



Diffusion of Social Innovation: the Innovation Provider's Perspective

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Abstract

Social innovation (SI) is a potential solution to various problems and challenges in the agriculture sector. Agri-tech start-ups can be considered important agents for developing SI in the sector. In Indonesia, agri-tech start-ups are also expected to develop SI for sustainable agricultural development in the medium-term national development plan 2020–2024. Using multiple case studies, this paper attempts to complement the currently available literature and deepen the knowledge regarding the differences between SI and traditional innovation. This research also discusses the role of business organizations, represented by agri-tech start-ups, in developing SI, by observing the diffusion model and innovation-decision process. This research identifies characteristics of SI theoretically complemented with empirical description. Three models of diffusion leading to different types of innovation-decision processes and communication channels are identified. Several internal and external factors are influencing the diffusion process. In the process, the start-ups also hold bridging roles that vary according to company characteristics. Practical implications regarding successful SI development are provided.

Keywords Social innovation · Diffusion · Start-up company · Innovation-decision process · Agricultural sector · Private sector

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Introduction

The role of the agricultural sector is crucial as it delivers food and raw material to other economic sectors and highly contributes to global economic growth (Khan et al., 2020). Based on World Development Indicator,¹ this sector also creates employment, which accommodates 26.8% of total employment worldwide in 2019. Nevertheless, this sector faces issues and challenges regarding the growing need for food, food security, finance, pest, digitalization, providing prosperity for farmers, and environmental protection.^{2,3} Besides, there are problems concerning productivity, resilience, and extreme poverty experienced by farmers (FAO, 2017) and other issues regarding demography and socio-economics (Giuliani & Wieliczko, 2018). Social innovation (SI) is considered a potential solution to solve various problems and challenges in the agriculture sector (Chiffolleau & Loconto, 2018; Kumar, 2020; Marchetti et al., 2020; Peters et al., 2018; Santini Pigatto & Brunori, 2021; Torre et al., 2020; Vercher et al., 2022). Much research has been conducted on SI. Nevertheless, the knowledge still needs to be developed since there were changes in the environment, creating more complex challenges and issues to be solved.

As in many countries worldwide, issues and challenges also arise in Indonesia's agricultural sector. As a developing country, Indonesia is dominated by an agrarian society, which relies on the agricultural sector as its economic growth engine driver. The share of the agricultural sector to the national GDP was 13% in 2018 (Chrisendo et al., 2021), and the number of employment accounts for 28.5% in 2020 (World Bank, 2021). The agricultural sector became the economic buffer when the country faced a recession in 2020 due to the COVID-19 pandemic. During 2020, the share of the agricultural sector in the national GDP consistently increased by 0.8% compared to the previous year (Statistics Indonesia, 2021). However, the sector's contribution to GDP and employment has declined over the decades. Compared to the performance of Indonesia's agricultural sector in 1998, the share of GDP in 2018 has decreased by 11% (Chrisendo et al., 2021), and the proportion of employment in 2020 has fallen by 16.5% (Statistics Indonesia, 2021). Indonesia's agricultural issues are closely related to socio-economic problems (Anandita & Patria, 2016; Aprilia et al., 2019; Moeis et al., 2020; Rafani & Sudaryanto, 2020; Setiartiti, 2021). These problems further lead to a regeneration issue that may endanger the sustainability of this sector in the future. Therefore, SI in this sector is considered essential.

In contrast to traditional business innovation that aims to maximize profit, SI is encouraged by social needs (Mulgan et al., 2007). One of the actors who play a role in diffusing SI is enterprises with social purposes (Hagedoorn et al., 2023). In the agricultural sector, the enterprises are known as agri-tech start-ups. These start-ups are actors that provide innovative solutions in the agricultural business (Sharma

¹ <https://databank.worldbank.org/reports.aspx?source=world-development-indicators#>, accessed on 10 December 2021.

² <https://www.oecd.org/agriculture/key-challenges-agriculture-how-solve/>, accessed 12 February 2023.

³ <https://www.worldbank.org/en/news/feature/2021/12/16/5-key-issues-in-agriculture-in-2021>, accessed 12 February 2023.

& Mathur, 2019; Smolová et al., 2018). In Indonesia, a similar role is played by agri-tech start-ups, as they carry out a social mission to develop farmers' welfare (Prihadyanti & Aziz, 2022; Putri, 2017). The start-ups are also expected to play a role in the digital transformation as part of the medium-term national development plan 2020–2024 (Bachtiar et al., 2022) as part of the effort regarding the SI development for sustainable development in the Indonesian agricultural sector. The start-ups are considered a new hope to achieve more remarkable agricultural development by implementing more efficient production and distribution mechanisms. Besides economic-related improvement, start-ups are also expected to improve the agricultural community's social and cultural aspects. Therefore, start-ups can be considered important agents for conducting SI.

Considering the importance of SI for developing the agricultural sector, research in this area remains crucial, either at the global level in general or for Indonesia in particular. Nevertheless, there are gaps in future research concerning the development of SI by the private sector, especially business organizations, including in what terms the innovation is distinguished from traditional innovation (TI) (do Adro & Fernandes, 2019). However, research in these areas is rarely found. Currently available research focuses on entrepreneurship and leadership (Grilo & Moreira, 2022; Rana et al., 2022; Vaccaro & Ramus, 2022), transition, transformation, and impact within society (Avelino et al., 2019; Dall-Orsoletta et al., 2022; Kim et al., 2021; Ruthemeier et al., 2022), inter-organizational collaborations and value creation (Ozdemir & Gupta, 2021), business model, strategy, and governance (de Souza João-Roland & Granados, 2023; Dionisio & de Vargas, 2020; Gasparin et al., 2021; Ney, 2014; Peris-Ortiz et al., 2018), the role of technology (Boussafi et al., 2021; Conti & Orcioni, 2022; Enciso-Santocildes et al., 2021; C. Li & Bacete, 2022; Peterlin et al., 2021), and literature or conceptual framework regarding the concept (Ahmadi et al., 2022; Cajaiba-Santana, 2014; Daniel & Jenner, 2022; Fursov & Linton, 2022; Kim et al., 2021; Nicholls & Dees, 2015; Osburg & Schmidpeter, 2013; Rao-Nicholson et al., 2017; Solis-Navarrete et al., 2021; van der Have & Rubalcaba, 2016). In Indonesia, research on SI is still rarely found, and this term remains less popular than TI.

This research contributes to two remaining crucial questions regarding SI, as do Adro and Fernandes (2019) mentioned. First, in providing a description regarding in what terms SI differs from TI. In providing the description, this article presents a literature review and an empirical description of SI conducted by six agri-tech start-ups in Indonesia. Second, this research discusses the role of business organizations, represented by agri-tech start-ups, in developing SI for farmers in the agricultural sectors. This research analyzes how agri-tech start-ups conduct the diffusion and analyze the innovation-decision process from the start-ups' perspective who act as the innovation provider. The diffusion is treated as a form of social marketing from the perspective of innovation management. The influencing factors are also discussed. Until recently, literature on the diffusion of social innovation (DoSI) is scarce (Hölsgens & Reichow, 2019) and focuses more on the DoSI from the adopter's point of view. Recent literature on the DoSI has focused more on the role of networks and stakeholders (Joseph Yun et al., 2011; Kuandykov & Sokolov, 2010; Phillips et al., 2019; Schuster & Kolleck, 2020), and the interactions (Rabadjieva &

Butzin, 2020), primarily through the online platform or social media (Gaftoneanu, 2015; Ma et al., 2014; Schuster & Kolleck, 2020). Other research gives more attention to leadership opinion (Blythe et al., 2017; Ma et al., 2014), opportunities and challenges (Ashta & Cheney, 2017; van Niekerk et al., 2021), social dynamics and intervention (Blythe et al., 2017; Cajaiba-Santana, 2014; Dearing, 2009), and the relation to the policy-making (Johansson & Stefansen, 2020). Since research on SI is still rarely found in Indonesia, research on DoSI is also scarce. One of the related articles was written by Fahmi and Arifianto (2021), highlighting the role of digital technology. At last, besides providing theoretical implications, this research also provides practical implications to support the development of SI in the agricultural community.

Literature Review

Social Innovation: Basic Concept and Characteristics

Innovation can be defined as new or improved products, services, processes, or organizational or marketing strategies, categorized into technological and non-technological innovation (OECD, 2005, 2009). This concept has been widely implemented and discussed primarily at the organizational or sectoral level to create economic value for the business or industrial sectors and organizations. The innovation is currently termed traditional innovation (TI). Meanwhile, a new term – social innovation (SI) – has attracted more attention from researchers and academicians due to the growing interest in addressing social issues. SI has various definitions and basis of concept (Agostini et al., 2016; Avelino et al., 2019; Cajaiba-Santana, 2014; Dall-Orsoletta et al., 2022; Daniel & Jenner, 2022; González & Alonso, 2022; Grilo & Moreira, 2022; Nicholls & Dees, 2015; Pol & Ville, 2009; van der Have & Rubalcaba, 2016). Although varied, the concepts have similar components, which include social actors and social change.

SI can be explained from two broad perspectives (Cajaiba-Santana, 2014), specifically from institutional and structuration perspectives. The institutional perspective depicts SI as an outcome of knowledge and resource exchange carried out by actors and then catalyzed through “legitimization activities.” This definition views SI based on the “product” or final output regarding the achievement of social goals, which may occur in various areas of implementation (Iwamoto & Cançado, 2020). The structuration perspective sees innovation from the undergone process (Cajaiba-Santana, 2014). From this perspective, SI is socially constructed by individuals’ collective engagement, conducted in purposeful actions. The actions and outcomes are reflexively monitored. Looking further, the two categories of definition have the potential to overlap. While one points out the final goal, the other looks at the process passed to achieve it. The process itself can be seen from actors-approach, by examining their roles and goals, or through an approach that observed it as simple stages which can be linear or non-linear.

SI is different from TI (Solis-Navarrete et al., 2021). The former stresses more on social purpose, while the latter emphasizes commercial success (Iwamoto

& Cançado, 2020). The social purpose is not always the only goal of an organization since it is often misunderstood as the sole purpose of the providers. Non-profit organizations (NPOs), hybrid, or social enterprises can also provide SI. Profit-oriented organizations can also deliver this innovation through a Corporate Social Responsibility (CSR) program, which then emerges the concept of Corporate Social Innovation (CSI) (Dionisio & de Vargas, 2020). However, profit-oriented organizations and hybrid enterprises often face a tradeoff between maximizing profits and achieving social goals. SI carried out by start-ups will undoubtedly be closely related to the level of social entrepreneurship, which determines the existence and the allocation of resources to achieve social goals. Therefore, any company can run SI as long as a social entrepreneur is in charge. In practice, many social enterprise managers are continuously challenged to choose between increasing productivity for financial gain versus increasing productivity for social benefits (Zainon et al., 2014). Lasso et al. (2017) divide types of entrepreneurs into six categories based on their motivation to open new ventures: self-realization, financial success, roles, innovation, recognition, and independence. These factors can affect the level of the social purpose of a social entrepreneur.

By referring to the definition and basic concept of innovation, SI is basically all new things in the form of products, processes, or methods created to respond to social needs through stages of the process with the involvement of specific actors. The definition of SI also affects how the innovation is categorized. There are various typologies of SI. Rabadijeva et al. (2017) distinguish the typology of SI based on how the SI affects a system. The proposed typology comprises four types: repairing, modernizing, transforming, and separating. Meanwhile, Brooks (1982) in Lisetchi and Brancu (2014) point out different distinctions between market, management, political, and institutional innovations. Seeing the overall condition systemically, the system where the SI is expected to work successfully is influenced by inter-organizational, organizational, interpersonal, and individual levels (Agostini et al., 2016). The individual level leads to the fundamental role of a social entrepreneur. Therefore, a social entrepreneur can significantly influence the success of SI.

Social entrepreneurs are usually involved in social enterprises (Hölsgens & Reichow, 2019). Nevertheless, it is still possible to find the entrepreneur in the general business if it has an explicit or implicit social purpose. One point distinguishing social entrepreneurs from traditional entrepreneurs is their motivation to innovate (Weerawardena & Sullivan Mort, 2006). They argued that social entrepreneurship is “a bounded multidimensional construct deeply rooted in an organization’s social mission.” Its drive for sustainability is highly influenced and shaped by environmental dynamics. Social entrepreneurs must be innovative, proactive, and risk considering achieving their social mission. Behind the SI created and diffused by start-ups as business entities, there is a role of social entrepreneurs who initiate and align overall activities with the business strategies. In aligning the activities to deliver SI successfully, the entrepreneurs should consider the characteristics of the innovation.

Tidd and Bessant (2009) proposed the “4Ps” approach to innovation space. The innovation includes the product, process, position, and paradigm innovation. Based on their primary substances, a comparison of characteristics between TI and SI conducted by a business organization can be summarized in Table 1.

