Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6, 2553-2567
2025
Publisher: Learning Gate
DOI: 10.55214/25768484.v9i6.8432

Simulating value co-creation in digital agri-food platforms: An agent-based model of consumer–producer interaction in the organic vegetable market

Neneng Kartika Rini[1*], Yosini Deliana[2], Kunto Adi Wibowo[3], Lucyana Trimo[4], Iwan Setiawan[5], Reny Sukmawani[6], Sunu Widianto[7], Eliana Wulandari[8]
[1]Department of Agricultural Science, Faculty of Agriculture, Universitas Padjadjaran, Indonesia; Neneng21001@mail.unpad.ac.id (N.K.R.).
[1]Agribusiness, Faculty of Agriculture, Universitas Muhammadiyah Sukabumi, Indonesia.
[2,4,5]Department of Agribusiness, Faculty of Agriculture, Universitas Padjadjaran, Indonesia; y.deliana@gmail.com (Y.D.) Lucy.trimo@gmail.com (L.T.) i.setiawan@unpad.ac.id (I.S.)
[3]Department of Communication Science, Faculty of Communication, Universitas Padjadjaran, Indonesia; kuntoadi@gmail.com (K.A.W.).
[6]Department of Agribusiness, Faculty of Agriculture, Universitas Muhammadiyah Sukabumi, Indonesia; renysukmawani@ummi.ac.id (R.S.).
[7]Department of Management, Faculty of Economics and Business, Universitas Padjadjaran, Indonesia; suni.widianto@unpad.ac.id (S.W.).
[8]Department of Agribusiness, Faculty of Agriculture, Universitas Padjadjaran, Indonesia; eliana.wulandari@unpad.ac.id (E.W.).

Abstract: This study explores how value co-creation (VCC) mechanisms shape consumer and producer engagement on digital platforms for organic vegetables using an Agent-Based Modelling (ABM) approach. It addresses key challenges such as trust issues, price sensitivity, and limited consumer participation. A virtual simulation was developed in NetLogo with diverse agents, including millennials, baby boomers, and organic producers, interacting across five scenarios: baseline, full VCC integration, high price sensitivity, trust shock, and enhanced co-learning. The model incorporates key dimensions of value co-creation, including co-design, co-learning, co-process, and co-service. Results indicate that full VCC integration enhances satisfaction, producer retention, and platform loyalty, with co-learning emerging as the most effective mechanism under difficult conditions. Although trust disruptions and price concerns negatively affect system behavior, adaptive platform features help reduce these impacts. Patterns such as behavioral convergence and reinforcing feedback loops were observed, underscoring the role of the platform as an adaptive facilitator. The study contributes to value co-creation theory in digital food markets and demonstrates the value of ABM in agricultural digital research. Practical implications include recommendations for participatory design features and strategies to strengthen trust. This research supports sustainable agriculture by offering a scalable framework for inclusive and resilient digital ecosystems.

Keywords: *Agent-based modelling, Consumer engagement, Digital platform, Organic vegetables, Simulation, Value co-creation.*

1. Introduction

The increasing demand for organic food reflects a global shift toward health-conscious and environmentally sustainable consumption. In Indonesia, this trend is evident in the steady expansion of organic farming areas and the diversification of organic products, particularly vegetables. According to the David and Ardiansyah [1] organic vegetable demand surged during the COVID-19 pandemic, highlighting consumer concerns regarding nutrition, food safety, and immunity. However, despite

History: Received: 17 April 2025; Revised: 16 June 2025; Accepted: 20 June 2025; Published: 28 June 2025
* Correspondence: Neneng21001@mail.unpad.ac.id

growing interest, challenges persist in aligning supply and demand, ensuring quality consistency, and establishing sustainable market access for organic producers.

Marketing channels for organic vegetables in Indonesia are still dominated by conventional intermediaries or fragmented digital efforts. Platforms aiming to connect producers and consumers directly through digital means often struggle with low engagement, uneven adoption, and unclear value propositions [2]. These inefficiencies are compounded by a lack of value co-creation between producers and consumers, where consumer feedback, co-design, and knowledge sharing remain underutilized.

Value co-creation is increasingly recognized in marketing theory as a means of enhancing service relevance, consumer loyalty, and sustainable interaction. In the Service-Dominant Logic framework, value is co-created through dynamic interactions between producers and consumers rather than being delivered unilaterally [3]. However, in the context of organic agriculture, empirical research on how co-learning, co-service, and co-design affect consumer behaviour and producer strategies remains limited [4]. Existing studies have mostly focused on consumers' willingness to pay for organic products or their perception of health benefits [5, 6] with few examining the interplay of digital platforms and collaborative value creation in organic vegetable marketing.

Moreover, conventional research methodologies, such as regression or structural equation modelling, offer limited explanatory power when addressing complex and adaptive behaviours in the agri-food sector. These models typically assume equilibrium and linearity, which restricts their ability to capture decentralized decision-making, feedback loops, and emergent patterns [7]. In contrast, Agent-Based Modelling (ABM) provides a robust framework to simulate heterogeneous agents interacting within a system, each driven by distinct preferences, resources, and behavioural rules. ABM has been applied in agriculture to model adoption of precision technologies [8] food security dynamics [9] and responses to climate change [10]. However, its application in modelling stakeholder behaviour in organic vegetable platforms, particularly integrating value co-creation principles, remains underexplored.

This study seeks to fill this gap by developing an ABM framework to simulate the decision-making behaviours of organic vegetable producers and consumers in Indonesia. The model incorporates variables such as profit expectations, certification visibility, platform usability, and value co-creation mechanisms. By simulating interactions under different market conditions, the study aims to evaluate the effectiveness of digital marketing platforms in promoting sustainable Business to Consumer (B2C) transactions. The findings are expected to offer theoretical contributions to service marketing literature and practical insights for the development of inclusive, participatory, and resilient organic food systems.

2. Theoretical Background

2.1. Digital Platforms in Agricultural Marketing

Digital platforms are increasingly seen as vital tools for connecting producers and consumers, reducing transaction costs, and improving transparency in agriculture. In developing countries, they enable inclusive agribusiness by offering access to information, logistics, and finance [11]. Platforms like e-commerce, mobile trading apps, and social commerce allow farmers to bypass intermediaries, increasing income and building trust through traceability and direct feedback.

However, in Indonesia, platform adoption remains limited. Many small-scale producers face digital literacy gaps, poor rural connectivity, and insufficient institutional support [12]. On the consumer side, lack of usability, unclear certifications, and limited farming transparency hinder retention and engagement.

Organic food platforms require even higher trust due to consumer demand for information on pesticide use, harvesting practices, and certification. Platforms lacking these features often lose credibility, especially among health-conscious groups like Millennials [13]. Without interactive and engaging features, platforms remain transactional, failing to cultivate loyalty or value co-creation.

