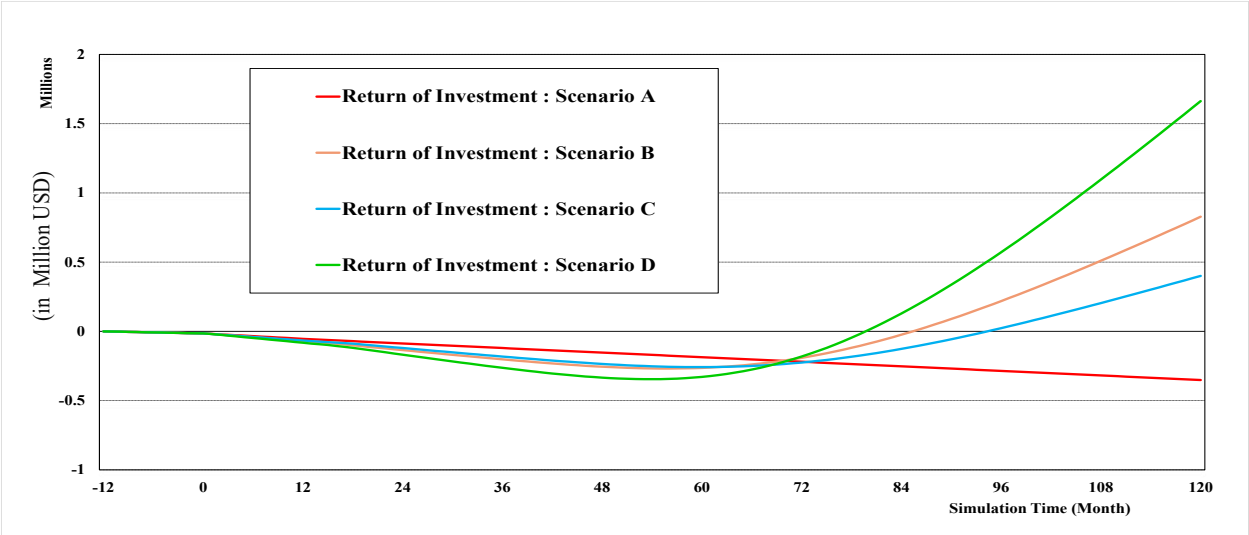


Fig. 18. The Return of Investment trajectories of the Subject Company across four distinct scenarios (A,B,C and D)