Table 1 Comparison of characteristics between traditional business innovation and social innovation

Aspect/dimension	Traditional innovation	Social innovation
Purpose	Commercial purpose, inward-looking (obtain profit gain and other benefits for business organization)	Outward looking but without neglecting internal needs of the organization; tend to focus on problems within society, either economic, social, or environmental (various levels of problem solving-capacity may occur)
Product/services offered	Tend to be based on consumer wants	Based on consumer needs
Ways of creation	Involving consumers for only a sequence or aspect considered crucial; possible occurrence of unsustainable ways of creation with negative impact, especially a particular community	More sense of humanism and civilization, sustainable co-creation, involving stakeholders within social activities in most stages of innovation
Context	Innovation for business growth and development	Innovation for social change in the community
Mental models	Low cost and achieve the highest economic benefits for business organization; driven by a typical entrepreneur	Cost is not always designed as lowest as possible; economic benefits for the organization are not always set as highest as possible but spare some parts to create social change directed for economic, social, and environmental benefits for the community, driven by social entrepreneur
Evaluation criteria	Tangible and intangible benefits for the organization (profit margin or sales)	Impact on solving social problems

Source: Constructed by authors based on elaboration from (Agostini et al., 2016; Avelino et al., 2019; Cajiaba-Santana, 2014; Dall-Orsoletta et al., 2022; Daniel & Jenner, 2022; Dionisio & de Vargas, 2020; González & Alonso, 2022; Grilo & Moreira, 2022; Iwamoto & Cançado, 2020; Mulgan et al., 2007; Nicholls & Dees, 2013; Pol & Ville, 2009; Solis-Navarrete et al., 2021; Tidd & Bessant, 2009; van der Have & Rubalcaba, 2016; Weerawardena & Sullivan Mort, 2006)

Contemplating with the concept of Tidd and Bessant (2009), the core substance of product innovation is the novelty of the product/services offered by an organization. In the context of agricultural SI, farmers should consider the products or services new, even if the products or services are already familiar to the business within the sectors or even in higher scope. Process innovation has a core in the creation and delivery method. In this case, the approach to creating and delivering the SI process can differ, including how the organization partners or collaborates with the related parties.

Regarding the position innovation, the context for introducing the product/services can be unique for SI for farmers since it relates to the higher provision of economic and social benefits for farmers and not solely for the business organization as the innovation provider. While the paradigm to conduct SI, which relates to mental models of the organization as innovation providers, may differ in terms of the type of entrepreneurs who direct the organization. Compared to the characteristics of TI, SI can be considered an innovation of TI.

SI consists of four dimensions (González & Alonso, 2022): (1) technological dimension, which relates to the product and services functionality for providing changes; (2) environmental dimension, which relates to a feature of the product or services to tackle the barriers and challenges of environmental problems; (3) economic dimension, which relates to the capability of the product or services to generate values either for the provider or in addressing economic issues in the society; and (4) cultural dimension, which relates to the feature of product and services to enhance the cultural and educational aspect of the targeted community. Nevertheless, the social aspect should also be considered, featuring products or services concerning social status, relationships, or any other social-related concern. These dimensions shape the characteristics of products and services business organizations offer as part of the private sector in their attempts to develop SI.

Social Innovation and the Role of Private Sectors: the Need for the Diffusion

SI has great potential to transform rural development. Nevertheless, it needs effort to actualize. A community can also develop SI, which benefits the community (Daniel & Jenner, 2022). Even though, concerning the constraint and limitations of the community, this kind of attempt often fails. Therefore, SI needs external support from actors outside the community (Nordberg et al., 2020). Moreover, the involved actors must present several bridging roles, including network enabler, knowledge broker, resource broker, transparency and conflict resolution agent, and shared vision champion (Castro-Arce & Vanclay, 2020). Actors and their collaboration in fulfilling the roles become crucial, including the role from the private sector (Smyth et al., 2021) with a particular social purpose.

A social mission can explicitly or implicitly state the social purpose set by a social entrepreneur of the organization (Lisetchi & Brancu, 2014). As one of the actors from the private agricultural sector, which has social missions, technology-based start-ups provide benefits in the form of various sustainability archetypes to farmers in the agricultural sector (Prihadyanti & Aziz, 2022). Examining these roles further, based on the bridging roles of Castro-Arce and Vanclay (2020), agri-tech

start-ups are network enablers, knowledge brokers, resource brokers, transparency and conflict resolution agents, and shared vision champions in carrying out SI. The presence of these roles indicates start-ups' potential to be related to the development of SI, starting from the creation of inventions which can then shift to innovations through the dissemination of the application in society through a particular process. The shifting process from invention to innovation requires initial adoption, which is "marketed" more broadly through diffusion. The concept of diffusion of social innovation (DoSI) is described in the following section.

Theories of Diffusion of Innovation: Contextualizing the Concept of Social Innovation

Diffusion of innovation shows a "process by which an innovation is communicated through specific channels over time, in markets, or among members of a social system" (Rogers, 2003; Straub, 2009). Rogers (2003) identified four main elements of the diffusion of innovations: the innovation itself, the communication channels, the time, and the social system. The diffusion of innovations in the context of agricultural technology can be seen as a "process through which technologies spread throughout the farm sector over time" (Zilberman, 2008). Meanwhile, the innovation-decision process refers to the mechanism of an entity deciding to either adopt or reject an innovation (Rogers, 1995). Thus, the adoption process is integral to diffusion (Straub, 2009). Rogers (1995) divides the adoption process in the form of an innovation-decision process into five stages which include awareness, persuasion, the decision to adopt or reject, implementation of the new idea, and confirmation. Based on Rogers (2003), the farmer who acts as a recipient of innovation becomes a "decision-making unit." Therefore, the characteristic will influence the diffusion process. In the context of DoSI, the innovation process starts with the social problem and ends with a social goal/social change with adoption as its precedence (Schümann & Džuriková, 2017). Therefore, it can be concluded that DoSI is a process repeated over time, aiming for widely spreading the SI.

The innovation-decision process becomes an essential part of the overall diffusion of innovation. As Rogers (1995, 2003) provides the most popular theory, there are other substantive diffusion theories (Sari et al., 2020), as stated by Bianchi et al. (2017), who explain several diffusion theories to identify early adopter characteristics. The theories are the Epidemic model, Probit Model, Bandwagon Theory, and Sociological Models. These theories vary regarding underlying assumptions and the main influencing factors.

The Probit model assumes that potential adopters have attributes associated with perfect rationality but can only estimate the potential benefit without certainty. The decision to adopt rationalizes the purchasing costs and benefits obtained by utilizing the innovations offered. Meanwhile, in the epidemic model (Fisher & Pry, 1971), the diffusion of innovation is much driven by information dissemination, in which potential adopters have the same characteristics and will only adopt when they have received sufficient information about the innovation. This model also considers that early adopters are an essential source of information, and information dissemination

will encourage the probability of adopting the innovation. For SI to provide more benefits for companies and their adopters, diffusion activities are needed in which the company's perspective becomes part of marketing activities (Li et al., 2017). These activities will encourage the widespread adoption of SI or enhance its diffusion. In the TI diffusion process, the plan of diffusion path is established as a guide for key opinion leaders in inseminating marketing information using online channels, including social media.

Another diffusion theory, namely Bandwagon Theory, argues that the adoption process occurs because individuals are driven by others who have already adopted the innovation (Abrahamson & Rosenkopf, 1990) and not because of the efficiency or the expected returns (Abrahamson & Rosenkopf, 1993). This impulse becomes a differentiator between the two leading theories of the bandwagon, namely Information Contagion and Fad Theory. The information contagion model assumes the existence of incomplete information. For potential buyers, information can be a source of considerable uncertainty. In this case, even though information about specifications and advertisements already exists, and the purchase costs are known for certain, the buyer can feel unsure whether the product will provide a benefit or can be integrated into the existing process. Potential buyers will ask for information about these things from parties who have made previous purchases; therefore, information about opinions on innovation will likely be disseminated through word-of-mouth.

On the other hand, based on The Fad Theories (Abrahamson, 1991), The Bandwagon Effect originates from the information about innovations that do not move within a social system but only to a few previous adopters known to potential later buyers. In this case, the early adopters' role is to stimulate imitative and competitive reactions between later adopters. However, The Bandwagon Theory must consider that potential adopters are part of a social network, filling different positions. Therefore, what potential adopters expect to know about an innovation depends on the structure of the social network disseminating information and its role in the network. This condition is accommodated in the sociological model, especially in the social cohesion model.

The social cohesion model assumes that diffusion is channeled through communication networks. In the early stages, external actors such as mass media can encourage awareness and shape potential adopters' perceptions of innovation. However, the next stage is greatly influenced by potential adopters, who will persuade them to adopt. Potential adopters at the network's core are interrelated and are more reputable than the others. This condition supports the argument that opinion leaders have a more significant role among other earlier adopters than later adopters. Therefore, the network position of the early adopters, primarily related to the opinion leaders, may determine the adoption decisions of the next adopters (Bianchi et al., 2017).

Various described theories on the diffusion of innovation indicate the variation of DoSI models, considering the influencing factors and the process of the spreading. Enabling technology can be crucial in introducing products or services as a form of innovation (Fursov & Linton, 2022). The technology is currently associated with digital technology. The use of technology, especially digital technology, which is widely spread, may construct digitalization as a form or part of SI

(Enciso-Santocildes et al., 2021; Fahmi & Arifianto, 2021; C. Li & Bacete, 2022; Sari et al., 2020), which can enable changes in the community.

Changes within the system over time may also create new variations of the DoSI model. Furthermore, currently available diffusion theories analyze the process from the adopter's perspective. Meanwhile, from the innovation provider's perspective, the diffusion can be considered a marketing innovation. In the context of SI, marketing has a different purpose. It is not mainly to obtain the highest profit or sales but to achieve a broader user who has the potential to use or benefit from the invention's applicability or the spread of the innovation after the invention has been applied. The private sector, including agri-tech start-ups, becomes the source of invention expected to be marketed to obtain values that further create innovation. Therefore, marketing differs from ordinary marketing and tends to be more social, occurring in the charity context. This unique character led to the term social marketing as a means for solving social problems. Paxton (2012) defined social marketing as "the systematic application of marketing approaches, notably advertising, to bring about changes in individual attitudes and behavior that are for the social good rather than commercial goods." In the context of DoSI by agri-tech start-ups, the social goods lead to the innovations provided by the start-ups, either tangible or intangible. Nevertheless, when the good is "produced" by profit-oriented organizations but with a particular social mission, the good can be a quasi-commercial or a quasi-social good, depending on the dominance of the social mission compared to the profit orientation. Like general marketing, managing the process is undeniably crucial to achieving successful social marketing, from planning to implementation and even for future planning and forecasting, leading to an innovation-decision process.

Proposed Model of the Innovation-Decision Process: the Innovation Provider's Perspective

In line with the general concept of diffusion of innovation, as Rogers (2003) has mentioned, in undertaking the DoSI, the innovation provider also becomes the decision-making unit in the social marketing of the product/services intended for creating social change in the community. However, from the innovation provider's point of view, the innovation-decision process does not lead to the decision of the provider to adopt or not adopt the innovation as perceived from the adopter's side but to determine the strategies to deliver widely adopted innovation that provides social benefits. The proposed innovation-decision process consists of five stages, as described below.

Stage 1: Awareness and Planning

At this stage, the innovation provider plans to whom, how, and where to diffuse the SI. The provider also identifies the required resources. In the case of the DoSI carried out by agri-tech start-ups, a "social commercialization" is directed at farmers as the "customers." To achieve successful social commercialization, a firm must understand the driving forces affecting innovation success in the specific context and

employ that comprehension when choosing activities and decisions (Aarikka-Stenroos et al., 2014). Therefore, the commercialization process must consider the suitability of ideation activities with marketing strategy and implementation, product or service evolution, or adaptation. In this case, the diffusion is directed at getting more customers so that it gives more expected values.

In the context of the commercialization of SI carried out by agri-tech start-ups, apart from profit, diffusion is also directed to deliver specific social missions so that more customers can receive value. In this process, the external contributors' role is essential for this commercialization's success (Aarikka-Stenroos et al., 2014). This role can indirectly influence the diffusion process regarding support for any necessary activity or resource for value creation.

Joseph Schumpeter argued that the innovation concept encompasses ideas of economic leadership and commercial success. Therefore, to become an innovation, an invention has to be commercially successful, which presumes both a successful product or service launch and diffusion in the market (Croitoru, 2012). In the case of SI conducted by social enterprises, the distribution in the market may prioritize the diffusion aspect. The prioritization can be accomplished by putting aside the high profits that can be achieved and diverting some of the profit for community benefits.. This prioritization is reasonable because the enterprises may have three options in their desire to provide benefits (1) to provide higher social value than the gained profit, (2) to provide the balance, or (3) to provide a small benefit for a social mission compared to the gained profit. Regardless of the specific orientation of the start-up, in general, the company still needs to prepare five attributes of innovation that affect the adoption rate: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1995, 2003). Moreover, the start-up company will also determine the diffusion path planning mechanism. At this first stage, planning will also involve profitability and estimating the impact of SI, which are generally related to the organization's characteristics, including the decision-making actors (Abrahamson & Rosenkopf, 1997).

Stage 2: Selecting

In diffusing SI, agri-tech start-ups must evaluate farmers to be further considered potential adopters. In this case, various things need to be considered as criteria for selecting farmers. According to Rogers (1995), farmers as a "decision-making unit" have socio-economic characteristics or unique demographic aspects that also determine diffusion. Rogers (2003) also points out the role of personality variables and communication behavior in the diffusion of innovation. These two variables show adopters' characteristics that will potentially determine farmers' responses to innovation. In addition, the location of the farmers can also affect the diffusion of innovations. The geographical condition is related to the climate and weather conditions that can affect the productivity of agricultural products farmers grow, which can influence the sales of the agri-tech start-ups as a source of the company's economic benefit. The location of farmers can also induce the ease of access to transportation which determines the ease of distribution as part of the business process of the start-ups, transportation costs, and the interaction between start-ups and farmers.