Recent studies advocate for participatory design, including traceability tools, storytelling, and peer interaction [12, 14, 15]. Yet, most platforms still rely on top-down models, limiting user agency.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

Moving toward co-creative, transparent platforms is essential for scaling digital agriculture in Indonesia's organic sector.

2.2. Value Co-Creation in Service and Agricultural Contexts

Value co-creation (VCC) has emerged as a central concept in contemporary marketing and service management literature, redefining how organizations engage consumers in the development and delivery of products and services. Rooted in the Service-Dominant (S-D) Logic proposed by Simanjuntak [16] co-creation views value not as embedded in the product itself but as co-developed through active interactions between service providers and beneficiaries. This perspective shifts the focus from transactional exchanges to relational and experiential processes where consumers, as resource integrators, contribute to the creation of personalized and contextualized value.

In the context of agri-food systems, VCC is particularly relevant given the rising demand for transparency, traceability, and participatory consumption. Consumers of organic products increasingly seek assurance not only about safety and quality but also about ethical sourcing, environmental impact, and farmer well-being. These expectations require more than one-way communication; they demand mechanisms that allow consumers to participate in co-designing, co-evaluating, and co-experiencing agricultural offerings [17, 18]. Such mechanisms may include feedback systems, joint product innovation, farm-to-table experiences, and educational content that bridges producers' knowledge with consumers' preferences.

Despite its theoretical robustness, the application of VCC in the agricultural domain remains limited and under-theorized. Most empirical studies have focused on manufacturing or service sectors such as hospitality, healthcare, and retail [19, 20]. In agriculture, VCC has been explored through case studies of community-supported agriculture (CSA), participatory guarantee systems (PGS), and direct-to-consumer (DTC) marketing, yet these are often informal and lack digital integration [17]. In developing countries like Indonesia, the institutionalization of co-creation processes in digital platforms for organic food remains at an early stage, constrained by platform design limitations, producer capacities, and consumer awareness gaps.

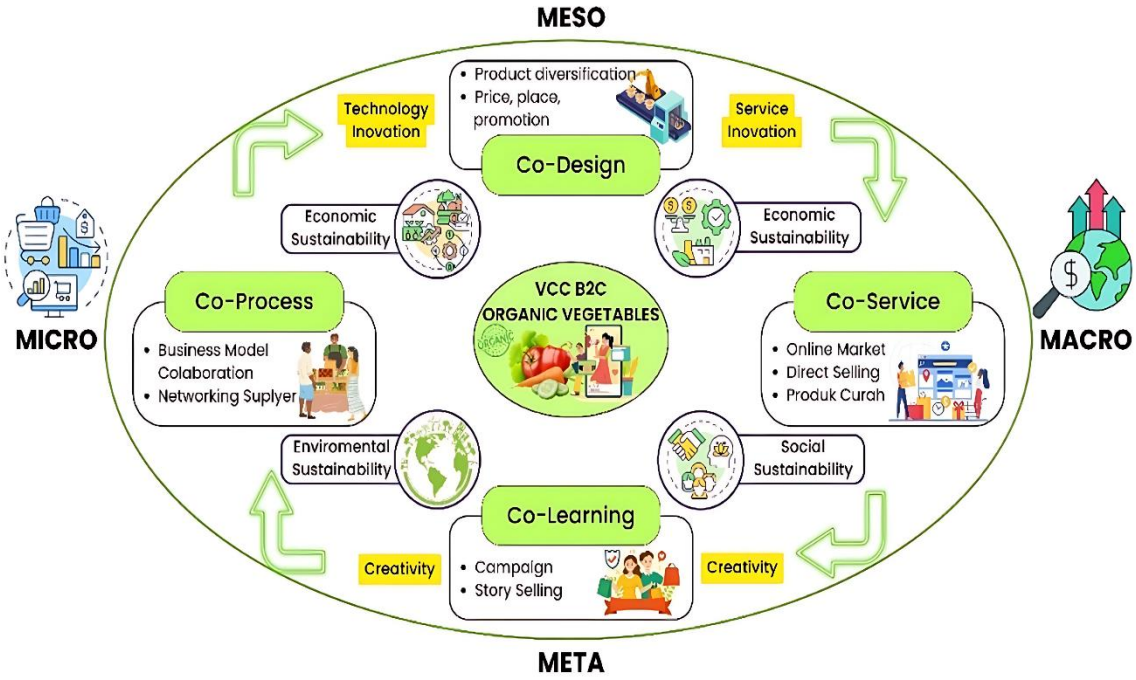

Figure 1.
VCC B2C Platform Model for Organic Vegetables.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

Four main dimensions of co-creation are particularly relevant to agri-digital platforms (see figure 1): co-design, co-learning, co-service, and co-process. Co-design refers to consumers contributing ideas or preferences in shaping products, such as choosing vegetable bundles or packaging types. Co-learning emphasizes mutual knowledge sharing, for instance, where farmers educate consumers about organic practices while consumers offer feedback on cooking preferences or price expectations. Co-service involves collaborative participation in service delivery, including joint promotion efforts or loyalty-building programs. Finally, co-process relates to the involvement of consumers in the transaction and delivery stages, such as selecting delivery windows or coordinating local pick-up points. Each of these dimensions contributes to building deeper engagement, personalized experiences, and long-term loyalty [21, 22].

Recent research has also emphasized the importance of digital affordances in enabling value co-creation. Adnan, et al. [21] argue that platforms must be intentionally designed to support customer participation through features such as interactive dashboards, review systems, and personalization algorithms. Without such design, attempts at co-creation may remain superficial or inaccessible to key user segments. Moreover, co-creation outcomes are influenced by individual differences such as digital literacy, trust orientation, and generational preferences. For instance, Millennials may be more responsive to social engagement features, while older consumers may prioritize credibility and usability.

In summary, the concept of value co-creation holds significant potential for transforming the relationship between organic vegetable producers and consumers. However, realizing this potential requires thoughtful integration of co-creation principles into platform design, user engagement strategies, and supply chain coordination. Empirical studies that examine how these mechanisms operate in real-world agricultural platforms, particularly in emerging markets, remain scarce. This study aims to address this gap by incorporating co-creation dimensions into an Agent-Based Model to simulate and analyse their effects on platform performance and stakeholder behaviour.

2.3. Consumer Behaviour Toward Organic Products

Consumer behaviour is pivotal in shaping effective marketing strategies for organic food. Unlike conventional purchases, organic buying decisions are driven by health concerns, environmental values, and ethical considerations rather than price alone [21]. Health consciousness remains a dominant motivator, with organic vegetables perceived as safer and more nutritious [23]. Concerns about pesticides and environmental impact also influence preferences [24]. However, this often leads to the "attitude–behaviour gap," where intentions fail to result in actual purchases.