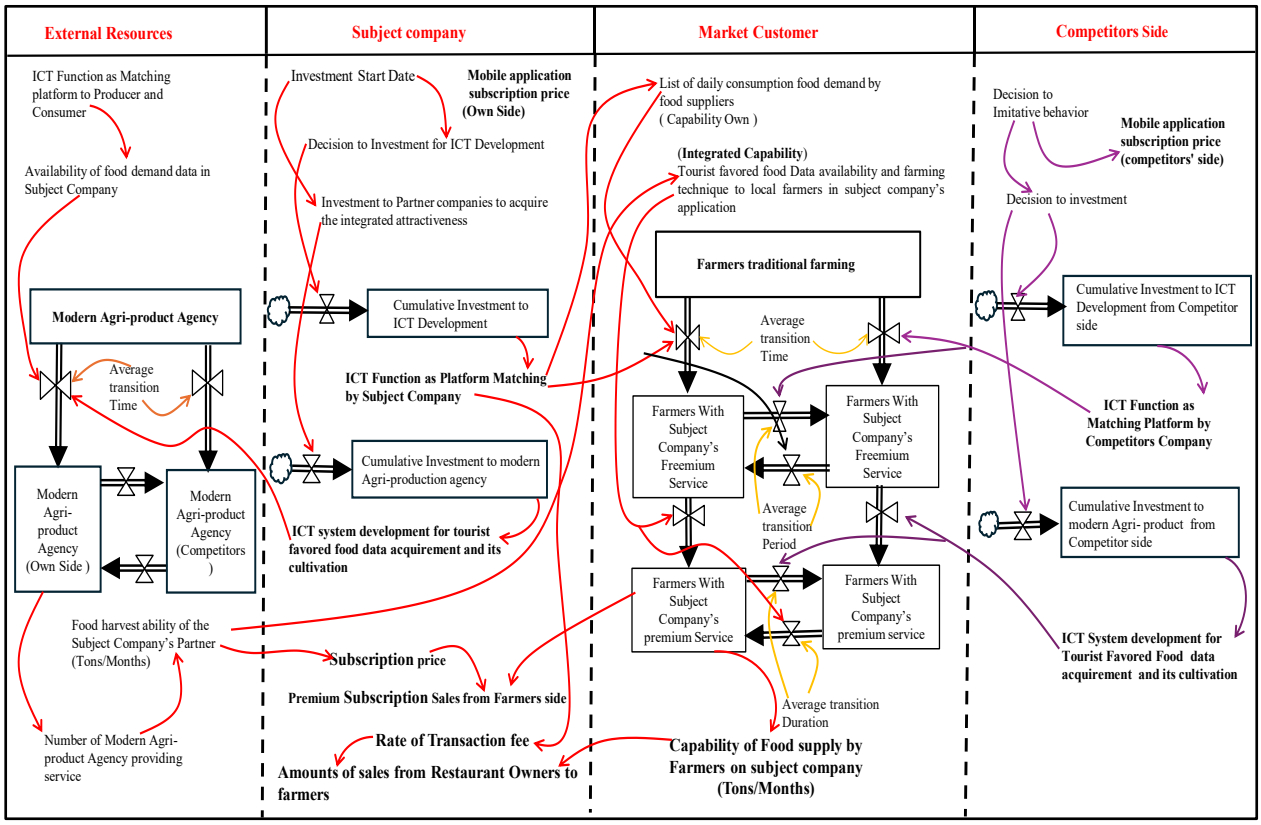
Scenario B (Orange) incorporates a $3 monthly subscription targeting 30,000 potential local farmers; once matching liquidity crosses a critical threshold (months 72–78), the transaction engine activates, reaching a projected cumulative ROI of $0.9 million by month 120 against $0.7 million cumulative investment — a net positive return.

Scenario C (Blue) generates approximately $0.4 million cumulative ROI from a 5,000-strong restaurant-owner base, with a $5 monthly subscription fee. Scenario D (Green), the fully integrated model, consolidates subscription revenues from both farmers and restaurant owners, complemented

by a $0.1/ton transaction fee upon successful matching, yielding the highest cumulative ROI of $1.6 million — validating the strategic superiority of the combined investment scenario.

4.7 Operationalizing the Ecosystem: Decision Logic and Mechanism

Figure 19 reflects how the overall business ecosystem modeling window spans the initiative's full lifecycle — from zero-based planning to decisions for investment, to project development and implementation — incorporating differentiated investment strategies across capability areas and corresponding customer acquisition strategies for technology adoption.