Therefore, location can be a potential criterion agri-tech start-ups consider when selecting potential adopters.

Apart from the geographical aspect, another criterion that agri-tech start-ups might consider in determining potential adopters is the type of commodity the farmers grow. Each commodity has a different value, depending on the demand for the market and the farmers who grow it. For the farmers themselves, there are local traditions and knowledge in farming they should preserve (Fatmawati, 2019). This local wisdom has been inherited from generation until it shapes their behavior or culture to cultivate certain commodities at certain times. In general, the adopters themselves often consider aspects of uncertainty that might be significantly reduced by the reputation of the innovation provider (Hewing, 2012).

Reputation is highly associated with a *brand image*, which shows the company's image. Holt's theory represents an interaction between branding and diffusion of innovation (Holt, 2013), which explains how iconic brands are formed using the diffusion of innovation theory. He argues that a product will keep admissible if it can sustain itself amid societal change. A brand that can overcome social inequality and achieve customers' devotion in the long term can be called exemplary (Florea, 2015). An appropriate advertising strategy will be needed regarding SI, especially for rural farmers who often have limited access to technology. The strategy can be different from the conventional strategy of TI since the SI has a different goal.

From the agri-tech start-ups' point of view, locations and commodities can be considered the two critical aspects before selecting an adopter. In carrying out the diffusion to farmers, agri-tech start-ups must also make decisions based on specific criteria to allocate resources optimally. Therefore, not all farmers can be selected as key early adopters. Only those with specific characteristics can be considered key early adopters. Furthermore, in today's global era, where ICT plays a vital role in life, this technology also becomes essential for people living in rural areas. Findings from Fahmi and Arifianto (2021) show that using digital technologies in livelihood strategies stimulates new social and institutional practices in rural areas. As adopted digital technologies may differ in several cases, the complexity of adoption and the required digital literacy and skills will also vary.

Stage 3: Trial

At this stage, agri-tech start-ups should have attempted to start innovation trials with farmers. This pilot project needs to be done to reduce the risk of failure in the bigger scale project that can result in loss of resources suffered by agri-tech start-ups. This stage is also crucial for exploring and identifying potential barriers during diffusion, which may be resource- and time-consuming and threaten its success.

Stage 4: Evaluating

The evaluating stage describes the phase to evaluate whether the start-ups will continue to diffuse the innovation. The evaluation is mainly related to the requirements of resources, especially financial resources. If the diffusion is successful, the start-up may also expand the adoption of innovations to farmers, either

spatially or by diffusing to different niches. There are several ways to follow up on the results of the evaluation. First, by expanding the diffusion and developing more appropriate innovations to provide more value (if the innovation is successful) or even thinking about other innovation options that are more feasible than the existing innovations (if the innovation is unsuccessful).

Stage 5: Implementing

The existence of this stage indicates that the diffusion of innovation is flourishing. It is the continuation of the previous execution but with a different object or adopter. This condition will undoubtedly require repeated evaluation as a form of prolonged future diffusion. The success of the precedent stages defines the presence and continuation of this stage.

Carefully managing the stages of the innovation-decision process can affect the performance of the DoSI, which further defines the success of the innovation concerning organizational performance. Apart from the organization type, diffusion is a dynamic process and can be viewed as a social marketing process. Since farmers usually find it difficult to be approached and tend to reject new things (Kinsella, 2018), diffusion also needs to have a particular management strategy to innovate. The success of a stage of the innovation-decision process will determine the success of the antecedents, and so on. Furthermore, the stages can be determined by various factors influencing the overall DoSI.

do Adro et al. (2022) identified five innovation management factors affecting the performance of NPOs, which also have the potential to influence the performance of other types of organizations in developing social innovation. The factors include (1) strategy, which is essential to ensure the achievement of social goals and the organization's sustainability (S. Almeida & Fernando, 2008) through various activities in the innovation process, which leads to mid-term and long-term goals of the organization; (2) processes, which is related to the operational and control activities and optimizing feedbacks to improve the performance of each stage; (3) organization, which leads to its characteristics that affect the organizational performance. For start-ups, the key characteristics usually relate to organizational culture, leadership rehearsing the characteristic of an entrepreneur (Men, 2021), and size (Cooper et al., 1986); (4) learning leads to crucial self-activities to ensure the gain and upgrading of currently available knowledge and skills (P. Almeida et al., 2003) which are the basis for conducting innovation (Sullivan et al., 2021), and; (5) networks, which relate to the potential source for start-ups to gain resources, source of innovation, knowledge and information, communication channel, and obtain a (sustainable) partnership for value co-creation (Alänge et al., 2022; Moritz et al., 2022). Based on the earlier description, this research examines two propositions.

Proposition 1: *Innovation-decision process from the innovation provider's perspective consists of five stages – awareness and planning, selecting, trial, evaluating, and implementing.*

Proposition 2: *DoSI is influenced by the innovation provider's strategy, processes, organization, learning, and networks.*

Methodology

This research used a qualitative approach with multiple case studies research strategy (Eisenhardt, 1989; Yin, 2003) in six agri-tech start-ups. In this research, SI is interpreted as all new things in the form of products, processes, or methods created to respond to social needs through stages of the process with the involvement of specific actors. An agri-tech start-up is a (mostly) technology-focused company that provides innovative and fast solutions and operates in the agricultural business (Sharma & Mathur, 2019; Smolová et al., 2018). The case studies were selected based on the business area's variation and the willingness to participate in the research. Eisenhardt (1989) was adopted to explore the variation of the diffusion model. Free coding was performed to construct the model. By combining Yin (2003) and Eisenhardt (1989), this research confirmed and tried to explore and (if necessary) re-construct the variations of the innovation-decision process as a part of the model of DoSI. For this respect, thematic coding was conducted to indicate the pattern of the innovation-decision process, followed by free coding to construct the most appropriate type. In complement, Maxwell's qualitative analysis (2005, 2012), consisting of three stages (categorizing, connecting, and displaying strategies), was employed to analyze the model and present the diffusion pattern and the innovation-decision process models in the form of figures.

Data was collected via a preliminary survey using an online questionnaire combining open and closed questions, confirmed by online semi-structured interviews, and complemented with secondary data collection from related documents and the information from agri-tech start-ups' websites. An online survey and interviews were conducted to gain information from respondents and interviewees represented by the top-level management and the related staff who had comprehensive knowledge of the diffusion process and the related supporting activities. Interview sessions were also conducted to explore other emerging essential variables from the questionnaire survey result. The interviews were then recorded and transcribed. The survey result and the transcribed interview were then processed using thematic coding. Lastly, a simple content analysis was conducted for the secondary data/information, and the results were categorized and used to support the results of the questionnaire survey and the interview results. The collected information was based on the variables shown in Table 2, while the research stage is shown in Fig. 1. The intra-case and the inter-case analysis was performed to analyze the diffusion model and the result/impact of the diffusion, the innovation-decision process, influencing factors, and bridging roles of the start-ups. Comparisons were made based on the organization type of the start-ups regarding their bridging roles and how the (combination of) factors influenced the innovation-decision process and the overall DoSI process.

Table 2 Research variables

No.	Aspect	Operationalization	References	Source of data
1.	Agri-tech start-up profile/characteristics	Number of employees, area of business, vision and mission	-	Online survey (through questionnaire); interview, secondary data
2.	Characteristics and form/type of social innovation	Purpose, products/services offered, ways of creation, context, mental models, evaluation criteria of SI as defined by start-ups; implementation area of SI	Rabadijeva et al. (2017); Brooks (1982) in Lisetchi and Brancu (2014); Agostini et al. (2016); Avelino et al. (2019); Cajaiba-Santana (2014); Dall-Orsoletta et al. (2022); Daniel and Jenner (2022); Dionisio and de Vargas (2020); Grilo and Moreira (2022); Iwamoto and Cançado (2020); Mulgan et al. (2007); Nicholls and Dees (2015); Pol and Ville (2009); Solis-Navarrete et al. (2021); van der Have and Rubalcaba (2016); Weerawardena and Sullivan Mort (2006); González and Alonso (2022); Tidd and Bessant (2009)	Online survey, interview, secondary data
3.	Characteristics of the adopter (the farmers)	Level of education, location, socio-cultural aspects, age, digital literacy, social system	Rogers (1995, 2003); Fatmawati (2019); Bianchi et al. (2017); Abrahamson (1991); Abrahamson and Rosenkopf (1993; 1990)	Online survey; Interview
4.	Diffusion stages/process	Involved actors, communication channel, marketing strategy, result/impact of the diffusion	Rogers (1995, 2003); Li et al. (2017); Florea (2015); Iwamoto and Cançado (2020)	Online survey; Interview; secondary data
5.	Decision-making for diffusion (innovation-decision process) characteristics	Decision-makers, decision stages, decision consideration, purpose of the decision/stages of decision-making, type of entrepreneur	Abrahamson and Rosenkopf (1997); Rogers (1995, 2003); Lasso et al. (2017)	Interview; secondary data

Table 2 (continued)

No.	Aspect	Operationalization	References	Source of data
6.	Influencing factors	Strategy, processes, organization, learning, networks	Almeida and Fernando (2008)	Interview; secondary data
7.	Bridging roles	Network enabler, knowledge broker, resource broker, transparency and conflict resolution agent, and shared vision champion	Castro-Arce and Vancley (2020)	Interview; secondary data

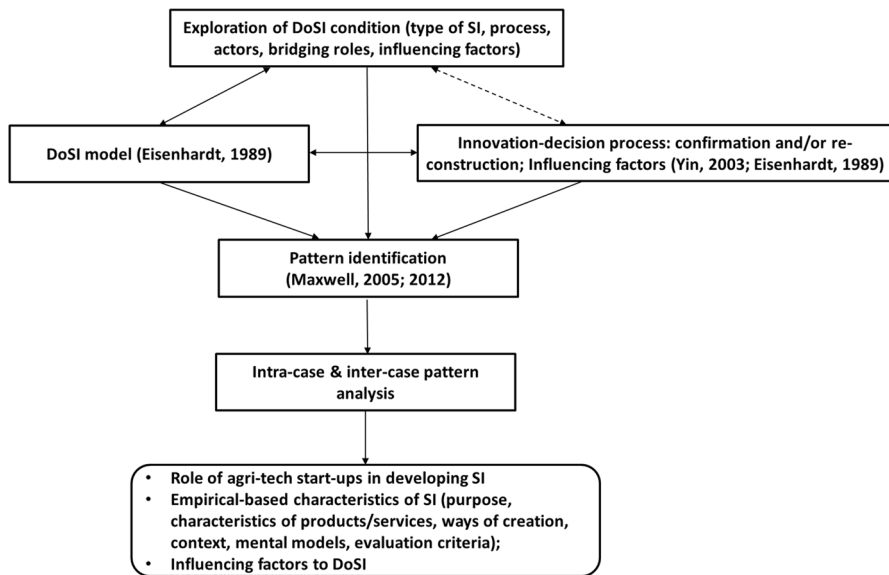


Fig. 1 Research stages

Results

The results of the case studies are summarized in Table 5, Table 6, and Table 7 in the Appendix. Based on the results, several bridging roles and factors were influencing the DoSI. Further description of the case studies is presented in the following sections.

Start-up A

As a social enterprise, Start-up A focused on improving farmers' social welfare, either through e-commerce or financial support through peer-to-peer (P2P) lending services. The services were related to the start-up's role as a network enabler by providing market and financial access, which showed its role as a network enabler and resource broker. As the start-up also provided more transparent transactions and bridged problems between farmers and intermediaries, the start-up also holds a role as a transparency and conflict resolution agent. The start-up also played a role as a knowledge broker since it acts as the source and the bridge between farmers and other sources of knowledge and skills.

In planning, designing, and creating social innovation, Start-up A directly involved farmers through informal R&D for an extended period. The implementation involved community empowerment, with a crucial role from key local persons in the field. The start-up spread the shared vision to improve farmers' life leading to their willingness, either consciously or not, to apply the SI provided by the start-up.

These activities supported the start-up in providing overall social impact, prioritizing farmers' importance by only taking minimum profit to maintain the business and as a responsibility to investors.

Within the process, the start-up continuously tried to communicate with its angel investors regarding the way of business that was not similar to typical "traditional" business, which only attempted to obtain the highest profit. This start-up also brought more focus to providing social impact to farmers. Besides depending on angel investors, this start-up relied on end consumers as the buyer of the agricultural products from farmers. Thus, change in the characteristics of the end consumers also changed the start-up's activity direction as a consideration in the innovation-decision process, especially in the business planning or the designation of the supporting activities. These activities influenced the DoSI. The start-up also often experienced obstacles concerning late credit payments due to unpredictable events, which unexpectedly led to the decrease or the disappearance of the capacity for monetary payback.