In Indonesia, trust in certification is a major determinant of willingness to pay. Consumers are wary of inconsistent labelling and unclear certification schemes [25]. Demographics also play a role, Millennials prefer digital features and peer reviews, while older consumers value product reliability and institutional credibility [25].

Digital trust is increasingly important, with online reviews, traceability, and platform design influencing purchase decisions [25, 26]. Price remains a barrier, especially when benefits are not clearly communicated. Integrating co-creation and transparency into platforms can enhance perceived value and consumer loyalty across segments.

2.4. Agent-Based Modelling (ABM) in Agricultural Research

Agent-Based Modelling (ABM) has emerged as a valuable methodological tool for analysing complex systems composed of heterogeneous and interacting agents. Unlike traditional analytical models, which often assume linearity and homogeneity, ABM enables researchers to capture the dynamic behaviours, adaptations, and interactions of individual agents over time and space [27, 28]. In agriculture, where farmers, consumers, and intermediaries operate under varied constraints and incentives, ABM offers a flexible and realistic framework to simulate market behaviour, technology adoption, and environmental responses.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

ABM has been widely adopted in agricultural economics, especially for modelling decision-making under uncertainty, land use change, resource management, and innovation diffusion [29, 30]. In recent years, it has also been used to examine the adoption of precision agriculture, the effects of climate change on cropping patterns, and the impact of subsidies on farming behaviour [28, 31]. These applications highlight ABM's strength in reflecting non-linear feedback loops, emergent phenomena, and adaptive learning, all of which are prevalent in agri-food systems.

In the context of digital platform usage in agriculture, ABM remains underutilized despite its potential. Platforms that connect producers and consumers involve diverse user types with varying levels of trust, digital literacy, price sensitivity, and responsiveness to marketing strategies. These differences can significantly influence platform success, yet they are difficult to model through conventional techniques such as regression analysis or structural equation modelling. ABM can bridge this gap by simulating how individual agents such as organic farmers, Millennial consumers, or platform operators make decisions based on rules, preferences, and interactions with others in a dynamic environment [32].

Previous studies using ABM in food systems have demonstrated its utility in testing policy scenarios, analysing market interventions, and predicting behavioural changes. For example, Tummers and Bakker [28] modelled the diffusion of agroecological practices among farmers based on peer influence and institutional incentives. Similarly, Tummers and Bakker [28] employed ABM to simulate shallot farmers' market behaviour under government intervention schemes, capturing price dynamics, crop cycles, and input access. These studies illustrate how ABM can incorporate real-world heterogeneity and evaluate the effectiveness of strategic interventions in agricultural ecosystems.

Despite its advantages, few studies have applied ABM to model consumer-producer interactions in the organic sector, particularly within digital platforms that include value co-creation mechanisms. Most existing ABM applications in agriculture remain focused on production-side issues, such as technology adoption or environmental response, with limited attention to marketing systems, trust-building, and consumer engagement. Given the growing complexity of platform-based markets and the importance of participatory behaviour, ABM offers a promising approach to simulate co-creation processes and assess their impact on market outcomes.

This study contributes to the literature by integrating ABM with service marketing concepts to model a digital platform for organic vegetables in Indonesia. The model incorporates agents with distinct attributes, including health awareness, certification trust, price tolerance, and responsiveness to co-creation mechanisms such as co-design and co-learning. By simulating various market scenarios and behavioural dynamics, the ABM framework developed in this research provides a novel lens to understand how platform design and user heterogeneity influence adoption rates, market participation, and long-term platform sustainability.

3. Methodology

This study applies a simulation-based research design using Agent-Based Modelling (ABM) to explore how digital platform features particularly value co-creation (VCC) mechanisms shape consumer–producer behaviour in the organic vegetable market. ABM is appropriate for modelling decentralized and heterogeneous actors, enabling dynamic analysis of interactions, feedback loops, and emergent outcomes in complex environments [28].

The simulation environment represents a digital platform where two main agent types, consumers and producers interact under varying conditions. Consumer agents are characterized by health consciousness, price sensitivity, trust in certification, digital literacy, and preference for co-creation. Producer agents possess attributes including price strategy, certification status, production capacity, and responsiveness to feedback. These agents engage in decision-making activities such as matchmaking, purchase selection, co-creation participation, and feedback exchange.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

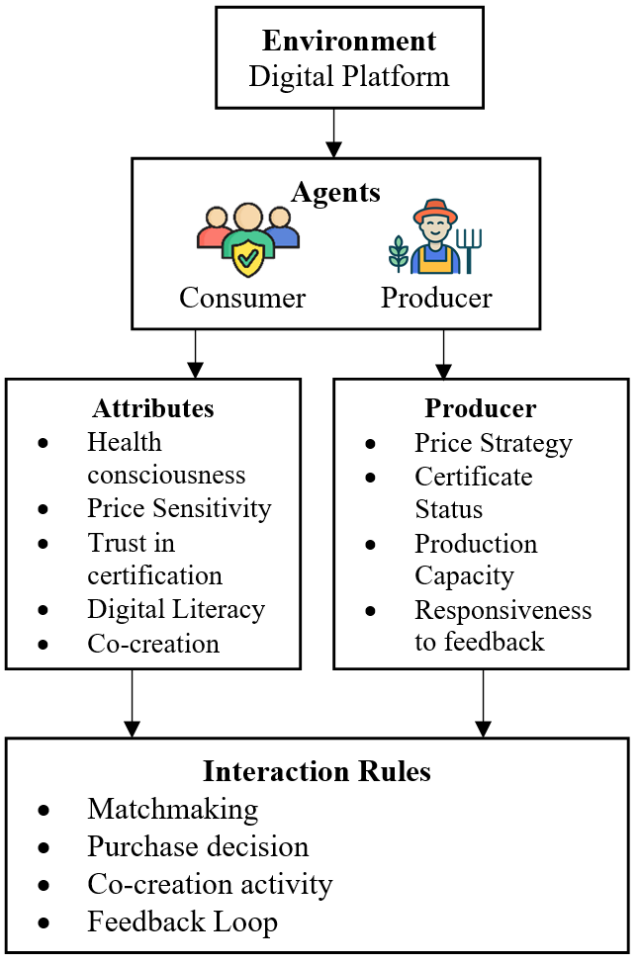

Figure 2.
ABM Architecture and Interaction Design.

Figure 2 illustrates the architecture of the model, which is constructed in NetLogo. Agents are governed by rule-based logic and probabilistic functions to simulate realistic behavioural patterns. Scenarios include five platform configurations: a baseline with no co-creation, full VCC integration, high price sensitivity, trust shock, and enhanced co-learning. Each is simulated for 100-time steps with 10 replications.