Continuing of the above figure

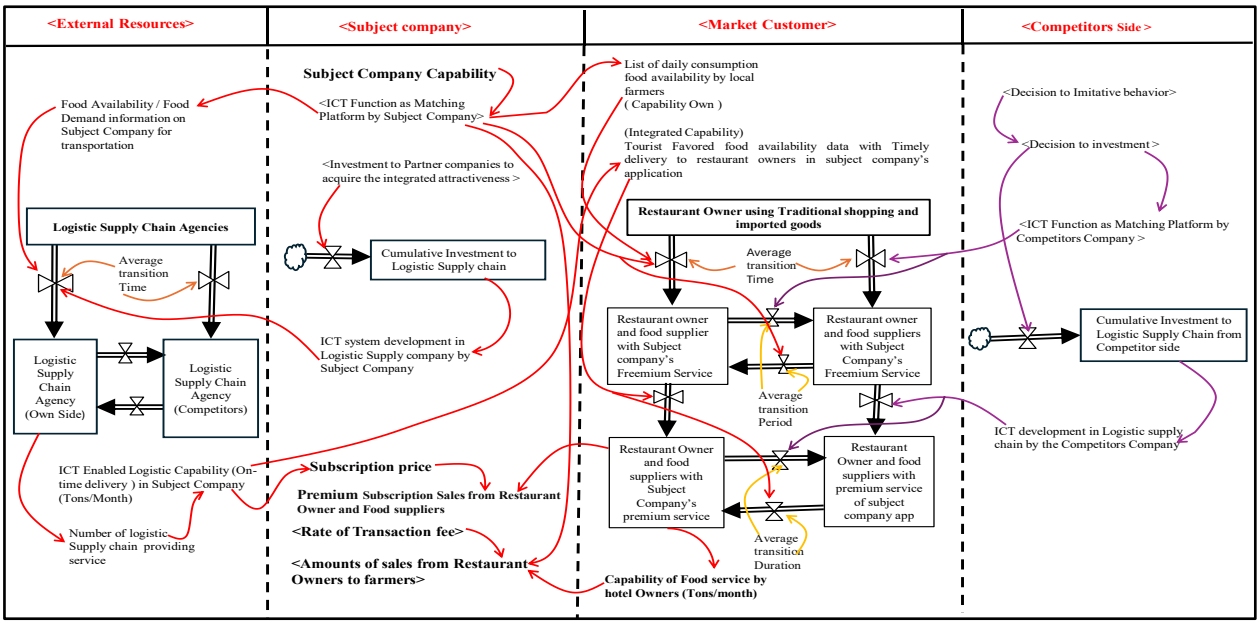


Fig. 19. Linking between mechanisms, markets/customers, and internal corporate mechanisms

The Subject Company operates the ecosystem through four integrated stages. (1) It invests monthly in ICT to build a core matching service, then competes for partnerships with a Modern Agri-Product Agency (supplying tourist-favored products, farmer training, and culinary market intelligence) and a Logistics Supply Chain Agency (enabling real-time, optimized delivery). Sustained investment builds capabilities over time, under the assumption that earlier development yields superior competitive advantage. (2) Competitiveness is assessed across multiple customer-segment axes, benchmarked against competitors, log-transformed, and calibrated via a sigmoid function into a customer appeal value (0–1). (3) Using this appeal score, the company invests in awareness and word-of-mouth to acquire two customer segments — local farmers and restaurant owners — while competitors, modeled with equivalent capability-building logic, enter later through imitation. (4) Value is captured through freemium and premium subscription tiers.

4.8 Food Supply Chain Optimization with Respect to the Subject Company

Based on Nepal Tourism Board data (2026), there was an 89.45% recovery relative to pre-pandemic November 2019 arrivals, with 114,496–116,553 tourists visiting Nepal in 2025. Of these, 40–50% visit Pokhara; assuming 25,000 monthly tourists staying one week with 0.035 tons/person/month food consumption. Similarly, National Statistics Office (2026) data, Kaski/Pokhara shows, approximately 824,000 domestic overnights trips in 2024/2025, representing 5.02% of Nepal's total 16,409 million domestic overnight trips, we assume for that year making it one of the country's leading domestic

tourism destinations not just international tourism destination. Based on that we assume 50,000 monthly arrivals and stays for 3 days, with 0.032 tons/person/month food consumption.

