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Identification of the relationships among the indicators of sustainable entrepreneurial ecosystems in agricultural startups

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ABSTRACT

A sustainable entrepreneurial ecosystem focuses on sustainable development and how entrepreneurs can work to achieve innovative, risky, and profitable entrepreneurial activity while maintaining economic, environmental, social, and cultural factors. In this regard, the present study aims to identify and determine the relationships between the indicators of a sustainable entrepreneurship ecosystem for agricultural startups. Sustainable entrepreneurship ecosystem dimensions were first extracted based on the summative content analysis. Then, the existing criteria and sub-criteria were weighted using the fuzzy analytic hierarchy process. For this purpose, 25 key experts in sustainable entrepreneurship were identified. In the second part, the data were analyzed using MICMAC software. Results indicate that ecological, economic, and institutional dimensions were of greater importance in a sustainable startup ecosystem. The results of applying the cross-impact analysis method reveal that employment, business ownership and scale, income and saving, reforming laws, access to information, the existence of NGOs, and awareness and understanding of risk are among the factors affecting the system sustainability. Finally, 12 key factors are selected after examining the extent to which factors affect each other and the status of sustainable startup ecosystems by direct and indirect methods. It can be concluded from the status of the scattering plane of variables affecting the measurement of sustainable ecosystems that the system is unsustainable.

Introduction

Entrepreneurship is a trans-sectoral multi-facet phenomenon that is influenced by economic, social, cultural, and political aspects on the one hand and influences them on the other hand. Thus, its development depends on considering different issues from various perspectives, highlighting the need for the use of the ecosystem approach. An entrepreneurship ecosystem refers to elements such as individuals, organizations, and institutions outside the entrepreneurship that encourage or discourage the individual's decision to be an entrepreneur or influence his/her success in launching an entrepreneurial business. Entrepreneurship ecosystems create an environment that motivates entrepreneurial endeavors (Rahimi, Abbasi, Bijani, Tahmasbi & Azimi Dezfouli, 2020; Stam, 2015). An entrepreneurship ecosystem encompasses a set of interrelated factors within a certain domain that, at least, includes universities and research organizations, qualified human resources, formal and informal networks, government, investors, capital, professional service providers, and entrepreneurship culture (Cohen, 2006; Neck, Meyer, Cohen & Corbett, 2004; Roberts and Eesley, 2011). Researchers argue that the components of a sustainable entrepreneurial ecosystem differ from those of a general entrepreneurial ecosystem. For example, they are different in principles and roles, actions, or user groups (Cohen, 2006; Fallah Haghighi, Hajihoseini, Ramezanpour Nargesi & Bijani, 2018). In a sustainable entrepreneurship ecosystem, incentives to engage in entrepreneurship and innovation to address sustainability issues or take up more sustainable opportunities should not be merely profitable (Dean & McMullen, 2007; Fallah Haghighi, Bijani & Parhizkar, 2020; York & Venkataraman, 2010).

Promoting sustainable entrepreneurship is widely accepted as a catalyst for economic growth and environmental sustainability, but outside developed countries, there has been little independent assessment of these policies. Regardless of the current hype, it will be indispensable for agricultural startups to find an appropriate and sustainable entrepreneurial ecosystem to ensure their long-term performance and survival. Sustainable entrepreneurial ecosystems

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represent the focal business logic of a firm and are essential to the successful commercialization of any technology. There is still much unknown in the literature on how sustainable entrepreneurial ecosystems emerge and develop and how institutions and actors interact with one another. In a sustainable entrepreneurship ecosystem, the term *sustainable* means the actors and institutions that need to create entrepreneurial actions that address complex ecological and social issues (Cohen & Winn, 2007; Hall, Daneke & Lenox, 2010; Hockerts & Wüstenhagen, 2010; Parrish, 2010). Sustainable entrepreneurs act as innovative agents of change because they identify and grab opportunities, processes, activities, and industrial markets to improve the social and ecological impacts and responsibility for the environment (Cohen & Winn, 2007; Dean & McMullen, 2007; York & Venkataraman, 2010). Some scholars have criticized sustainable entrepreneurship in the sense that sustainable entrepreneurs cannot resolve complex sustainability issues (Hall et al., 2010; Schaltegger & Wagner, 2011). Most sustainability issues are related to common resources that no specific individual belong to and no one can manage them (Ostrom, 2015). To avoid these problems, various actors and stakeholders have contributed to monitoring and resolving sustainability issues (George, Howard-Grenville, Joshi & Tihanyi, 2016; Ostrom, 2009; Sonenshein, DeCelles & Dutton, 2014; Wright & Nyberg, 2016). Simatupang, Schwab and Lantu (2015) argues that to understand the benefits of sustainable entrepreneurship, it is essential to understand how sustainable entrepreneurs interact within a large ecosystem that encompasses actors, geographical areas, and diverse organizations.