Based on the description, Start-up A tended to make a basis of a strategy to achieve social goals through implementing an appropriate diffusion strategy and continuing to survive as an organization through various co-creation activities with farmers, consumers, investors, and local human resources. In the operationalization, the planning activities also optimized feedback from multiple parties, especially the investors. The activities include knowledge and information sharing and upgrading from the informal R&D. Aligning the social mission, Start-up A also built organizational culture through a process based on the socio-cultural norms implemented by the employees, especially when interacting with farmers. Leadership from the founders characterized as social entrepreneurs also becomes an exceptional basis for forming the organizational culture. The start-up, categorized as an SME, could bring social impact for farmers in several areas in Indonesia. To upgrade knowledge and skill for increasing creativity and innovation, this start-up also benefited from experiential learning, learning by doing, experimenting by experimenting, and interacting with university experts. These activities utilized domestic networks, which were open but limited to personal networks. These factors shape the innovation-decision process, leading the start-up to choose the diffusion by face-to-face mechanism.

Start-up B

As a hybrid enterprise, Start-up B focused on gaining profit and improving farmers' social welfare through knowledge sharing, e-commerce service, agricultural surveyor data management, and agricultural supply chain management. The services were related to the start-up's role as a network enabler by providing agricultural knowledge, agricultural market, and supply chain management. The start-up also provided more transparent transactions and bridged problems between farmers and business consumers as a payment guarantor.

In planning, designing, and creating social innovation, Start-up B directly involved farmers in their business model. The implementation involved community empowerment through knowledge sharing, with a crucial role from key persons

in the field. Within the process, the start-up consults with local heroes to decide whether farmers can join the program. Thus, the approach strategy by local heroes is essential to find the right farmers. Besides that, the approach to local authority supports the start-up's activity, especially in designing and implementing SI. These activities influenced the DoSI.

Based on the description, Start-up B tended to make a basis of a strategy to achieve social goals by implementing an appropriate diffusion strategy and continuing to survive as an organization through various co-creation activities with farmers, local heroes, and local authorities. In the operationalization, the planning activities optimized feedback from local heroes, especially in deciding targets for social innovation. The start-up considered an SME can bring social impact for farmers besides maximizing profit from their business. This start-up also benefited from experiential learning and learning by doing to upgrade knowledge and skill for increasing creativity and innovation. These activities utilized domestic networks, which were limited to personal networks. These factors shape the innovation-decision process, leading the start-up to choose the diffusion by face-to-face mechanism and utilizing Information and Communication Technology (ICT).

Start-up C

Start-up C is a hybrid enterprise. The start-up focused on gaining profit and improving farmers' social welfare through B2B e-commerce service, financial support, and agricultural supply chain management. The services were related to the start-up's role as a network enabler and resource broker, seeing from its role in providing market, financial access, and supply chain management. As the start-up also provided more transparent transactions and bridged problems between farmers and intermediaries, the start-up also holds a role as a transparency and conflict resolution agent.

In planning, designing, and creating social innovation, Start-up C directly involved farmers in their business model. The implementation involved community empowerment, with a crucial role from key persons in the field. The start-up spread the shared vision to improve farmers' lives, which leads to their willingness, consciously or not, to apply the SI provided by the start-up.

Within the process, the start-up tried to convince its investors regarding the way of business that was not only to gain the highest profit but also to create a social impact on farmers' lives. Besides depending on investors, this start-up relied on end consumers as the buyer of the agricultural products from farmers. Thus, change in the characteristics of the end consumers also changed the start-up's activity direction as a consideration in the innovation-decision process, especially in the business planning or the designation of the supporting activities. These activities influenced the diffusion of SI.

Based on the description, Start-up C tended to make a basis of a strategy to achieve social goals through implementing an appropriate diffusion strategy and continuing to survive as an organization through various co-creation activities with farmers, consumers, and investors. In the operationalization, the planning activities also optimized feedback from key persons in the field. Aligning with the social

mission, Start-up D also built organizational culture through a process based on the employees' socio-cultural norms, especially when interacting with farmers. The start-up creates a social impact on farmers' lives through its business model and focuses on maximizing profit. The start-up considered an SME can bring social impact for farmers in several areas in Indonesia. To upgrade knowledge and skill for increasing creativity and innovation, this start-up also benefited from learning by doing and experimenting. These activities utilized domestic and foreign networks. These factors shape the innovation-decision process, leading the start-up to choose the diffusion by face-to-face mechanism.

Start-up D

As a hybrid enterprise, Start-up D focused on gaining profit and improving farmers' social welfare through e-commerce service, financial support through P2P lending, and agricultural supply chain management. The services were related to the start-up's role as a network enabler and resource broker by providing market, financial access, and supply chain management. As the start-up also provided more transparent transactions and bridged problems between farmers and intermediaries, the start-up also holds a role as a transparency and conflict resolution agent. The start-up also played a role as a knowledge broker since it acts as the source and the bridge between farmers and other sources of knowledge and skills.

In planning, designing, and creating social innovation, Start-up D directly involved farmers through informal R&D for an extended period. The implementation involved community empowerment, with a crucial role from key local persons in the field. The start-up spread the shared vision to improve farmers' life which leads to their willingness, either consciously or not, to apply the social innovation provided by the start-up. These activities supported the start-up in providing overall social impact, prioritizing farmers' importance, and gaining more profit by improving the quality of agricultural products.

Within the process, the start-up tried to convince its angel investors regarding the way of business that was not only to gain the highest profit but also to create a social impact on farmers' lives. Besides depending on angel investors, this start-up relied on end consumers as the buyer of the agricultural products from farmers. Thus, change in the characteristics of the end consumers also changed the start-up's activity direction as a consideration in the innovation-decision process, especially in the business planning or the designation of the supporting activities. These activities influenced the DoSI.

Based on the description, Start-up D tended to make a basis of a strategy to achieve social goals through implementing an appropriate diffusion strategy and continuing to survive as an organization through various co-creation activities with farmers, consumers, investors, and local human resources. In the operationalization, the planning activities also optimized feedback from multiple parties, especially through gaining information and knowledge from the informal R&D. Align with the social mission, Start-up D also built organizational culture through a process based on the socio-cultural norms. The culture was embedded in the employees,

especially when interacting with farmers. Leadership from the founders characterized as social entrepreneurs also becomes an exceptional basis for forming the organizational culture. The start-up creates a social impact on farmers' lives through its business model but also focuses on maximizing profit. The start-up can bring social impact for farmers in several areas in Indonesia. To upgrade knowledge and skill for increasing creativity and innovation, this start-up also benefited from experiential learning, learning by doing, experimenting, and learning from university experts. These activities utilized domestic and foreign networks, which were open but limited to principles of sustainable partnerships. These factors shape the innovation-decision process, leading the start-up to choose the diffusion by face-to-face mechanism and utilizing ICT.

Start-up E

Start-up E is a hybrid enterprise. Besides focusing on profit gain, Start-up E also improves farmers' social welfare by providing integrated agribusiness platforms, financial support, and training. The services were related to the start-up's role as a network enabler by providing various stakeholders with an agribusiness platform for a transaction. The start-up also provided transparent transactions and bridged problems between farmers and consumers as a payment intermediary. As a payment intermediary, Start-up E guarantees transactions between farmers and their consumers to protect them from fake transactions.

In planning, designing, and creating SI, Start-up E directly involved farmers in their business model. The implementation involved community empowerment, with a crucial role from key persons in the field. Within the process, the start-up depends on local heroes, especially young people, to teach older farmers to use the start-up platform. Thus, the approach strategy by local heroes is essential to familiarize start-up platforms for older farmers. Besides that, the approach to local government and authority supports the start-up's activity, especially in implementing social innovation. These activities influenced the DoSI.

Based on the description, Start-up E tended to make a basis of a strategy to achieve social goals by implementing an appropriate diffusion strategy and continuing to survive as a business organization through various co-creation activities with farmers, local heroes, local authorities, local government, and multiple stakeholders in agribusiness. In the operationalization, the planning activities optimized feedback from local authorities and local heroes, especially in deciding targets and implementing SI. The start-up considered an SME can bring social impact for farmers besides maximizing profit from their business. This start-up also benefited from learning by doing and learning by experimenting with upgrading knowledge and skill for increasing creativity and innovation. These activities utilized domestic networks, which involved the government, both central and local government, as well as local authorities, such as traditional leaders. These factors shape the innovation-decision process, leading the start-up to choose the diffusion by face-to-face mechanism.

Start-up F

As a social enterprise, Start-up F focused on improving farmers' welfare through increasing agricultural productivity using 4.0 technology. These attempts were related to the start-up's role as a knowledge broker. The start-up provided learning for farmers regarding the use of modern technology in agriculture, especially for monitoring soil quality and weather conditions.

Start-up F involved investors in planning, designing, and creating SI, especially deciding farmers' locations who could obtain 4.0 technology assistance. The implementation involved community empowerment, with a crucial role from key local persons in the field. The start-up spreads the shared vision to improve farmers' lives, which leads to their willingness, consciously or not, to apply the SI.

Within the process, the start-up continuously tried to communicate with its investors regarding the way of business that creates a social impact on farmers' lives through the implementation of 4.0 technology. This start-up depends on its investor to provide 4.0 technology for farmers. Thus, changes in the characteristics of investors also changed the start-up's activity direction as a consideration in the innovation-decision process, especially in the business planning or the designation of the supporting activities. These activities influenced the DoSI.

Based on the description, Start-up F tended to make a basis of a strategy to achieve social goals through implementing an appropriate diffusion strategy and continuing to survive as an organization through strengthening networks with their investor. In the operationalization, the planning activities also optimized feedback from investors, especially through the decision regarding farmers' location. Leadership from the founders characterized as social entrepreneurs also becomes an exceptional basis for forming the organizational culture. The start-up creates a social impact on farmers' lives through its business model by utilizing 4.0 technology to enhance agricultural productivity. The start-up considered an SME can bring social implications for farmers in several areas in Indonesia. To upgrade knowledge and skill for increasing creativity and innovation, this start-up also benefited from learning by doing, learning by experimenting, and learning from experts. These activities utilized domestic and foreign networks, which were open but limited to personal networks. These factors shape the innovation-decision process, leading the start-up to choose the diffusion by face-to-face mechanism and utilizing the project with the company's partners.

Based on the results, there were differences in the characteristics of the model of DoSI, which led to different characteristics of the innovation-decision process. Three types of DoSI models were identified: (1) the direct approach diffusion model, (2) the ICT-based diffusion model, and (3) the project-based diffusion model. These models describe the general flow of the DoSI.

Type 1: Direct Approach Diffusion Model

This model shows a diffusion pattern that relies more on a personal approach through face-to-face interaction. Before visiting farmers, the start-ups conducted preliminary research to explore the problems faced by the farming community and

their characteristics. After choosing a location, the start-ups would assign a person or a team to directly visit the farmers to introduce the innovation and help them find solutions to their problems. There were two types of interaction between start-ups and farmers. First, the start-ups directly approached the farmers. Second, the start-ups indirectly approached the farmers through intermediaries. Intermediaries (e.g., farmer shops, middlemen, head of the village) could act as “recommendation providers” or as “entry points” (e.g., traditional leaders) before the start-ups could interact with the farmers. In this first diffusion model, agri-tech start-ups attempted to establish or enhance farmers’ digital literacy by increasing their mastery of technology.

“We tried to observe there (farmers’ location) for more or less almost seven months. There are our teams who have been there for nearly 1.5 years. We tried to live there. We saw how we could observe what is lacking, from the farmers themselves, what we need to be able to dig there. That is why our start-up appears. So, from the beginning, we focused on (informal) research first. We collaborated with the farmers at the very beginning. When we went to the farm, we immediately knew the farmers, and then we also often hung out with them, drinking coffee for a personal approach. Then, for example, if we schedule an evaluation together, it is just by having a meal with our farmer friends and our team. We were sharing whether there were any problems or anything. They even came to a personal approach because they have family problems, asking to vent like that. The initial approach we used, the first one, is different. At that time, there were nine commodities, chilies, tomatoes, cabbage, carrots, etc. So, at that time, we were groping about the area’s primary commodities to have a selling point. For example, even if we were all (planting) the same (commodity), the results would be different due to the (variations of) skills of the farmers. Because sometimes, when we talk about commodities, the treatment for chilies and potatoes, for example, is very different. For example, if we are planting potatoes. Like it or not, we must know where the seeds are coming from because the main factor of the potato is in the seeds. If the seeds are good, then the results will be good. This often (happens) when you are in the field. You do not know where to get the seeds from. However, when we talk about chilies, we are talking about the market, not the production problem, since production is the same as any other commodity. For example, it can fall very much if we do not get the price. Because the capital (needed) for (planting) chilies is super expensive per hectare, it can be 150 million. So, we do research on which commodity we want to focus on. We have been running for two years this year. In this field, we focus only on Berastagi potatoes and carrots. Because it is the main commodity that is really good, we can handle it, and the farmers also have an excellent experience.” (Co-founder, Start-up A, online interview)

“Central Java and East Java are just different. So does for East Java, the approach must be through community leaders, and for West Java, you can go directly to the farmer groups.” (Top-level management, Start-up B, online interview)

“What is certain is that the more remote the area, the more difficult it is for the farmers to change the system. Yes, change the culture. Maybe what was in your questionnaire was considered a social status risk or whatever, right? It is just that they want the right approach. You cannot do it the way the city people do, come right away and offer money, come back right away, no, you cannot do that. You have to talk first. You have to be friends, a week or two weeks, or a month like that, and buy his stuff, little by little. After a while, we buy a lot, and he will later want to be our sourcing center. We cannot go straight.” (Founder/CEO, Start-up C, online interview)