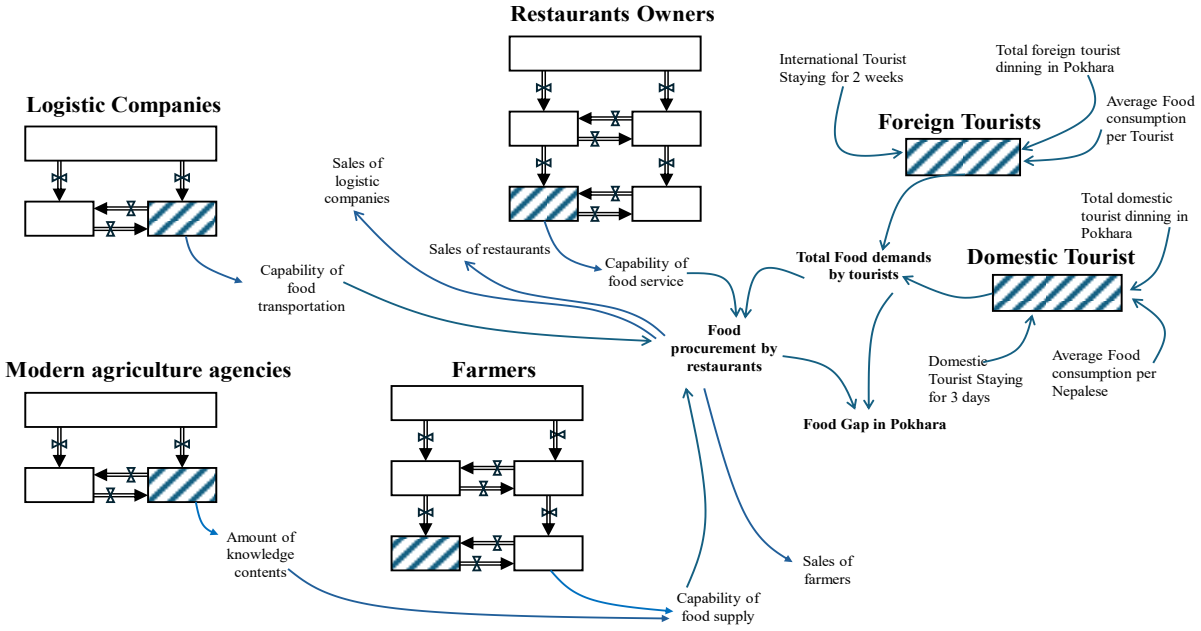


Fig. 20. Supply and Demand Optimization model of the Subject company.

Following successful adoption by production- and consumption-side partners and customers, a bottleneck model grounded in Theory of Constraints was applied to Pokhara's food supply chain in the figure 20. Total demand, farmers' supply, hotel/supplier handling, ICT-enabled logistics, and modern Agri-production support were treated as constraints and simulated over 120 months to identify binding bottlenecks, which is shown in figure 21.

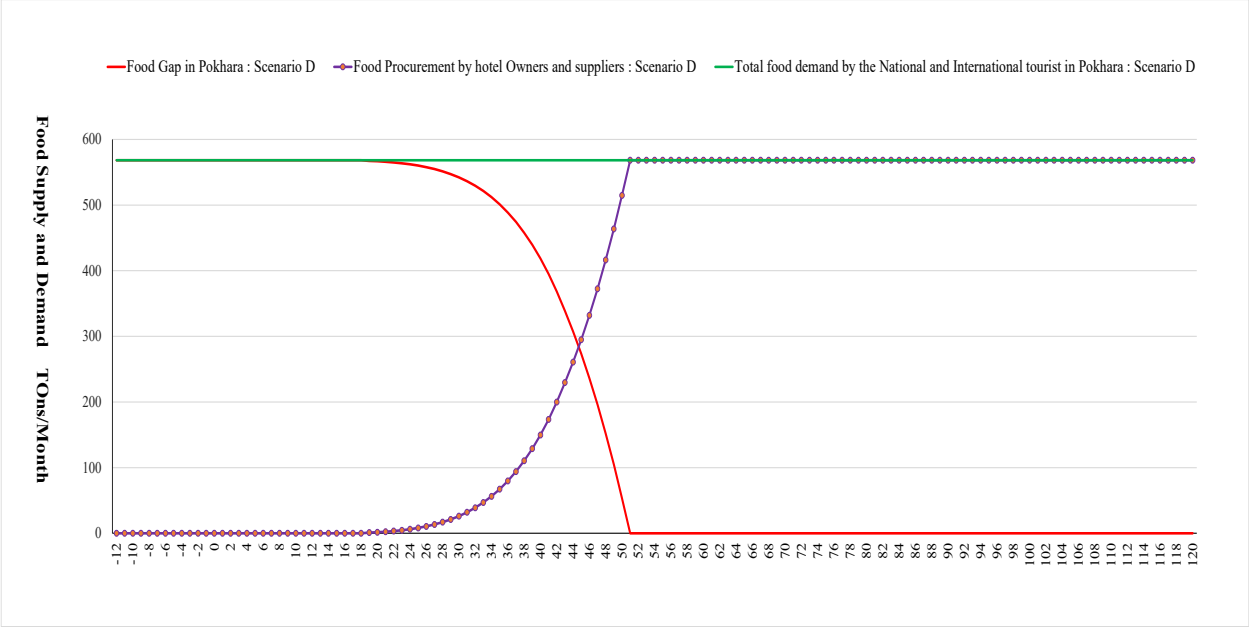


Fig. 21 Supply and Demand Bottleneck Simulation Output

Total Food Demand by National and International Tourists in Pokhara — Scenario D (Purple): Throughout the simulation, this demand remains constant at approximately 570 tons/month. As tourist arrival demand cannot be controlled by the system, it is treated as an exogenous input.