Cohen (2006) first introduced the concept of *sustainable entrepreneurial ecosystem*. He stated that a sustainable entrepreneurial ecosystem focuses on sustainable development. This study raises the question as to how sustainable entrepreneurial ecosystems emerge and evolve. Researchers suggest that sustainable entrepreneurial ecosystems motivate and support sustainable entrepreneurship (social and ecological entrepreneurship) and are distinct from general entrepreneurship ecosystems in methods. In sustainable entrepreneurship, entrepreneurial economic action can help solve complex social and environmental issues and these entrepreneurs act as a catalyst for industrial development (Cohen & Winn, 2007; Hall et al., 2010; Hockerts & Wüstenhagen, 2010). To realize the benefits of sustainable entrepreneurship, it is essential to understand how sustainable entrepreneurs interact in a larger ecosystem that includes various actors that differ at the personal, organizational, and geographical levels (Simatupang et al., 2015). Therefore, this study aims to identify and determine the relationships of sustainable entrepreneurship ecosystem indices in agricultural startups. The results of the research contribute to the literature in two aspects. First, this study contributes to enriching the literature on sustainable entrepreneurial ecosystems and agricultural startups. Building on the central question on the indicators of sustainable entrepreneurial ecosystems, this study documents the entrepreneurship ecosystem as an important precursor to individuals" decision to start new agricultural startups. Furthermore, this study contributes to recognizing influential, dichotomous, regulatory, dependent, and independent variables that improve the process of agricultural startup creation.

Theoretical review

A sustainable entrepreneurial ecosystem is an ecosystem that focuses on sustainable development. Although Cohen's studies are instructive, many questions have remained unanswered, such as whether the components of an entrepreneurial ecosystem are more important for the emergence of a sustainable entrepreneurial ecosystem or activists and individuals, or whether the culture of society is more important for sustainable or institutional factors from social contexts. Different insights can be drawn from the literature on sustainable development. For example, some research has addressed internal and external conditions of a business that encourage sustainable development or sustainable entrepreneurship (Cohen & Winn, 2007; Hockerts et al., 2006; Muñoz & Dimov, 2015). On the other hand, some have examined norms, perceptions, and acceptance of sustainability (Clemens, 2006; Clemens & Douglas, 2006; De Clercq & Voronov, 2011; Meek, Pacheco & York, 2010; O'Neill, Hershauer, & Golden, 2006; Pacheco, Dean & Payne, 2010; Spence et al., 2010). Muñoz Dimov (2015) examined the internal and environmental conditions of sustainable entrepreneurship and introduced two types of sustainable entrepreneurs – conformist and insurgent. In the conformist view, social support is the key to the adaptation of the business environment in which the perception of sustainability (social and environmental responsibility) by stakeholders (e.g. suppliers, customers, employees, and investors) is invaluable. On the other hand, the insurgent type operates in an environment that contributes to sustainability aspirations. These results are consistent with the fact that community culture (local or regional) provides particular conditions for the environment (Cohen, 2006). In addition, in terms of the natural environment, they considered the identification of the key elements such as natural environment and biodiversity, services for the protection of natural resources, and cultural communities, groups, and locations (Shepherd & Patzelt, 2010). Support agencies (formal and informal) come in contact with actors seeking sustainable development. In line with the concept of insurgency, sustainable entrepreneurs may need to participate in organizational entrepreneurship to create or change new institutions in order to provide incentives for actors in a sustainable entrepreneurial ecosystem to participate in sustainable development or entrepreneurship (Pacheco et al., 2010).

Ostrom (2009) explored different perspectives on sustainable development and explained that sustainable development forms through socio-environmental systems. He identified four socio-environmental subsystems, including the resource system (e.g. natural resources or domains such as forest areas), the resource unit (e.g. trees), the governance system (e.g. laws or regulations to protect resources and units system), and resource users (e.g. recreational or business users such as visitors). Within these subsystems, the actors may self-organize themselves or put themselves in entrepreneurial opportunities for cooperation. The factors differentiating sustainable entrepreneurial ecosystems include value creation for all stakeholders, the environment, natural resources (the use of resources and the protection of the communities depending on these environments), market incentives for cooperation in sustainable entrepreneurial activities, and local/social support for sustainability, and the responsibility to protect the environment and natural resources.