Model parameters are informed by existing literature and empirical observations. Calibration uses published estimates on trust thresholds, engagement rates, and retention behaviours. Where empirical data is unavailable, expert opinion and trial-and-error are applied to refine assumptions.

Validation follows a two-step process: internal logic verification using NetLogo tools, and external face validation by three agricultural platform experts. Sensitivity tests are conducted to assess model robustness across key inputs like trust level and co-creation frequency.

The model outputs include key performance indicators: consumer satisfaction, producer retention, co-creation frequency, platform loyalty, and engagement rates. These metrics allow comparison across scenarios to evaluate which digital platform strategies most effectively support value co-creation and sustainability in the Indonesian organic vegetable market.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

4. Result

4.1. Simulation Scenarios

To explore the impact of value co-creation features and contextual variables on consumer-producer interactions within a digital platform for organic vegetables, five simulation scenarios were developed (see Table 1). Each scenario reflects a distinct platform condition by varying the activation of VCC mechanisms, consumer behaviour parameters, and trust levels.

Table 1.
Scenario Description and Key Input Settings.

Scenario	Description	Key Input Settings
Baseline	Simulation without any value co-creation features; agents operate in a standard transactional mode	VCC = 0; Trust = normal; Price Sensitivity = medium
Full VCC Integration	All four VCC mechanisms (co-design, co-learning, co-process, co-service) are activated simultaneously	VCC = full (design, learning, process, service); Trust = normal
High Price Sensitivity	Consumers' price sensitivity is increased significantly, reducing willingness to purchase higher-priced items	VCC = full; Price Sensitivity = high (0.9); Trust = normal
Trust Shock	Consumer trust in certification is lowered, simulating misinformation or certification failure	VCC = full; Trust = low (0.2); Certification = ignored
Enhanced Co-learning	The co-learning feature is amplified to reflect greater knowledge sharing between producers and consumers	VCC = high on co-learning (value = 95); Others = standard

The baseline scenario simulates the platform without any value co-creation activities. Agents interact purely on price and availability, representing a transactional model where feedback and collaborative engagement are absent. The second scenario, full VCC integration, introduces all four value co-creation mechanisms, co-design, co-learning, co-process, and co-service simultaneously. This condition allows for maximum interaction between agents and reflects an ideal participatory environment.

In the high price sensitivity scenario, consumers are modelled with stronger aversion to price, significantly impacting their willingness to engage with more expensive organic products. This reflects market segments where affordability remains a dominant constraint. The trust shock scenario simulates a sudden decline in consumer trust in certification schemes, representing real-world issues such as misinformation or regulatory failures. Finally, the enhanced co-learning scenario increases the influence of knowledge-sharing activities, reflecting an environment where educational content and awareness campaigns play a prominent role in platform engagement.

These scenarios were designed to test both isolated and combined effects of behaviour parameters and platform design features. The next sections will present the results of these simulations, focusing on system-level outcomes such as satisfaction, retention, engagement, and VCC effectiveness across different market conditions.

4.2. Agent Dynamics and Interaction Patterns

The agent-based simulations revealed distinct interaction patterns among heterogeneous consumers and producers operating within the digital platform. Two consumer segments, millennials and baby boomers exhibited divergent behaviours based on health consciousness, digital literacy, trust levels, and value co-creation preferences. Millennials, with higher digital fluency and stronger inclination toward co-learning and co-design, consistently demonstrated greater engagement and retention across all scenarios. In contrast, baby boomers, characterized by lower digital familiarity and stronger reliance on certification trust, displayed more conservative behaviours, particularly in the trust shock scenario.

Producer agents responded adaptively to consumer feedback. Those with responsive pricing strategies, visible certification, and openness to co-design were more likely to retain consumer interest and maintain interaction cycles. Notably, producers who participated actively in co-service (e.g., logistics feedback) and co-learning (e.g., product information sharing) tended to experience higher levels

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

of consumer satisfaction and repeat interactions, especially under the full VCC and enhanced co-learning scenarios.

Across all scenarios, the platform functioned as an evolving interaction ecosystem rather than a static transaction space. Agent decisions were governed by trust thresholds, satisfaction updates, and probabilistic logic, which led to the emergence of stable engagement loops over time. The interface visualization in Figure 3 illustrates the dynamic interaction between agents, where green and blue nodes represent consumer types, and brown nodes represent producers. The simulation captured behaviours such as agent churn, matching frequency, and satisfaction clustering, critical indicators for platform sustainability.

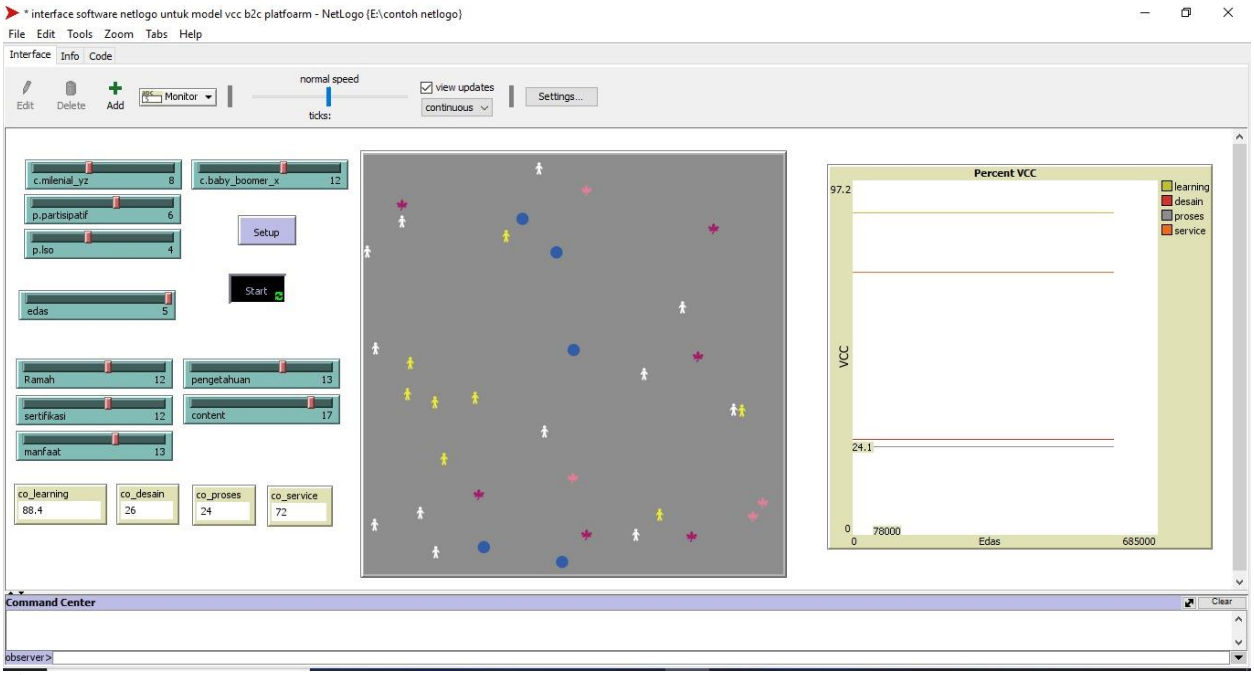

Figure 3.
Agent Movement and Interaction.