Food Procurement by Hotel Owners and Suppliers — Scenario D (Green): During the early phase, food procurement remains at zero, then begins growing slowly between months 24 and 36, rising in an S-curve to meet demand by approximately month 52, after which it holds flat (fully meeting demand).

Food Gap in Pokhara — Scenario D (Red): Starting at approximately 570, it holds flat until month 20, then declines in an S-curve to zero by month 52.

The graph shows Procurement = Demand − Gap, with each constraint binding at a different phase of supply and demand. Initially, farmer supply, hotel-supplier capability, and ICT logistics are all at zero — capability and matching ability are at stagnation from month 0 to 20. From month 20 to 50, the gap collapses and procurement rise, building the classic S-shaped curve. After month 50, the gap halts at zero — procurement capability has caught up to and matches/exceeds demand.

5 DISCUSSIONS:

By extending Chaudhary et al.'s (2024b) conceptual business model — proposed from zero-base thinking for the transformation of Nepal's agribusiness-tourism-ICT sector and resulting from a series of business analyses conducted to resolve existing social issues such as poverty and unemployment — this study set out to test the feasibility of the conceptual To-Be business model by operationalizing the transformation process through the Kimata framework, using system dynamics simulation.

The constructed To-Be business model shows that Nepal's fragmented agribusiness-tourism-ICT resources become a sustainable economic opportunity only when capability investment — not mere information — resolves segment-specific constraints ecosystem-wide, forming a symbiotic, holistic business solution.

Through this simulation, the platform strategies of customer acquisition and customer monetization are clearly differentiated, reflecting the finding that solving one does not solve the other. In this transformation model, Scenario A — investment in the ICT system only — represents an intentional strategy by the Subject Company: providing a free information service to acquire attention rather than commitment. The only value delivered is data (matching availability and visibility), making the service easy to join and easy to leave at zero cost. The failure of premium conversion in Scenario A is structural: because the freemium service already meets the actual needs of local farmers and restaurant owners, upgrading becomes irrational — which is why revenue never materializes, even though adoption is enormous.

By contrast, Scenarios B and C — segment-specific capability investments — succeed. By investing in Modern Agri-Product Agency capability (B) and Logistics Supply Chain capability (C), each integrated with the ICT core matching function, the Subject Company competes not on information but on capability that a given segment cannot provide independently, because each segment in the Nepalese market faces its own distinct constraints. In the agriculture sector, despite sufficient production capacity for crops, farmers' inability to find customers, access markets, and meet product qualifications for tourist-grade cuisine has curbed production. In the tourism sector, meanwhile, tourism has recovered to 89.45% of pre-pandemic levels, drawing an estimated 114,496–116,553 tourists to Nepal in 2026 — with Pokhara alone attracting half of all international tourists, alongside millions of domestic tourists. This demand forces restaurant owners to import goods and creates a bottleneck in the on-time delivery of specialty goods meeting international standards. Because Scenario C resolves this constraint directly, rather than at a surface level (i.e., through information alone), restaurant owners are willing to pay for the monetary value delivered, extending that value and opportunity to Logistics Supply Chain agencies as well. Based on the theory of complementary asset

alignment and shared value, the Subject Company's investments do not merely benefit its own profitability — they activate value across the broader business ecosystem simultaneously, reinforcing rather than straining the partnership.

Scenario D's superior performance illustrates a deeper platform-strategy principle. Among the four scenarios, Scenario D — reflecting integrated investment across ICT, Modern Agri-Product Agency, and Logistics Supply Chain — produces the most significant technology adoption outcomes, driven by a three-tier transitional system: the incumbent baseline (traditional farming-technique users and restaurant owners relying on traditional shopping and imported goods), the funnel (freemium users), and the destination (premium users trending upward along a classic S-shaped curve).