“We have what is called a field specialist. The field specialist’s office is a field. They meet farmers every day, meet farmer groups, then they see their fields, see their gardens, see the process like that, and that is because, even though they are field specialists, their education is very high, and even their knowledge is excellent. So, as I said earlier, from an educational point of view, apart from building a good platform or relationship. Later, the field specialist will give some input or some alternatives, like, for example, most of our farmers have planted according to patterns that have been passed down for generations. So, it is difficult to say directly, “Sir, don’t use that plant watering technique. Use this technique”. There will be resistance. “No, I’ve used this pattern from my great-grandfather, this is already blah blah...”. This is, for example. They have one hectare and so many times so many meters, we ask, “sir can we use this as an example? Later, I want to show you the planting technique or method. I mean, we will see the results later”. If we provide an example, then at the end, it turns out that the results are better (than those obtained by the old method), they will feel open, and the trust is built from there.” (Manager, Start-up D, online interview)

“That’s right (agreeing that using a local resource person made the approach to farmers easier than the direct approach from a stranger). That’s why we appointed local people there. Usually, young people who understand the technology are used to using WhatsApp and typically communicate via the internet. It’s not easy to teach them either. You taught your (old) parents how to use the internet. You feel you have taught them, but they cannot understand immediately. You have to be extra patient with them.” (Co-founder/CEO, Start-up E, online interview)

The selection process of communication channels was started by approaching key or potential farmers. When key farmers were willing to adopt the innovation, which was successfully proven, other farmers in the same village would adopt the innovation and follow by farmers in other villages who have heard the success stories. This condition shows that diffusion of innovation went through past adopters and opinion leaders, as well as the spatial diffusion occurrence. Farmers who have heard the success stories would then try to interact with the start-ups to find out more about the offered innovation. The start-up would select the farmers by considering several factors. However, in the case of technological innovation, not every farmer who used technology from a start-up could master it. Often,

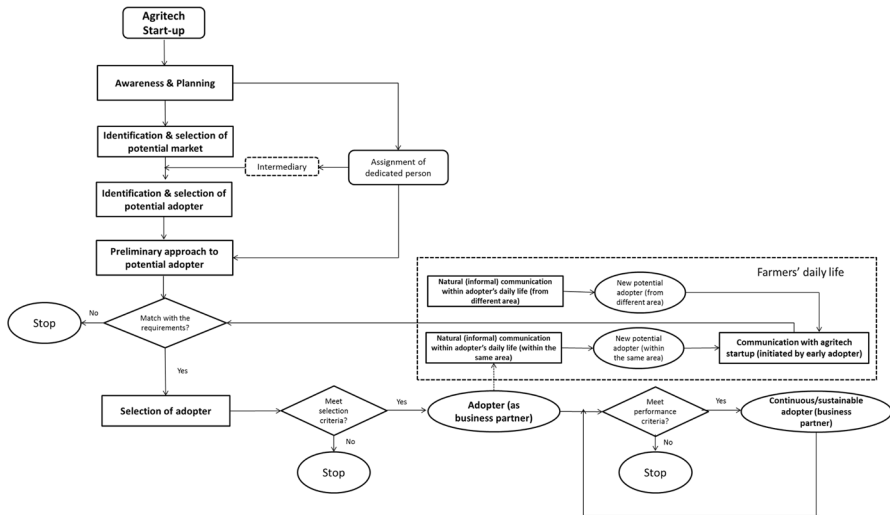


Fig. 2 Type 1 – direct approach diffusion model

these farmers required assistance from personnel/teams from start-up companies, their families, or close relatives to operate the technology. In addition to the key farmers, start-ups would usually approach the head of the farmer group, attracting other farmers to join and adopt the innovation offered by the start-ups. This model can be found in all case studies except case study F. The diffusion model is shown in Fig. 2.

“Of the various challenges we face in the field, not everything is smooth. So, we are finally looking for several other ways to approach farmers, including collaborating with a farmer’s shop. This farmer’s shop is one of our partners who help us choose recommended farmers. Like the gentlemen from the farmer’s shop, they must have memorized which one often takes products from them, pays in full, and has good product quality. That is the approach we are trying to take now. So we know which farmers are recommended. For example, oh Sir, go to farmer A, Sir. He is good, Sir. And for many other things. So that’s what we do for them to make it easier for us to trace farmers, along with recommendations from farmers who have worked with us, that’s what we do. However, the most important approach is when you have a deep chat with them, like hanging out together, having coffee or lunch together. We know that if they go to the market, for example, we just go with them and find out where they have lunch. So, yes, we have a team who are always on standby for them if there is a problem. They come right away. We have a house like that, Sir, in the area of the farmers we live in, so when there is a problem, they come directly to our team to tell us what’s happening. So far, that’s our approach, and we maintain it like that.” (Co-founder, start-up A, online interview)

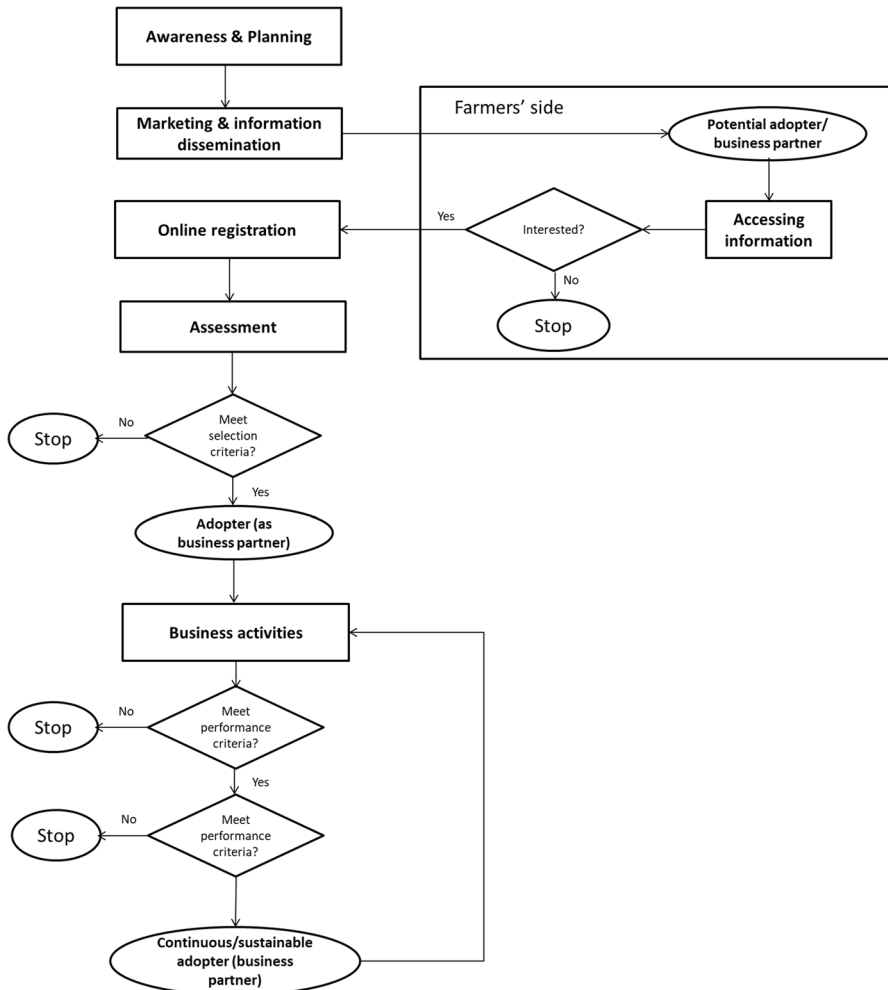


Fig. 3 Type 2 – ICT-based diffusion model

Type 2: ICT-based Diffusion Model

This second type of diffusion model utilizes digital media/information and communication technology as the primary communication channel for the diffusion of innovation. In this model, the start-up targeted farmers with digital literacy, especially those who own and can operate a cell phone/smartphone for browsing the internet. Farmers tend to be more active in the diffusion process, seeking information from various media, including start-up companies' websites. Furthermore, interested farmers would sign up to be the start-ups' partners through the website by fulfilling various set requirements. This diffusion model is found in case studies B and D, as shown in Fig. 3.

“First, we have data collection. In this data collection, we collaborate with institutions or people whom we call local heroes. This local hero knows farmers who want information access, so we direct them to our application. Now, if he/she uses our application, we can identify who can make (online) transactions, and then we will lead them to become our partners, so there are stages. So initially, we went through data collection carried out by this local hero.”
(Top-level management, start-up B, online interview)

Type 3: Project-based Diffusion Model

The third type of diffusion model is slightly different from the two previous types. In this model, the start-up carried out the project-based diffusion. In this type, start-ups rely heavily on projects whose funding comes from the Indonesian government or financial institutions, either domestic or foreign. Start-ups involved in this kind of diffusion model were technology developer/technology-based start-ups, whose technology level and price of innovation were still far beyond the capabilities of farmers. Through this project, the project owner “bought” the start-ups’ innovations in order to diffuse the innovation to the farmers. In this case, the project owners had the authority to determine the location of farmers as potential adopters. From the specified location, the start-ups – represented by their field workers and assisted by facilitators from the project owners – approached the potential farmers, especially those who have the enthusiasm to work together and have utilized smartphones in daily life. Therefore, the diffusion depended on the location determined by the funders. The diffusion model is shown in Fig. 4.

“So, actually, for this area, we didn’t choose, because for that area we didn’t move alone. We usually have a facilitator from the Ministry of communication and information, the Ministry of agriculture, and the Ministry of Village. But usually, those who have the projects are also different. For example, in the project in Sukabumi and Pasaman Barat areas, we collaborated with an international bank, and then in Dompu, we worked together with a famous domestic bank. And then, like in the Situbondo area, we worked together with our central bank. So, we do not go it alone because that’s how it is. If we go directly to the farmers, it will be difficult for them to buy the sensors if we want to sell them because the sensors are relatively expensive. That’s why we participate in the project, whether from whoever is the facilitator or the initiator, so we participate in smart farming projects. There, they buy our sensors. Their farmers know our application, and so on. We have been running for three years since 2018, and we also feel it ourselves, for example, when we deal with farmers who are still traditional and are old enough. They don’t even use smartphones, even though our application requires an Android smartphone, so it is difficult, and it makes the farmers feel sad if there is a regulation. They are forced to use it. So, our company is aware of this, so we focus on our targets, not the traditional ones, who have never even used a smartphone, we don’t target. So, we focus on farmers whose terms are more, at least have used a smartphone.

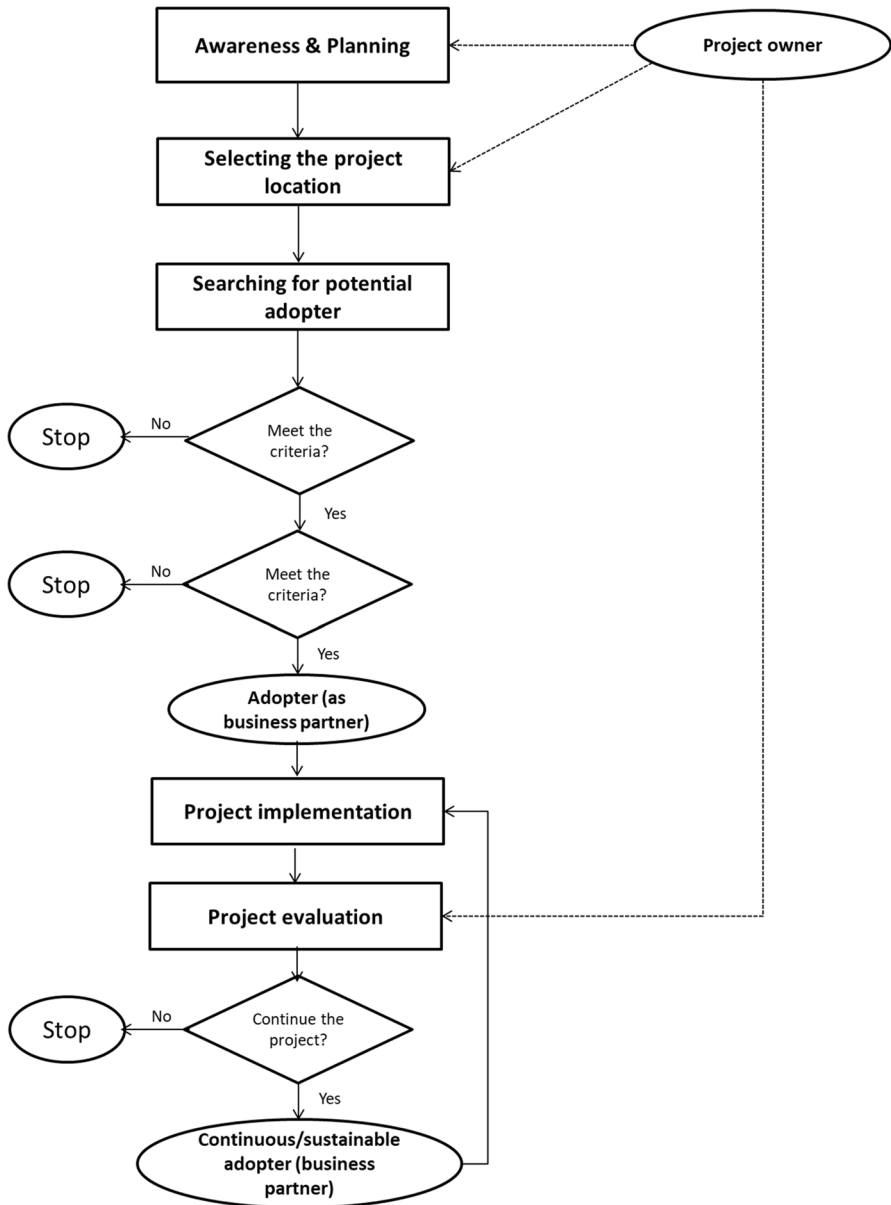


Fig. 4 Type 3 – project-based diffusion model

So, because our network is quite good, from one ministry to another, it can be both ways. Yes, there are indeed those we are invited to, some we initiate and offer cooperation. So, for example, our CEO is also now appointed as staff, especially the Ministry of Agriculture, or from marketing. Our CEO used to have relations with the Ministry of Communication and Informatics,

Table 3 The implementation of the diffusion of innovation model by the agri-tech start-ups

Agri-tech start-up	Type of diffusion model		
	Direct approach	ICT-based	Project-based
Start-up A	V		
Startup B	V	V	
Startup C	V		
Startup D	V	V	
Startup E	V		
Start-up F	V		V

the Ministry of Industry, and so on, including national and international banks.” (CTO, Start-up F, online interview)

Overall, the agri-tech start-ups tended to apply the first type of diffusion model – the direct approach type (Table 3). However, there were also agri-tech start-ups combining this first model with the second one – the ICT-based type. Only one agri-tech start-up in this case study employed the project-based approach. Even though further examined, each start-up has different conditions for each influencing factor regarding the diffusion from the innovation management perspective. These factors influenced the diffusion model and the innovation-decision process’s characteristics and further shaped the bridging roles. Nevertheless, the start-ups tended to combine two or more diffusion models, which led to adopting at least two types of innovation-decision processes, except for Start-up F.