Figure 3 also shows how spatial distribution and interaction density evolved differently depending on the scenario. In the full VCC condition, agent clusters were denser and more sustained, while in the trust shock scenario, agent dispersion and drop-out rates were visibly higher. These visual patterns confirm the role of trust and co-creation in shaping system behaviour and indicate that the presence of robust feedback mechanisms reinforces long-term engagement.

4.3. Impact of Value Co-Creation Features

The results demonstrate that the integration of value co-creation (VCC) mechanisms significantly enhanced both consumer and producer outcomes on the digital platform. As shown in Table 2, the full VCC integration scenario achieved the highest levels of consumer satisfaction (0.83), producer retention (0.88), engagement frequency (0.91), and platform loyalty (0.86). This highlights the critical role of participatory features such as co-design, co-learning, and co-service in fostering meaningful interaction and system resilience.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

Table 2.
Summary of Simulation Outcomes Across Scenarios.

Scenario	Avg. Consumer Satisfaction	Avg. Producer Retention	VCC Engagement	Platform Loyalty
Baseline	0.58	0.62	0.00	0.54
Full VCC Integration	0.83	0.88	0.91	0.86
High Price Sensitivity	0.64	0.57	0.69	0.60
Trust Shock	0.49	0.45	0.48	0.42
Enhanced Co-learning	0.79	0.82	0.87	0.81

By contrast, the baseline scenario, which lacked co-creation features, resulted in lower satisfaction (0.58) and weaker retention and loyalty metrics. The limited feedback loops and transactional nature of this scenario restricted consumer engagement, leading to greater volatility in platform usage.

In the trust shock scenario, where consumer confidence in certification was artificially reduced, outcomes dropped across all dimensions. Consumer satisfaction fell to 0.49, and producer retention decreased to 0.45. This decline illustrates the fragility of digital ecosystems in the absence of institutional trust, affirming that trust-building is not just a behavioural driver but a structural necessity in platform design.

The enhanced co-learning scenario approached the performance levels of full VCC integration, especially in consumer satisfaction (0.79) and engagement frequency (0.87), suggesting that knowledge-sharing mechanisms alone can play a substantial role in improving user experience. This is particularly relevant in the context of organic agriculture, where consumer education is crucial for informed decision-making.

Visual confirmation of these dynamics is presented in Figure 4, which illustrates the interface simulation outputs. The figure highlights how VCC-rich environments produce denser interaction clusters and higher agent engagement, whereas scenarios with limited trust or high price sensitivity display scattered participation and increased churn.

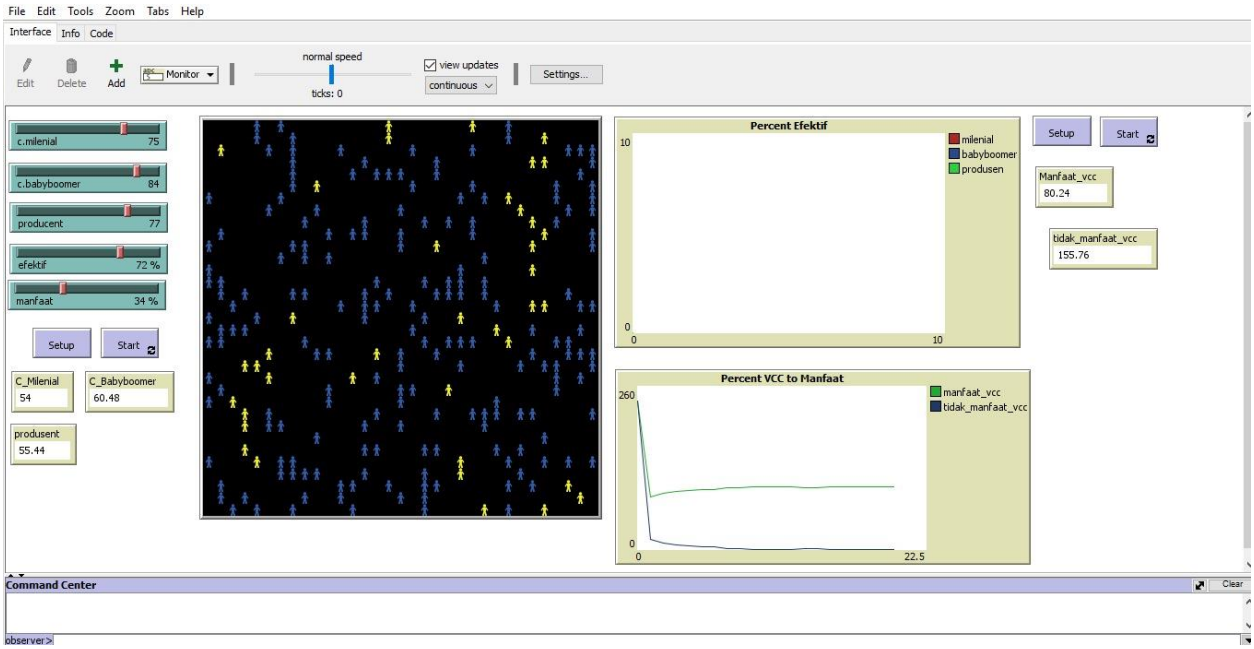

Figure 4.
Simulation Interface Displaying Agent Interaction and vcc

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

Collectively, these findings confirm that embedding multiple VCC features into platform architecture not only supports individual agent behaviour but also enhances system-level outcomes such as retention, satisfaction, and loyalty.

4.4. Effectiveness under Different Market Condition

This section evaluates the resilience and comparative strength of each value co-creation (VCC) strategy under varying levels of market uncertainty. Two market stressors, trust shocks and price sensitivity were introduced to assess how VCC design features withstand adverse conditions (Table 3).

Table 3.
Effectiveness Metrics per Scenario.

Scenario	Effectiveness Score (%)	Resilience to Trust Shock	Resilience to Price Sensitivity	Most Beneficial VCC Dimension
Baseline	52	Low	Medium	None
Full VCC Integration	91	High	High	All
High Price Sensitivity	67	Medium	Low	Co-design
Trust Shock	45	Very Low	Medium	Co-process
Enhanced Co-learning	87	High	High	Co-learning

In the trust shock scenario, consumer engagement and producer retention declined significantly, confirming that diminished institutional trust erodes platform performance. Even with all VCC features present, effectiveness dropped to 45%, highlighting the foundational role of trust in sustaining co-creation dynamics. Similarly, high price sensitivity affected outcomes by decreasing consumer satisfaction and loyalty, although the platform maintained moderate engagement through value co-design and learning, achieving 67% effectiveness.