Beyond the funnel-conversion dynamic, Scenario D's superior adoption rate also reflects the strength of the proposed business model's value-creation strategy — specifically, its Key Partners structure and its clear understanding of each customer segment's distinct needs. Rather than serving a single value proposition to a homogeneous user base, the model creates differentiated value for each stakeholder group: farmers gain reliable market access and demand visibility, restaurant owners gain consistent, quality-assured supply, Modern Agri-Product Agencies gain coordinated production planning, and logistics providers gain predictable delivery volumes. This interdependence produces a symbiotic relationship among stakeholders, in which each actor's participation reinforces the others' incentives to remain engaged, creating a self-reinforcing environment in which the platform's components function seamlessly together.

Another key result, shown in Figure 3.2.1.1-A, is that the platform performs two core functions: acquiring data from local farmers (food availability) and from restaurant owners (food demand, via a POS system linked to the Nepal ICT Corporation, modeled on Seven-Eleven Japan's 1982 system; Chopra, 2017), then aggregating this data through mass-balance stock accounting to generate matched supply-demand orders. Tourist food-preference data is similarly relayed to farmers and Modern Agri-Product Agencies for collaborative production, packaging, and delivery via logistics partners. Despite seven decades of Nepal's food security planning, no prior instrument has operationalized real-time supply-demand matching (NPC & WFP, 2019); the simulation results suggest that this mechanism addresses the Atlas's diagnosed "slow and uneven progress." The bottleneck-model analysis confirms that procurement remained at zero for the first 20 months. By month 52, procurement capability had fully closed the food gap and matched constant tourist demand of approximately 570 tons/month, suggesting that, under Scenario D's assumptions, the supply chain can achieve full self-sufficiency within 4.3 years if the underlying capacity-building trajectory holds.

The revenue architecture itself reflects the same principle underlying Scenario D's adoption advantage. The dual-revenue architecture — transaction fees ($1.10/ton) and subscriptions (~$3–5/month) — mirrors the ecosystem's multi-sided value creation, maximizing adoption while securing a superior cumulative ROI of ~$1.6 million against ~$0.9 million invested, validating capability-based investment as both strategically and commercially sound.

6 CONCLUSION

This study examines the dynamic testing of the To-Be business model conceptually developed in Chaudhary et al. (2024a, 2024b), applying a framework for simulation-based experimentation on business model transformation using system dynamics theory. By moving beyond static and binary approaches to business model transformation, we aim to observe the business dynamics of this transformation within the social context of Nepalese issues such as poverty and unemployment, viewed through a business lens. Through the business model transformation perspectives, this study yields significant theoretical, methodological, and policy implications for Sustainable futures.

6.1 Theoretical contributions:

(Foss & Saebi, 2017; Peñarroya-Farell et al., 2021) highlights the need of tracking how business model change over time. Not just comparing 'As-Is' and 'To-Be' business models, this study builds on the authors' earlier series of analyses — a canvas-based business model proposal later extended into a zero-based theory — to conceptualize transformation as a dynamic, time-based process. Drawing on Sterman's (2000) dynamic systems theory, this study introduces a temporal dimension (months, years) that is typically absent from canvas-based frameworks such as Osterwalder and Pigneur's (2010), as well as from binary frameworks more broadly.

Despite decades of poverty-reduction projects and the Employment Act addressing unemployment, low wages, and damage from the civil war (1996–2006), these efforts have failed to curb high migrant-worker mortality and heavy reliance on imported consumables, as the working-age population continues to leave for foreign employment — never offering a holistic, sustainable solution connecting the whole business ecosystem. This gap is evident across the literature on agriculture (Dhungana, 2022; Atreya et al., 2020; Suvedi et al., 2017; Bhatta et al., 2019; Poudel et al., 2022), tourism (Bennike et al., 2023; Shrestha & Jeong (2016); Tan et al., 2019), and ICT frameworks for agriculture and tourism (Mishra et al., 2023) — a fragmentation that is broadly addressed and synthesized in Chaudhary et al. (2024a).