Further examining the diffusion process results based on the six case studies, the models indicate differences in the stages of the innovation-decision process and the characteristics of each stage. The source of variation came from the differences in the characteristics of the innovation. Some start-ups provided solely social innovation, and some start-ups provided combinations between traditional and social innovation for farmers or other actors within the agriculture system. There were three variations of the innovation-decision process, as shown in Fig. 5, Fig. 6, and Fig. 7.

1. Type A – key adopter selection focused

The first diffusion model differs slightly from the basic model – from awareness and planning to the implementing stage – but with certain feedback activities. The awareness and planning stage was carried out following the company’s mission, the characteristics of the innovations, the characteristics of the farmers, and the farmers’ needs. The identification was conducted through in-depth research over a long period so that it became the basis for the development of digital technology as a medium to diffuse it. The agri-tech start-ups assigned dedicated persons as field managers to explore the potential obstacles in interacting

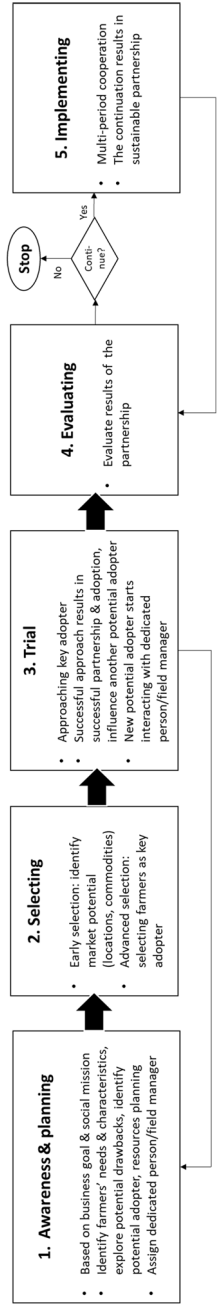


Fig. 5 Type A innovation-decision process

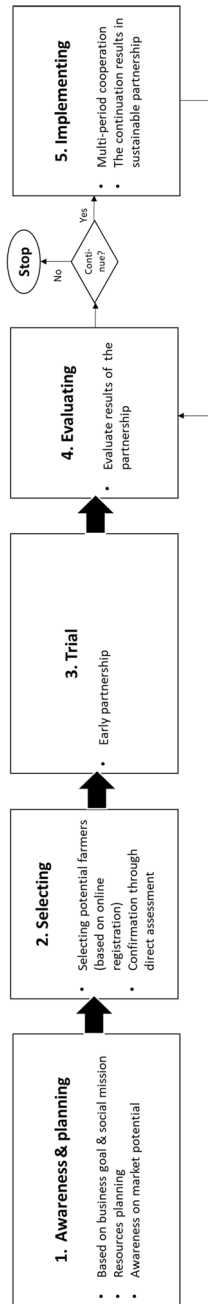


Fig. 6 Type B innovation-decision process

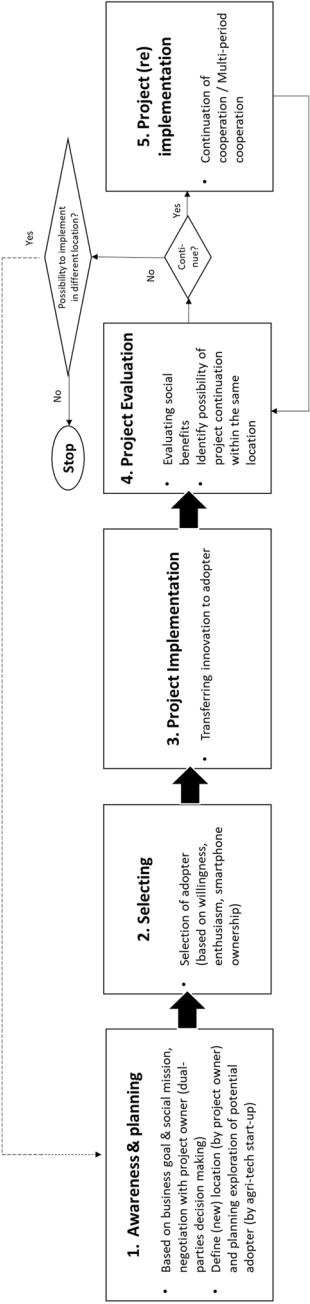


Fig. 7 Type C innovation-decision process

with farmers in specific locations. They were also appointed to identify and select the right intermediary to approach potential adopters.

2. *Type B – digital-literate adopter focused*

The agri-tech start-ups that applied this innovation-decision process were usually active in online marketing to farmers. Based on the information from the start-ups' websites, the farmers were required to conduct online registration before beginning the partnership, indicating that they focus on farmers already familiar with digital technology. The start-ups selected potential farmers based on the information they provided through the registration, which was confirmed by direct assessment afterward. This innovation-decision process did not directly approach the potential farmers, as found in Type A. Similar to the first model, the last stage, the implementing stage, would only occur if the evaluation resulted in the continuation of the partnership.

3. *Type C – recipient's readiness focused*

The agri-tech start-ups applying the Type 3 model tended to have project-based business activities. The most significant difference of this model compared to the previous two was the absence of a "trial" stage, but there was "project implementation" instead. The innovation as the core part of the project was directly implemented after the adopters were selected. If the evaluation yielded a positive result, the innovation or the project would be re-implemented within a similar or different location. If the project is implemented in the same location, it becomes the continuation without repeating the complete stages of the first and second stages of the innovation-decision process. Diffusion to another area was possible but depended on the project owners' decision. The sustainability of this project-based diffusion depends on the continuation of the funding from the project owner because the diffused innovation was high or medium-high technology that also required high cost.

The comparison among the three types of innovation-decision process is shown in Table 4. Each model has different characteristics regarding the decision-making, communication channel, type of innovation adopter, required precondition, and determinant factors for the success of the DoSI. Each model has its advantages and disadvantages.

Discussion

Theoretical Implications

This research provides a theoretical contribution to clearly distinguish the differences between SI conducted by the private sector and traditional business innovation. The unique characteristics of SI can occur in terms of purpose, the characteristics of the product/services, ways of creation, context, mental models, dimension,

Table 4 The comparison of the type of innovation-decision process

Aspect	Type A	Type B	Type C
Decision-making characteristics	Start-up as the decision maker; considering market potential but still aligning with a social mission	Start-up as the decision maker; considering market potential but still aligning with a social mission	Project owner as the decision maker in terms of the spatial aspect), start-up as the decision maker in terms of adopter selection based on the social mission
Type of diffusion	Spatial (systematic), from one area to the nearest neighborhood (affected by word-of-mouth factor from early adopter); new different area (far from initial location) must first be initiated by the start-up	Spatial (diffused) according to the location of the farmers who access the start-up's website	Targeted location; the spatial diffusion depends on the decision of project-owner
Communication channel	Internal: field personnel (field manager) External: local actors (traditional leader, local leader, early adopter farmer, etc.)	ICT (especially website); supported by field personnel	Internal: facilitator/field worker External: early adopter, project owner
Type of innovation adopter	Passive adopter	Active adopter	Passive adopter with low access to innovation source
Required precondition/determinant factors for the success of the diffusion	Capacity and capability of the field workers; proper selection of intermediary/communication channel	Digital literacy of the adopter; sufficient infrastructure condition	Availability of funding; active participation of the adopter
Advantage	High social benefit (especially for the farmers in peripheral areas and low digital and financial literacy); build a long-term relationship Need more resources and time; much depend on the agri-tech start-up's resources and managerial capacity (mainly to attract investor)	Low social benefit; resource-efficient	Low-medium social benefit; increase farmers' technological capability level (by adopting advanced digital technology)
Disadvantage		Depending on the popularity and "traceability" of the start-up on the internet; only farmers with high digital literacy can access	Depending on the availability of funding (from external parties) to obtain resources, quite challenging to find the appropriate farmers as the adopter

evaluation criteria, and diffusion characteristics. Nevertheless, based on the results from the case studies, there were variations in these aspects due to the enterprise's characteristics concerning the level of social entrepreneurship.

The start-ups presented SI aligned to the fundamental substances underlying the work from Tidd and Bessant (2009) "4Ps" approach to innovation space. The substances can be further translated into their purpose, product/services offered, ways of creation, context, mental models, and evaluation criteria. SI can also be considered paradigm innovation from traditional business innovation. Regarding the ways of creation, agri-tech start-ups preferred a direct approach to farmers through local resource persons. The resource persons are those who had an understanding not only in terms of agricultural production techniques but more of the socio-cultural aspect, which further created community empowerment by showing co-creation activities. In terms of mental models implemented by the start-ups, there were differences between the start-ups, which were social enterprises, and the ones which were hybrid enterprises. The variation leads to enterprises' evaluation criteria for the resulting SI. Social enterprises tend to maximize the social impact but with minimum profit to run their business.

In contrast to social enterprises, hybrid enterprises tend to achieve maximum social impact. Nevertheless, this type of enterprise still maintains sufficient profit to enable business development. Nevertheless, there is an indication that the level of benefits and social impact differed between and among the hybrid and social enterprises. Furthermore, hybrid enterprises do not consider a particular social impact measurement. Even though Start-up D, categorized as a large enterprise, has already provided specific measurement and reporting regarding social impact. The requirements from the foreign stakeholders influenced this condition.

The start-ups with only domestic stakeholders still need to implement similar measurements or specific reporting. This condition shows foreign stakeholders' influences in driving the occurrence of particular indicators and reporting regarding social impact. Furthermore, empirically, SI is related to economic, social, and cultural dimensions. In some cases, the technological dimensions only occur regarding the type of products and services and start-ups' strategy.

This research identifies variations in the innovation-decision process based on the different characteristics of the start-ups concerning the variation of the DoSI model. This research also found unique characteristics between DoSI and diffusion of "traditional innovation," especially in the "delivery" process. DoSI tends to have a longer time and requires different actors' roles as communication channels compared to the diffusion of traditional innovation since it involves a social process in the community. In addition, the communication channel in the DoSI can be distinguished into three categories which include (1) intermediaries (as a facilitator who help bridge direct communication between the source and the adopter); (2) indirect hub (which helps throughout the diffusion and adoption process); and (3) direct hub (direct interaction). This finding enriches the concept of the communication channel from Rogers (2003).

Furthermore, this study identifies the variations of DoSI, which implicate the variations of the innovation-decision process model. Each model has particular characteristics. The characteristics that underlie the differences among the models

involve three aspects: (1) market conditions that imply different actors involved; (2) the characteristics of the farmers as the agri-tech start-up's partners that determine the ability to adopt social innovation; and (3) the characteristics of the company that determine the availability of resources devoted to achieving its social mission. These facts provide evidence that the private sector had essential roles in developing SI, which in this paper is referred to as DoSI.

There was evidence that digital technology can be an enabler for the diffusion of various types of SI, as also found by Hölsgens and Reichow (2019). However, farmers' adoption of digital technology, as targeted by the agri-tech start-up's social mission, did not occur as a flawless adoption. The adoption was only a "partial adoption" – an imperfect condition where even though the farmers have the technology, the adopter does not entirely own and use it. Even though it is imperfect, the adoption can still support the diffusion of SI, with assistance from the field manager/dedicated person or other family parties. Their existence is also part of the agri-tech start-ups' strategy in carrying out SI with attempts to upgrade farmers' digital literacy.

The DoSI involving digital technology is related to the concept of "traditional" innovation diffusion and participatory models (Morris, 2003). This fact brings out the need to redefine the concept of SI. The concept of SI, which is more widely understood within the institutional perspective and emphasizes the outcome primarily related to the social goals, also needs to connect it to the social processes to attract the participation of various actors. This finding aligns with Morris (2003), who has slightly touched on blending the diffusion and participatory models. In the case of agri-tech start-ups in Indonesia, the diffusion model of social innovation can solve the farmers' long-term problems, such as limited access to information and resources regarding finance, knowledge, technology, or human resources.