The full VCC integration scenario delivered the highest overall effectiveness (91%) across all measured dimensions. This condition confirms that integrating multiple co-creation mechanisms (co-learning, co-design, co-process, and co-service) creates a robust feedback system that drives sustained satisfaction and engagement even under moderate stress. In contrast, the baseline scenario, with no co-creation features, achieved only 52% effectiveness, primarily due to the absence of user-driven interaction loops.

Notably, the enhanced co-learning scenario demonstrated strong resilience (87% effectiveness), suggesting that consumer-producer knowledge exchange is a particularly influential dimension of VCC. This finding aligns with prior literature emphasizing the role of learning in trust formation and product satisfaction.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

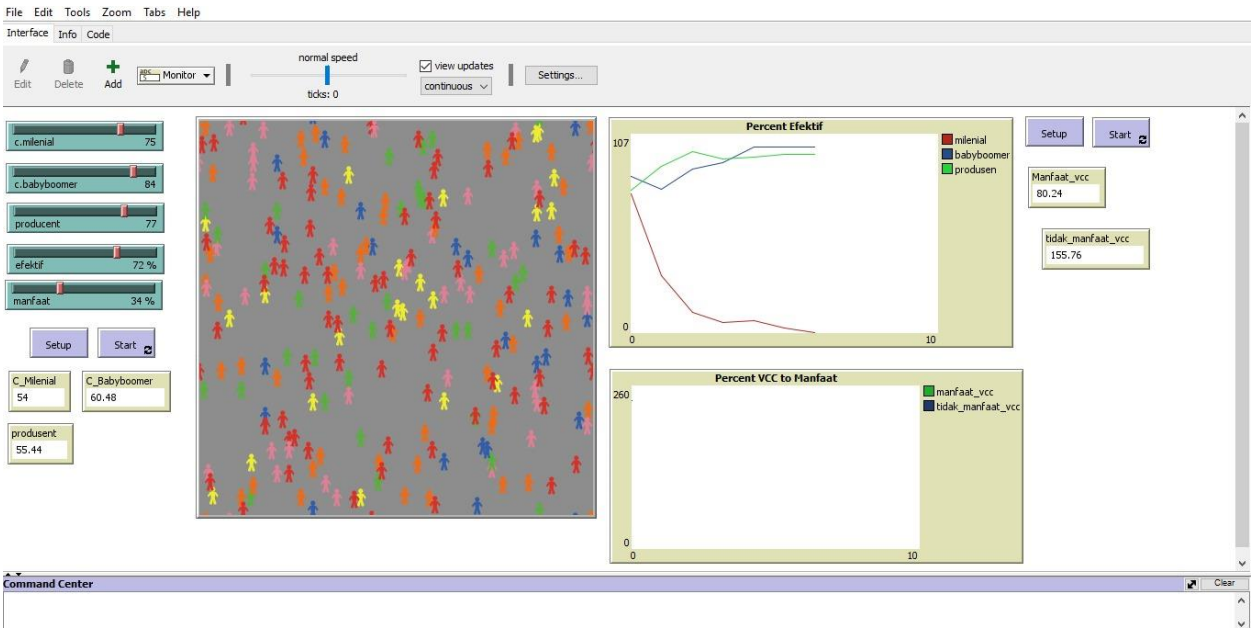

Figure 5.
Percent Effectiveness of Platform Outcomes by Scenario.

As illustrated in Figure 5, VCC-rich scenarios consistently outperform minimal-intervention conditions, confirming the robustness of co-creation strategies in uncertain markets.

4.5. Emergent Pattern and System Behaviour

The agent-based simulations revealed several emergent behaviours that were not explicitly programmed into the system but arose from repeated local interactions between agents. One of the most notable trends was behavioural convergence, particularly in scenarios with strong co-creation components. Over multiple time steps, consumers who initially showed low trust gradually aligned their behaviour with more engaged peers, especially when exposed to consistent co-learning interactions and visible producer responsiveness. This convergence led to a stabilization of satisfaction scores and reduced churn, indicating the presence of self-organizing dynamics within the platform ecosystem.

Another emergent pattern was the reinforcing feedback loop between co-creation participation and platform loyalty. Consumers who participated in co-design or knowledge-sharing activities reported higher satisfaction levels, which in turn increased the probability of repeated engagement. This cycle created a compounding effect, where producer agents, in response to positive feedback, adjusted their strategies to become more collaborative and responsive. Over time, this mutual reinforcement between agent roles enhanced overall system efficiency and cohesion.

The platform agent, conceptualized as an adaptive facilitator rather than a passive infrastructure, played a vital role in guiding these dynamics. By managing visibility of feedback, adjusting co-creation incentives, and moderating trust signals (such as certification labels), the platform influenced the speed and direction of behavioural convergence. In high-trust environments, the platform acted as an enabler, while in volatile settings such as the trust shock scenario, it became a stabilizer dampening agent uncertainty through reassurance mechanisms like rating systems or curated producer highlights.

These emergent properties suggest that the success of agri-digital ecosystems depends not only on individual agent behaviour but also on the adaptive capacity of the platform as a dynamic orchestrator. Recognizing and designing for such systemic behaviours can greatly enhance resilience, engagement, and equitable participation across the value chain.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

4.6. Theoretical Integration and Literature Comparison

The findings of this study offer several points of alignment and departure from existing literature, thereby contributing to both the theoretical development of value co-creation and the methodological application of Agent-Based Modelling (ABM) in agri-digital contexts.

First, the observed role of co-learning, co-design, and co-process mechanisms in enhancing satisfaction and engagement reinforces the foundational principles of service-dominant logic articulated by Tummers and Bakker [28]. Their assertion that value is co-created through interaction within service ecosystems is directly reflected in the emergent feedback loops and behaviour convergence patterns observed in this study. Notably, this research extends their logic by demonstrating that co-creation not only generates value but also contributes to adaptive system resilience, particularly under market shocks such as trust decline or price sensitivity.

Second, the study resonates with Weretecki [33] who emphasized digital co-creation engagement as a multi-actor, iterative process influenced by user participation, interface design, and contextual dynamics. The simulated platform confirmed that co-creation does not occur in isolation but is deeply embedded in the design architecture of the digital environment. Our findings suggest that engagement grows not linearly but through complex interdependencies between agents, reinforcing the view that digital platforms must actively curate co-creation affordances to sustain interaction quality.