By proposing a data-driven agriculture system for Nepal, connecting the local availability of quality-assured, timely, tourist-favored cuisines to enhanced restaurant operations, while generating jobs across supply-chain agencies. Growing demand for rare cuisines incentivizes Modern Agri-Product Agencies to develop Nepal's untapped mountainous, hilly, and Terai regions, advancing SDG 12 (Responsible Consumption and Production), while drawing youth into agriculture and supporting SDG 8 (Decent Work and Economic Growth).This study demonstrates that such transformation is achievable, channeling investment into local production as a domestically grounded, simulation-validated alternative to Nepal's cycle of unsustainable labor export. It also offers a theoretical bridge between business model innovation and sustainable development strategy, through value co-creation strategies among business stakeholders in the ecosystem — supporting the United Nations' 2030 Agenda and its pledge to leave no one behind.

6.2 Methodological Contributions

From the methodological point of view, this study contributes to the understanding of the application of Sterman (2000) business dynamic to business model transformation in Agri-tourism industry of developing economics.

This study introduces simulation-based feasibility assessments (system dynamics) as an alternative to purely qualitative or quantitative business model validation in the Nepalese social context. It establishes a business ecosystem operating through value co-creation across four actors — the Subject Company, Modern Agri-Product Agency, Logistics Supply Chain Agency, and end customers — where ICT investment and partnerships build competitiveness, driving both acquisition and value capture through freemium/premium tiers. It advances business ecosystem-based value co-creation theory, showing how value capture (freemium/premium tiers) and competitiveness (via ICT and partnerships) emerge from actor interdependence rather than from a single firm's strategy.

Financially, Scenario D's integrated investment model proves most viable, confirming that combined ICT, agricultural, and logistics investments offer the strongest technological and financial pathway. This bottleneck model shows that Pokhara's tourism food supply chain can achieve full self-sufficiency within 4.3 years (by month 52), as procurement progressively overcomes constraints in farmer supply, hotel/supplier handling, and ICT-enabled logistics to meet constant tourist demand of 570 tons/month.

Beyond financial viability, it eliminates initial food deficits, reduces import reliance, and redirects subsequent oversupply toward local demand and exports — mitigating market volatility and price competition from Indian imports. It operationalizes 'bottleneck' analysis within a business ecosystem

model and demonstrates scenario-based investment strategies (investment in ICT only, investment in ICT and Logistics Supply Chain, investment in ICT and Modern Agri-Product Agency, and an integrated strategy combining all three) as a method for comparative feasibility assessment — offering a template other researchers can adopt to test multi-investment strategies under uncertainty.

6.3 Policy Contribution:

Provides an evidence-based alternative to labor export dependency, directly relevant to Nepal's policy challenge of youth outmigration and remittance-based economics — showing a domestically grounded investment pathway (Scenario D) as a viable substitute.

It offers a quantified timeline (52 months) for self-sufficiency, giving policymakers a concrete planning horizon rather than an abstract recommendation, useful for aligning investment cycles with development targets.

Beyond financial viability, it eliminates initial food deficits, reduces import reliance, and redirects subsequent oversupply toward local demand and exports — mitigating market volatility and price competition from Indian imports. It operationalizes 'bottleneck' analysis within a business ecosystem model, highlighting market-protection implications relevant for trade and agricultural policy design for Nepal's rural farmers.

7. Limitation and Future Research

While the simulation results offer compelling evidence for the feasibility of an integrated ICT-enabled agriculture-tourism model, this study is not without limitations, each of which points toward a concrete direction for future work.

The present study is simulation-based; the societal impacts projected by Scenario D — including farmer adoption, restaurant participation, and supply chain self-sufficiency — have not been validated through field deployment. The model's parameters were calibrated using secondary data obtained from government sources, including agricultural, tourism statistics, food demand, food consumption, and food production of Nepal. Future research should therefore pursue a phased pilot implementation, beginning with a limited rollout in Pokhara and Dang, incorporating pre- and post-intervention measurement of farmer income, restaurant procurement patterns, and supply chain reliability.

In addition, the model was prototyped using only two specific production and consumption locations under a minimal-investment scenario. A data-driven agricultural system remains one of the most critical assets in which Nepal must invest at a national level; however, extending this model beyond Pokhara would require explicitly identifying and testing the structural preconditions — including market access, logistics density, and digital connectivity — under which the model's assumptions would continue to hold.

Availability of data and materials: The simulation model built in Vensim software will be available upon request.

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