This study found that brand image from the agri-tech start-ups did not determine the "marketing" level of SI as found in Type 1 and Type 3 diffusion model. This finding differs from Florea (2015) and Holt (2013) findings. However, the brand image becomes vital for the Type 2 diffusion model. This condition occurs due to the different characteristics of farmers who are already digitally literate. Thus, they have trust and can easily access information since the start-ups have much information available on various internet sources.

Based on the characteristics of early adopters, the DoSI conducted by agri-tech start-ups leads to the epidemic model (Fisher & Pry, 1971). However, in some specific cases, the adopter does not purchase the technology but is only limited to utilizing innovations in the form of digital technology. This condition shows the role of the communication network. Nevertheless – slightly different from the social cohesion model – the DoSI by the start-ups is dominantly influenced by actors in the inner circle or trusted parties who become opinion leaders from the community or the government. This finding is slightly distinctive from the theory proposed by Rogers (2003), which emphasizes the characteristics of innovation as the main factor influencing diffusion. The results of this study show that only one element, observability, becomes an essential factor. This circumstance is well-considered by agri-tech start-ups carrying the DoSI to the farmers.

The results of this study also refute The Fad Theory (Abrahamson, 1991) that states that innovation does not move within a social system. On the other hand, the results of the multiple case studies show that the social innovations by agri-tech start-ups can move within and between social systems. The movement occurs through spatial diffusion to other areas with similar or different social system characteristics. Within the social system, farmers interact with other farmers who became early adopters to different areas considered potential or within the same area but with different adopters when the diffusion is considered successful.

Furthermore, although the DoSI by the agri-tech start-ups involved various actors, the potential early adopters were the network's core or the one having a higher network position. They could have a similar position in the network if trust occurred within the social system. The trust was often built from informal interactions between/among the farmers, especially the early adopter(s) and the potential adopter. This finding is different from the argument of The Social Cohesion Model.

Regarding the entrepreneurial side of agri-tech start-ups, if SI is generally considered the means for a social entrepreneur to achieve a social mission, then there is an indication that there is a convergence between the concepts of SI and technological innovation in the case of digital technology. As an implication, the term social entrepreneurship also converges with technopreneurship. Digital technology also helps the diffusion of non-technological SI.

The finding from Weerawardena and Sullivan Mort (2006) revealed that the social mission achieved through social innovation is not a sacred goal as has been believed traditionally and suggested that the role of social mission must be embedded within the competitive and dynamic environment of the organizations. Based on the multidimensional model Weerawardena and Sullivan Mort (2006) developed, the COVID-19 pandemic's effect faced by agri-tech start-ups relates to the sustainability aspect concerning risk management. Indeed, to get through it, a balance among entrepreneurial drivers to obtain profit is necessary for the organization's continuation. This research confirms and strengthens this argument. Besides keeping their competitiveness and aligning with their social mission, the agri-tech start-ups also need to survive amid uncertainty caused by the COVID-19 pandemic and maintain the business' sustainability, which will have an impact on the sustainability of farmers' welfare. For example, in the case of study A, as a social enterprise, the start-up still tries to gain profit to develop and sustain the business, not just to achieve the break-even point.

On the other hand, case studies B, C, D, and E show that agri-tech start-ups are dominantly profit-oriented with a small portion of social missions. However, case study F is slightly different from the other cases. In achieving its social mission, the start-up was not entirely taking control but involved external parties, e.g., project owner. This condition shows that the level of social entrepreneurship also determines firms' strategy for fulfilling their social mission.

Prabhu (1999), who conceptualized social entrepreneurship, suggests that the ability to take risks may be high, given that social experiments are conducted in good faith. Both success and failures are rich learning experiences. He also finds that social entrepreneurs' behavior in facing risk is highly constrained by their primary objective of building a sustainable organization. This research indicates that

social entrepreneurs are risk-averse due to the pandemic. The company's growth and sustainability issues are the current focus. The rise of this issue indicates that the awareness stage is the initial stage as a basis for the diffusion and commercialization of innovation. However, this commercialization is not always become the primary goal. It implies that there are issues considered for the long term in improving farmers' welfare and safety. In addition, agri-tech start-ups also provide support to overcome farmers' lack of digital literacy since low literacy causes the imperfect adoption of digital technology. An "imperfect adoption" is a form in which the potential adopter has decided to use it without having full authority and ability to continue to use it independently. In other words, farmers still need assistance from other parties in operating the technology.

Based on the previous explanation, agri-tech start-ups had a role in the emergence and spread of SI. Furthermore, the DoSI and the innovation-decision process characteristics can also differ depending on the strategy, process, organization, learning, and network factors. The condition of these factors also determines the choice of the bridging role of agri-tech start-ups in generating social impact. Strategic factors for social and hybrid enterprises tend to differ since the evaluation criteria differ even though they both have a social mission. These differences are also influenced by organizational characteristics, especially leadership, size, and organizational culture, determined by leadership characteristics. Leaders from social enterprises are more inclined to the character of a pure social entrepreneur. Meanwhile, leaders from hybrid enterprises still have the characteristics of traditional entrepreneurs.

The business scale, related to brand image, also determines the variance and scale of activity, affecting the social impact level. Networks built by start-ups also support a bridging role, especially in knowledge and resource brokers and network enablers for farmers. In order to be able to overcome various obstacles and challenges in the DoSI, start-ups learn in various ways, which, apart from being supported by leadership and network factors, are also determined by organizational culture. The DoSI process, including the innovation-decision process itself, tends to be non-linear. There was feedback between/among stages, where the results of the learning activities would significantly influence the quality of the feedback itself. Based on this finding, this study enriches do Adro et al. (2022) work regarding factors influencing SI performance in non-profit organizations. Apart from the five factors influencing the outcome of SI, the case studies found that these factors also determine the process that goes through and the bridging role played by agri-tech start-ups. Advancing the finding from do Adro et al. (2022), who provided evidence for NPOs, these factors are also applied to social and hybrid enterprises. Figure 8 shows the relationships between the factors and the steps to achieve economic and social impact for the organization and community.

Practical Implications

This research brings practical implications regarding the strategy for DoSI through the innovation-decision process with a particular variation of characteristics. Each start-up has a unique or case-specific strategy for creating SI, which

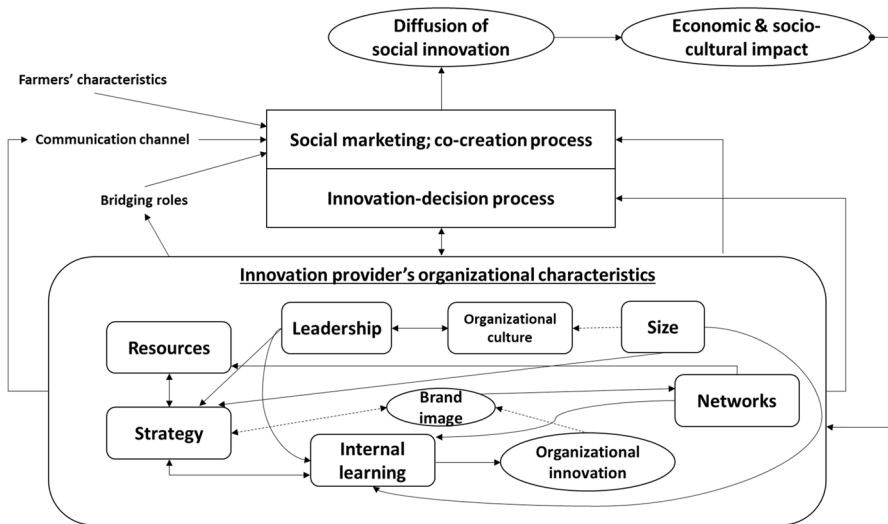


Fig. 8 Interrelationships among innovation provider's organizational characteristics, innovation-decision process, and diffusion of social innovation

is expected to have a social impact aside from profiting for business organizations, especially hybrid ones. In this case, the start-ups need to pay attention to the conditions of various factors, namely strategy, process, organization, learning and networks, brand image, as well as economic, social, and cultural conditions of farmers, including the condition and characteristics of investors and any other stakeholders as part of start-ups networks.

As start-ups depend on the condition of consumers as their market, changes in the consumers' conditions also need to be of particular concern. The start-ups should focus on more than just the conditions of farmers. The existence and continuity of economic activities and the social life of farmers depend on various things in the agricultural system, including the tendency to depend on start-ups. Therefore, start-ups should hold only crucial roles that may bring high risk to the core competencies and business continuation to reduce the “burden,” which can affect resources, energy, and time. Other roles that are not highly disruptive should be shared with other parties as much as possible, taking into account sustainable strategic partnerships in terms of financial support and any other tangible or intangible supports.

Due to the dynamics of consumers and farmers, especially their economic and social life, where poverty in various countries is also increasing, the conditions will gradually trigger changes in the behavior of consumers and farmers. With various uncertainties that arise, there is a tendency for money, which currently tends to be the primary medium of exchange, the potential to be increasingly scarce. Furthermore, with the threat of inflation, crisis, or recession in

many countries worldwide, start-ups also need to start thinking about future digital and conventional business models that can be applied to deal with the worst conditions where money is formidable to be obtained. This issue may become a global challenge that needs a solution and mitigation.

Therefore, it is necessary to consider restarting the barter or debt bondage system, as well as a trade-in in various business transactions between start-ups and farmers and consumers, whether in the form of products or services provided. In its implementation, it is also necessary to consider business integration with small-scale local traders, who often exist in local markets, and with various supply chain actors for daily necessities or intermediate and final consumers. The implementation must be based on the principle that “what we need is the fulfillment of life’s necessities and not just collecting money.” Therefore, the business model being developed, including digital platforms for digital business models, needs to think about transactions that are not only based on exchanging money but can also involve bartering between goods/services needed. For example, for farmers, the credit given may not be in the form of money but rather in the form of production tools and other production facilities and infrastructure. Likewise, the return does not have to be in the form of money, but it can also be in the form of goods or services.

The business model and platform also need to be designed to allow for “charity” transactions where parties with excess income or resources can donate to those in need. The design may also include integrating CSR activities carried out by various companies. In its implementation, alternative means of exchange can also be considered in the form of digital coins or vouchers that can be exchanged for goods/services. The medium of exchange should not be able to be cashed but can be used to buy or give to other parties in need. This mechanism can be applied not only to the case of agri-tech start-ups in Indonesia but also to various companies or other activities involving the private sector worldwide to create inclusivity. In this case, digital trade integration, interconnected value chains, and support for transportation and logistics activities for borderless delivery or exchange between countries are needed to support economic and trade policies. This concept can also be a solution for humanitarian assistance for emerging countries or countries affected by disasters or calamities. For this reason, it is also necessary to have special hubs that can become brokers to overcome the problem of access to digital transaction platforms or conventional transactions.

The hub becomes essential because it is likely that many people cannot carry out transactions due to distance, internet access, or any other limitation in the infrastructure aspect. Furthermore, it will also require “rules of the game” that are always adapted to the dynamic economic, social, and environmental conditions so that all transactions can be carried out with professionalism and transparency and hindered from unsustainable practices. Since the “rule of the game” may involve various parties, appropriate government regulations are needed.

Conclusion

SI is a potential solution to various community problems and challenges, including in the agricultural sector. This type of innovation is considered a paradigm innovation of TI. Nevertheless, since the literature is scarce, SI still needs to be widely understood as TI, especially in Indonesia. Furthermore, the role of the private sector in developing SI needs to be sufficiently explored. This paper attempts to contribute to these aspects.

SI can be distinguished from TI in terms of purpose, product/services offered, ways of creation, context, mental models, and evaluation criteria. The characteristics are varied due to the type of enterprise. Furthermore, the development of SI, which in this paper is referred to as diffusion of social innovation (DoSI), shows a clearer distinguishment from TI regarding the “delivery” and the communication channels involved.

DoSI is a process that spreads SI from the source to the recipients. There are three models of DoSI, with different types of innovation-decision processes. Based on the empirical case studies, there are three diffusion models: 1) direct approach, (2) ICT-based, and (3) project-based. Agri-tech start-ups often use the combination of the ICT-based and direct approach as a part of the strategy to optimize the DoSI. Each model has both advantages and disadvantages in achieving its goal. Based on the DoSI models, SI – often seen from the institutional perspective – also involves various actors in developing or implementing the SI seen from the structuration perspective. Therefore, redefining SI by converging the two perspectives is necessary to obtain a complete picture of the system.

From the innovation providers’ side, innovation-decision relates to project stages and decision-making within it to deliver SI with a specific marketing strategy by adjusting the level of commercialization and the social benefit they provide to the farmers. The general innovation-decision process consists of five stages: awareness and planning, selecting, trial, evaluating, and implementing. Empirically, based on the case studies, the stages can occur in different variations depending on the type of diffusion model the agri-tech start-ups choose. There are three different types of innovation-decision processes: (1) the key adopter selection focused, (2) the digital-literate adopter focused, and (3) the recipient’s readiness focused. Each type has advantages and disadvantages and leads to a different diffusion model. The decision-making during the innovation-decision process tends to be based on internal resources, especially for the awareness and planning stage. In the selecting stage, decision-making is grounded more on the criteria to select business partners who also act as the recipient of the social innovation. However, these criteria can be varied according to the characteristics of social entrepreneurs and the selection of commercialization and SI diffusion strategy from agri-tech start-ups. The process is also influenced by strategy, process, organization, learning, and network factors. The brand image and farmers’ characteristics also have particular effects.