Third, from a methodological standpoint, this research contributes to the growing literature on ABM applications in agriculture. While Ravaioli, et al. [34] employed ABM to simulate land use decisions and Chemeris, et al. [35] explored farmer adaptation under subsidy shifts, the current study shifts focus to the consumer–producer interface within digital platforms. By simulating feedback-driven engagement patterns, our model introduces behavioural nuances often omitted in macro-level agricultural simulations, thus filling a methodological gap in ABM literature.

Theoretically, the study contributes to the refinement of value co-creation theory in digital food markets, especially in emerging economies. Unlike conventional co-creation studies that assume a stable institutional environment, this study demonstrates how co-creation remains effective even under uncertainty, provided that platform-level design features are robust and trust mechanisms are adaptive. This positions value co-creation not only as a marketing strategy but also as a resilience-building tool in digitally mediated food systems.

Finally, the integration of co-creation theory and ABM methodology provides a novel interdisciplinary bridge between service science and agri-digital innovation. It highlights the importance of bottom-up simulations in capturing the lived complexity of stakeholder behaviour, reinforcing the need for theory-informed yet empirically grounded modelling approaches in future agricultural platform research.

4.7. Practical Implications

The study offers concrete strategic guidance for platform developers, agri-tech entrepreneurs, and policymakers working to enhance digital ecosystems in the organic agriculture sector. One key takeaway is the critical role of co-creation features particularly co-learning and co-design in improving platform engagement, satisfaction, and loyalty. These mechanisms should be embedded early in platform development, not treated as add-ons. For instance, co-learning modules can be prioritized for younger, digitally literate consumers such as millennials and Gen Z users, who respond positively to interactive educational experiences. In contrast, trust-building features, including transparent certification and user reviews, are especially important for older users like baby boomers who tend to be more risk-averse.

From a system design perspective, the platform interface should support agent segmentation, enabling customized user journeys based on behavioural profiles. Integrating dashboards that display visible trust signals, producer responsiveness, and past engagement metrics can boost transparency and increase repeat usage. Additionally, implementing robust feedback mechanisms such as consumer ratings that influence producer visibility can reinforce positive behaviour and co-creation over time. For

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

policymakers, these findings suggest that public incentives and regulatory frameworks should support participatory innovation, invest in digital literacy programs for farmers, and ensure certification credibility to build trust at scale.

5. Limitations and Future Directions

While the agent-based model provides valuable insights into behavioural dynamics on digital agri-platforms, several limitations must be acknowledged. First, the model adopts stylized agent behaviours and simplified decision rules to represent consumer and producer actions. These abstractions, while useful for simulation, may not fully capture the diversity of motivations and cultural contexts present in real-world settings. Second, although parameter calibration relied on literature and expert input, the absence of primary empirical data introduces uncertainty into some assumptions, such as trust thresholds or price sensitivity coefficients.

Future research can address these limitations by conducting empirical validation studies, where simulation results are compared with field data or experimental findings. Additionally, future models could incorporate AI-enhanced agent rules, such as reinforcement learning or adaptive heuristics, to simulate more realistic decision-making processes over time. Region-specific extensions of the model tailored to distinct sociocultural contexts or value chain structures in Southeast Asia or Sub-Saharan Africa could further enrich the applicability of findings. Expanding the scope to include environmental metrics or supply chain disruptions would also deepen the model's relevance to resilience planning and sustainability evaluation in agri-digital transformation.

6. Conclusion

This study demonstrates the value of integrating agent-based modelling (ABM) and value co-creation (VCC) theory to understand digital platform dynamics in the organic vegetable sector. By simulating interactions between heterogeneous consumers and producers, the model reveals how co-creation mechanisms particularly co-learning and co-design significantly enhance satisfaction, retention, and engagement. The results highlight that trust and price sensitivity are critical variables influencing platform performance, especially under uncertain market conditions. Full VCC integration consistently outperformed baseline scenarios, while knowledge-sharing strategies proved highly resilient and effective. These findings align with service-dominant logic and extend prior ABM applications by focusing on consumer–producer interactions in a B2C agricultural context. Practical implications emphasize the importance of segment-specific design, transparent certification systems, and adaptive platform management. Despite limitations related to data calibration and rule abstraction, the study offers a foundation for future empirical validation and model refinement. Overall, the research contributes to both theory and practice by illustrating how participatory digital ecosystems can foster sustainable food systems through innovation, trust, and engagement.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Copyright:

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

References

[1] W. David and Ardiansyah, "Organic agriculture in Indonesia: Challenges and opportunities," *Organic Agriculture*, vol. 7, pp. 329-338, 2017. https://doi.org/10.1007/s13165-016-0160-8

[2] A. B. Milford, G. Lien, and M. Reed, "Different sales channels for different farmers: Local and mainstream marketing of organic fruits and vegetables in Norway," *Journal of Rural Studies*, vol. 88, pp. 279-288, 2021.

[3] R. Alam, "Building adaptive workforces: Hrm and digital competency in tourism innovation," *Global Review of Tourism and Social Sciences*, vol. 1, no. 2, pp. 119-128, 2025. https://doi.org/10.53893/grtss.v1i2.357

[4] N. K. Rini, Y. Deliana, K. adi Wibowo, and L. Trimo, "Sustainable business to customer value co-creation model: A novel theory," 2025. https://www.preprints.org/manuscript/202504.1216

[5] B. Y. Ariadi, R. Relawati, B. Szymoniuk, and W. A. Khan, "The factors influencing purchase and willingness to pay for organic vegetables," *Sarhad Journal of Agriculture*, vol. 37, no. 1, pp. 189–199, 2021.

[6] A. Y. M. Noor, H. Toiba, B. Setiawan, A. Wahib Muhaimin, and N. Nurjannah, "Indonesian consumers' preferences and willingness to pay for certified vegetables: A choice-based conjoint approach," *Journal of International Food & Agribusiness Marketing*, vol. 36, no. 4, pp. 617-642, 2024. https://doi.org/10.1080/08974438.2023.2187916

[7] J. F. Hair, M. Sarstedt, C. M. Ringle, and S. Gudergan, *Advanced issues in partial least squares structural equation modeling*, 2nd ed. Thousand Oaks, CA: Sage Publications, 2024.

[8] C. Gao *et al.*, "Large language models empowered agent-based modeling and simulation: A survey and perspectives," *Humanities and Social Sciences Communications*, vol. 11, no. 1, pp. 1-24, 2024.

[9] L.-M. Hemerijckx, K. De Vos, J. O. Kaunda, and A. Van Rompaey, "Future scenarios for urban agriculture and food security in sub-Saharan Africa: Modelling the urban land-food system in an agent-based approach," *Computers, Environment and Urban Systems*, vol. 118, p. 102258, 2025.

[10] N. Bernigaud *et al.*, "The impact of climate change on the agriculture and the economy of Southern Gaul: New perspectives of agent-based modelling," *Plos one*, vol. 19, no. 3, p. e0298895, 2024.