In developing SI, agri-tech start-ups play roles in creating and spreading innovation. During diffusion, agri-tech start-ups also hold bridging roles as network enablers, knowledge brokers, and resource brokers. Nevertheless, based on the case studies, not all start-ups play a role as transparency and conflict resolution agent and also as shared vision champions. The roles played are influenced by their strategy, which is shown in the process, organization characteristics, type of learning process, and type and range of the networks.

Digital technology plays an essential role in the diffusion process, either as a communication channel, as a medium for diffusion, or as the innovation itself. When digital technology occurs as a form of SI, the DoSI conducted by agri-tech start-ups can result in either perfect or imperfect technological innovation adoption, which depends on the digital literacy of the farmers as adopters. Nevertheless, SI can still spread out with the support from fieldworkers assigned to monitor the farmers' activities and assist farmers' digital technology adoption process. The support also comes from the farmers' close relatives, especially the young ages. For farmers with a low level of digital literacy, the digital technology provided by the agri-tech start-up can be perceived as a radical innovation. The increasing role of digital technology is affected by the presence of the concept of socio-technopreneurship. This concept converged from three basic concepts: entrepreneurship, SI, and technological innovation.

This research has practical implications for managing agri-tech start-up companies, especially for strategic planning of a sustainable diffusion from agri-tech start-ups and farmers during and after post COVID-19 pandemic. The research also suggests future business models when crises, recessions, natural disasters, or catastrophes threaten the global economy. In addition, this study also brings implications that government supports and global cooperation are required for sustainable DoSI to create inclusivity for the community and encourage rural or marginalized community development.

This research still has limitations, mainly because it only analyzes the agricultural sector. The analysis needs to clearly distinguish each type or category of SI with different characteristics. Therefore, future research is needed, especially studies related to the conditions of the DoSI and the innovation-decision process in other sectors for each possible SI category. This research also has limitations in not observing the diffusion period to compare the diffusion model's efficiency and effectiveness as the result of the innovation-decision process. The basis for selecting the diffusion model as an agri-tech start-up's diffusion strategy can be related to the business scale and the company's position within its life cycle. However, this study still needs to look deeper at these aspects. This research also needed to distinguish the diffusion of each type of SI carried out by agri-tech start-ups and provide exact measures of the resulting social impact based on a comparable indicator. Future research is also essential to observe the more specific required resources and speed of the diffusion and a more in-depth exploration of each type of SI regarding the value propositions of the involved actors.

Appendix

Table 5 Case study profile

Aspect/case study	Start-up A	Start-up B	Start-up C	Start-up D	Start-up E	Start-up F
Company's characteristics (type of services, number of employees, type of company)	1) Employee: 45 2) Type of services: - E-commerce - Peer-to-peer (P2P) lending 3) Type of company: social enterprise	1) Employee: unknown 2) Type of services: - Application development - E-commerce - Agriculture database - Logistic distribution 3) Type of company: "traditional" (profit-oriented) company with a social mission	1) Employee: 200 2) Type of services: - E-commerce (B2B) - P2P Lending 3) Type of company: "traditional" (profit-oriented) company with a social mission	1) Employee: 336 (non-permanent) and 359 (permanent) 2) Type of services: - P2P lending - E-commerce (B2B and B2C) - Supply management business 4) Type of company: "traditional" (profit-oriented) company with a social mission	1) Employee: 15 (permanent) and 12 (non-permanent) 2) Type of services: ecosystem platform 5) Type of company: "traditional" (profit-oriented) company with a social mission	1) Employee: unknown 2) Type of services: - precision farming - e-commerce 3) Type of company: social enterprise
Digital technology provided by the agri-tech start-up	1) Agri Credit Scoring, 2) Surveyor Apps, 3) Field Manager Apps, 4) Fintech Apps 5) Project Manager apps	1) Knowledge sharing platform 2) E-commerce platform 3) Agricultural statistic platform 4) Logistic platform	1) Enterprise Resource Planning (ERP) 2) E-commerce 3) Chatbot	1) E-commerce platform 2) P2P lending apps 3) Farmer's apps 4) Crop monitoring apps	Agricultural ecosystem platform (including economic transactions, logistic services, financial services, production facilities and infrastructure, and quality management.	1) Land and weather sensors with IoT technology 2) E-commerce 3) Drone surveillance and drone sprayer (suspended due to small demand)

Table 5 (continued)

Aspect/case study	Start-up A	Start-up B	Start-up C	Start-up D	Start-up E	Start-up F
Mission	Bring happiness through agriculture: using technology and collaborating to develop agriculture; empowering local communities; improving the economy and welfare; creating agripreneurs.	Accelerate Village Modernization; providing a fair price for farmers; bridging farmers to consumers	Justice for farmers and consumers by creating price transparency on both sides.	Agriculture for everyone: One-stop platform to grow customers' food businesses and provide kitchen ingredients through value-for-money offerings, access to funding, and an efficient supply chain to become the reliable business partner of their clients	To become the digital industry leader in the agribusiness sector; to benefit Indonesia's economy; to pursue agribusiness actors' welfare; to create an integrated agribusiness ecosystem through daily technology solutions; to pursue a fair and transparent transaction for all actors for sustainable business.	To become a number-one agri-tech company in Indonesia; to achieve the welfare of farmers, breeders, and fish cultivators.
Form of social innovation	1) Financing for farmers through P2P lending 2) Developing cultivation techniques and financial literacy	1) Interactive knowledge sharing between extension workers and farmers through social media 2) Invite farmers to sell using e-commerce apps 3) Setting quality standard 4) Financial access 5) Waste processing	1) Financing through an internal funding source	1) Financing through P2P lending 2) Developing cultivation technique	1) Providing a digital platform that connects various agribusiness actors 2) Bridging the economic transaction process between farmers and consumers through the platform and joint bank account. 3) Facilitating discussion forums and providing educational videos for farmers' knowledge sharing 4) Disseminating online and offline tutorials for apps operation	1) Delivering technological learning to operate apps for weather and land monitoring

Table 5 (continued)

Aspect/case study	Start-up A	Start-up B	Start-up C	Start-up D	Start-up E	Start-up F
Characteristics of adopter	1) Good credit score 2) Age 37–45 (majority), a few under 25 3) Member of farmers' group or have a partnership with business	1) Own smartphones 2) Age 30–40 (majority) 3) Sufficient level of digital literacy to operate online applications 4) Can communicate directly with consumers 5) High-quality product standard	Member of farmers' group	Young age	1) All kinds of farmers and fishermen 2) Age 25–50 (40–50 in the majority)	Appointed by the program owner
Targeted location criteria	1) Type of commodity(s) 2) Land assessment	Focus on Java area, but currently has covered all 34 provinces in Indonesia	Any farming area with a suitable climate	1) Center of vegetable and fruit crops production 2) Relatively close distance from the headquarter	1) Potential commodities	1) Determined by program owner (grant provider)
Actors involved in the diffusion process	1) Field manager: assists farmers in operating applications and documenting data 2) Key farmer as an opinion leader	1) "Local heroes," such as youth organizations: approach farmers 2) Local government: to disseminate information and direction to farmers	Field agents: to stay at farmers' location	1) Field specialist: assisting farmers with cultivation techniques and apps operation 2) Farmers' children/family members: to help operate applications	1) Local youths: assisting senior farmers in operating applications 2) Government (local and central): opening the access to reach the farmers 3) Extension workers: assisting farmers to recover the land, to improve production and post-production process	1) Field agents: assisting farmers in operating applications 2) Extension workers: persuading farmers to use the sensor and apps, assisting them to operate it.

Table 5 (continued)

Aspect/case study	Start-up A	Start-up B	Start-up C	Start-up D	Start-up E	Start-up F
Approach used for dif- fusion	1) Cultural approach 2) Key farmers approach	1) "Local heroes" approach 2) Cultural approach 3) ICT-based (as an alternative option for digital-literate farmers)	1) Field agent approach 2) Building sourcing cent- ers in the local area 3) Cultural approach	1) Field specialist/agent approach 2) Key farmers approach 3) Cultural and social system approach 4) ICT-based (as an alternative option for digital-literate farmers)	1) Government approach 2) Key figure approach 3) Youth approach	1) Government/ NGO program approach 2) Extension worker approach

Table 6 Comparison of influencing factors to the diffusion of social innovation based on the innovation provider's perspective

Factor	Startup A/ianjoy	Startup B/δvillage	Startup C/edenfarm	Startup D/tanihub	Startup E/ekosis	Startup F/msmb
Strategy	Combining open and closed innovation, close relationships with farmers and investors; crowdfunding	Closed innovation; internal source of capital	Combining open and closed innovation	Combining closed and open innovation	Combining closed and open innovation	Closed innovation; project-based; network strengthening
Processes (control for each feedback)	Informal R&D depends on key resource persons in the field, community empowerment	The process depended on the approach strategy by local heroes to farmers; approach to the local authority; deploy market needs to the overall process	The process depended on key resource persons in the field	Informal R&D; depend on key resource person in the field; community empowerment	The process depended on the approach strategy by local heroes to farmers (young people); approach to local authority and local government	The process depended on investors to deploy technology for farmers and key resource persons in the field
Organization (culture, leadership/ entrepreneurial characteristics, size)	Social enterprise (SME), had a mindset in providing as great as possible social impact to farmers with minimum benefits for the organization	Hybrid enterprise, maximizing benefits but still contributing to farmers (via non-CSR program)	Hybrid enterprise (SME)	Hybrid enterprise (LE)	Hybrid enterprise (SME)	Social enterprise (SME)
Learning (activities regarding knowledge gain and upgrading)	Experiential learning; learning by doing and experimenting; learning from experts	Experiential learning; learning by doing	Learning by doing; learning by experimenting	Experiential learning; learning by doing and experimenting; learning from experts	Learning by doing; learning by experimenting	Learning by doing; learning by experimenting; learning from experts
Networks	Open but limited networks (considering principles of sustainable partnerships); domestic partners	Closed networks (close business relatives)	Local government; local resource person	Open networks (considering principles of sustainable partnerships); domestic and foreign partners	Central government; local government	Central government; international organization/ foreign partners

Table 7 Bridging roles by agri-tech start-ups

Role	Start-up A	Start-up B	Start-up C	Start-up D	Start-up E	Start-up F
Network enabler	V	V	V	V	V	V
Knowledge broker	V	V	X	V	V	V
Resource broker	V	V	V	V	V	V
Transparency and conflict resolution agent	V	V (only for transparency)	V (only for transparency)	V	V	X
Shared vision champion	V (accommodate aspirations from farmers, shared to the investors)	V (concerning village modernization)	X (unshared)	V (aspiring excellence in supply chain management)	V (pioneering in ecosystem platform)	V (high-level technological learning)

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Availability of Data The data that support the findings of this study are available on request from the corresponding author (Dian Prihadyanti). The data are not publicly available due to their containing information that could compromise the privacy of research participants.

Code Availability B-5522/JI/HK.01.03/VII/2020

Author Contribution Dian Prihadyanti (DP) developed the idea of the paper and designed the (detailed) outline. Karlina Sari (KS) and Subkhi Abdul Aziz (SAA) approved the idea and the outline. SAA wrote research positioning in the Introduction section. DP drafted the complete introduction section and elaborated on the research positioning in the draft. KS assisted in the writing of the Introduction section and completed the section with the background information on Indonesia's agricultural sector and agri-tech start-ups. DP drafted the Literature Review section. KS provided suggestions to improve the writing flow. DP revised the draft based on the suggestion. DP drafted the methodology section. SAA provided feedback to improve the clarity. DP revised the draft based on the feedback. KS designed the data collection process. DP and SAA approved the design. KS, DP, and SAA conducted the data collection (through an online survey, interviews, and secondary data collection), processed the results of the online survey (through a questionnaire), transcribed the recordings of the interviews, and conducted coding based on the transcripts and content analysis to the qualitative secondary data. KS, DP, and SAA interpreted the data. SAA summarized the interpretation in a table. KS improved the content of the table. DP interpreted and analyzed the content and identified the findings. DP drafted the Results and Discussion sections. KS and SAA provided feedback to improve the findings. DP drafted the Conclusion and Abstract. SAA and KS provide feedback to improve the clarity of the abstract. SAA arranged the reference list. KS proofread the overall draft. DP, KS, and SAA read the final draft (submission version) and agreed that this work was appropriately investigated and analyzed/interpreted.

DP defined the revision plan (based on reviewers' comments). KS provides part of the suggested literature for the literature review section. DP drafted the revision for the Introduction, Literature Review, Methodology, Discussion, and Conclusion. SAA checked the Introduction section and drafted the revision of the Results section, edited by DP. The draft was edited and proofread by KS. DP re-edited the draft, finalized by SAA. DP, KS, and SAA read the final draft (revised version) and agreed that this paper was appropriately investigated and analyzed/interpreted.

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Declarations

Conflict of Interest The authors declare no competing interests.

⁴ Currently, LIPI and other public research institutions in Indonesia are already merged into a new agency called National Research and Innovation Agency (well-known as BRIN)

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