[11] H. F. Atli, "Digital marketing in the agricultural sector and digital transformation in agricultural marketing," in *Proceedings of the 8th International Tokyo Conference on Innovative Studies of Contemporary Sciences (pp. 415–424)*, 2024.

[12] M. Konoplyannikova, L. Radkevych, M. Netreba, M. Bilan, I. Lorvi, and O. Nahorna, "Digital marketing and communication strategies of agri-food enterprises on social media platforms," *Agronomy Research*, no. 22 (S1), pp. 444-463, 2024.

[13] N. T. Giannakopoulos, M. C. Terzi, D. P. Sakas, N. Kanellos, K. S. Toudas, and S. P. Migkos, "Agroeconomic indexes and big data: Digital marketing analytics implications for enhanced decision making with artificial intelligence-based modeling," *Information*, vol. 15, no. 2, p. 67, 2024.

[14] P. Fernandes Marques da Fonte, "Transformative technologies and techniques in innovation and financial management," Master's Thesis. Theseus Digital Repository. https://www.theseus.fi/handle/10024/807120, 2023.

[15] M. N. U. Imran and J. Ferdous, "Cultivating connections: Leveraging digital Innovation to engage gen Z in agricultural marketing 2025. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5171775

[16] M. Simanjuntak, "Designing of service dominant logic and business model canvas: Narrative study of village tourism," *Golden Ratio of Marketing and Applied Psychology of Business*, vol. 1, no. 2, pp. 73-80, 2021.

[17] G. Cascone, A. Scuderi, P. Guarnaccia, and G. Timpanaro, "Promoting innovations in agriculture: Living labs in the development of rural areas," *Journal of Cleaner Production*, vol. 443, p. 141247, 2024.

[18] E. Sørensen and J. Torfing, "Private-sector actors initiating and driving local green co-creation partnerships," *Cities*, vol. 163, p. 106062, 2025.

[19] S. Z. Huang, H. H. Tian, and O. Cheablam, "Promoting sustainable development: Multiple mediation effects of green value co-creation and green dynamic capability between green market pressure and firm performance," *Corporate Social Responsibility and Environmental Management*, vol. 31, no. 2, pp. 1063-1078, 2024. https://doi.org/10.1002/csr.2613

[20] S. Yin and Y. Zhao, "Digital green value co-creation behavior, digital green network embedding and digital green innovation performance: moderating effects of digital green network fragmentation," *Humanities and Social Sciences Communications*, vol. 11, no. 1, pp. 1-12, 2024.

[21] S. Adnan, M. G. Kakakhel, and S. K. A. Latif, "Exploring value Co-creation in B2B relationship through SDL: A qualitative and empirical study of Pakistan's railway sector," *Journal of Managerial Sciences*, vol. 18, no. 4, pp. 15-33, 2024.

[22] Jamaluddin, "The impact of remote working on employee productivity during covid-19 in indonesia: The moderating role of job level and the influence of cultural adaptability," *Global Review of Tourism and Social Sciences*, vol. 1, no. 2, p. 2, 2025. https://doi.org/10.53893/grtss.v1i2.356

[23] V. Radulescu, I. Cetina, A. F. Cruceru, and D. Goldbach, "Consumers' attitude and intention towards organic fruits and vegetables: Empirical study on romanian consumers," *Sustainability*, vol. 13, no. 16, p. 9440, 2021.

[24] S. Talwar, F. Jabeen, A. Tandon, M. Sakashita, and A. Dhir, "What drives willingness to purchase and stated buying behavior toward organic food? A Stimulus–Organism–Behavior–Consequence (SOBC) perspective," *Journal of Cleaner Production*, vol. 293, p. 125882, 2021.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432

[25] N. Ahmed, C. Li, A. Khan, S. A. Qalati, S. Naz, and F. Rana, "Purchase intention toward organic food among young consumers using theory of planned behavior: Role of environmental concerns and environmental awareness," *Journal of Environmental Planning and Management*, vol. 64, no. 5, pp. 796-822, 2021. https://doi.org/10.1080/09640568.2020.1785404

[26] Syarifuddin, D. Indriani, and Junaidin, "Balancing demands and resources: The role of psychological resilience in driving employee engagement," *Global Review of Tourism and Social Sciences*, vol. 1, no. 2, pp. 145-157, 2025. https://doi.org/10.53893/grtss.v1i2.371

[27] K. L. Fatihah, M. D. A. Wulandari, A. S. Pintrandhita, and R. S. D. Tarigan, "Microtremor-based mitigation pathways and disaster post placement in the merapi geotourism area, Yogyakarta," *Global Review of Tourism and Social Sciences*, vol. 1, no. 2, pp. 68-87, 2025. https://doi.org/10.53893/grtss.v1i2.353

[28] L. G. Tummers and A. B. Bakker, "Leadership and job demands-resources theory: A systematic review," *Frontiers in Psychology*, vol. 12, p. 722080, 2021. https://doi.org/10.3389/fpsyg.2021.722080

[29] B. Al Farishi *et al.*, "Geodiversity and geoheritage potential of basalt caves in girimulyo village, east lampung, indonesia: A mixed-method assessment approach," *Global Review of Tourism and Social Sciences*, vol. 1, no. 2, pp. 41-58, 2025. https://doi.org/10.53893/grtss.v1i2.351

[30] N. Ghaffarzadegan, A. Majumdar, R. Williams, and N. Hosseinichimeh, "Generative agent-based modeling: An introduction and tutorial," *System Dynamics Review*, vol. 40, no. 1, p. e1761, 2024. https://doi.org/10.1002/sdr.1761

[31] T. Schrieks, W. W. Botzen, M. Wens, T. Haer, and J. C. Aerts, "Integrating behavioral theories in agent-based models for agricultural drought risk assessments," *Frontiers in Water*, vol. 3, p. 686329, 2021.

[32] S. Sulfiana, "Driving Agricultural Productivity in Indonesia: The Impact of Digital Transformation and Regional Disparities," *Global Review of Tourism and Social Sciences*, vol. 1, no. 2, pp. 172-181, 2025.

[33] P. Weretecki, "Value co-creation in multi-actor ecosystems," 2021. https://research.utwente.nl/en/publications/value-co-creation-in-multi-actor-ecosystems

[34] G. Ravaioli, T. Domingos, and R. F. Teixeira, "A framework for data-driven agent-based modelling of agricultural land use," *Land*, vol. 12, no. 4, p. 756, 2023.

[35] A. Chemeris, Y. Liu, and A. P. Ker, "Insurance subsidies, climate change, and innovation: Implications for crop yield resiliency," *Food Policy*, vol. 108, p. 102232, 2022.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 2553-2567, 2025
DOI: 10.55214/25768484.v9i6.8432