The concept of sustainability serves as a tool to balance and reconcile ecological, environmental, social, and business dimensions with financial and economic dimensions. Business sustainability is increasingly interested in by scholars and researchers (Fuerlinger, Fandl & Funke, 2015). Business sustainability refers to the strategic achievement and integration of corporate social, environmental, and economic goals by systematically coordinating intra-organizational business processes to improve a company's long-term economic performance and corporate value (Carter & Rogres, 2008). It should, however, be noted that sustainability differs from the continuity of a firm's activity in the sense that it refers to the ability of business units to survive in the environment and society and ultimately sustain within the whole economic system. In fact, business sustainability leads to the greater flexibility of companies, enabling them to adapt to changes. Based on previous research, the creation of socially optimal values, including social efficiency, social effectiveness, social responsibility, inter-generational justice, and foresight, are the goals that sustainable businesses seek both for their business and society. Given the nature of sustainable development, the goals of sustainability in small and medium-sized businesses are to create a balance between social health, the protection of environmental quality, and

economic well-being. In other words, in business sustainability, environmental values (conservation, improvement, and responsibility of the environment), economic values (price, quality, and cost), and social values (ethics, benefits, and social responsibility) are addressed in the context of an integrated management approach. Accordingly, most businesses prioritize their sustainability policies in their agendas with a focus on three primary aspects of sustainability, i.e. accomplishment to positive financial performance while emphasizing social and environmental performance (Jonas & Eriksson, 2007; Parrish, 2010). Given the importance of the concept of sustainability in the context of businesses, various definitions have been introduced in recent years. Business sustainability has been considered as guiding business operations to satisfy the present needs without compromising future generations' ability to meet their own needs and with a focus on their impact on environmental, social, and community life issues. In summary, a sustainable business can be defined as a business that creates economic value, enhances public wealth with a proper mechanism for its distribution, has economic justification, does not destroy the environment, is managed ethically, and complies with the laws and regulations.

So far, various classifications of methods and tools have been proposed for the assessment of entrepreneurship sustainability. For example, a systematic approach has been proposed to assess economic, social, and environmental sustainability (Christina, Neelufer & AlAmri, 2014; Skibinski & Sipa, 2015). As a product-oriented sustainability approach, this approach mainly focuses on the result of the sustainability of executive activities and practices and is more applicable in economic and environmental contexts (Bagheri & Shabanali Fami, 2016; Ismail, Ahmad Domil & Isa, 2014; Jaonsson, Nilsson, Modig & Hed val, 2017). To tackle humanity's food challenges, the agricultural sector needs to exploit technological advancements by innovating its business models. Agricultural startups play a central role in business model innovation (Schirmer et al., 2021). In recent years, due to the highly active risk environment in the world and the strong appetite for technological integration of agribusiness players, the ecosystem of agricultural startups has shown exponential growth. Mendes, Bueno, Oliveira and Gerolamo (2022) point out that there is an exponential growth in investments in agriculture technology. Most of these technologies are developed and marketed by AgTechs, the technological startups in agribusiness (Kakani, Nguyen, Kumar, Kim & Pasupuleti, 2020). Studies should find out whether the agricultural startups and farmers can solve the problems they face for which it is necessary to know that the agricultural sector is a very abundant source of food in the world. With the existence of agricultural startups that handle these problems, food self-sufficiency can be implemented well in the world to meet the food needs of all people. Tiwari, Hogan and O'Gorman (2021) found that startups have had a positive effect in reducing regional entrepreneurial disparities but have been less successful due to the lack of financial support and funding. Furthermore, the policy has failed to recognize and address the under-representation of marginalized caste groups and entrepreneurs in the startup ecosystem.

Regasa (2015) argues that the most important issue in sustainable entrepreneurship is to consider the rights of consumers because agricultural entrepreneurship deals with environmental issues and should be considered in production processes. In this regard, Spence, Gherib and Biwolé (2011) state that sustainable entrepreneurship is closely linked to social responsibility and environmental development as it reflects the participation of entrepreneurs in various social and environmental dimensions. In addition, Richomme-Huet and Freyman (2011) suggest that sustainable entrepreneurship should address the needs of the whole community through social solidarity. On the environmental side, researchers place great emphasis on environmental sustainability through sustainable entrepreneurship in agriculture. Some researchers argue that the ecosystem is the basis of environmental systems because natural resources such as air, water, and energy are parts of environmental systems that are non-renewable and require sustainability (Slaper & Hall, 2011). Biome sustainability plays an important role in entrepreneurial activities. In the economic dimension of sustainable entrepreneurship, economic life is associated with the flow of money and investment (Dixon & Clifford, 2007; Slaper & Hall, 2011). This implies that no activity can be done for any type of entrepreneurship, including sustainable entrepreneurship, if there are no financial and economic assets. However, some researchers state that, in the economic dimension, entrepreneurs should take advantage of the available financial resources and opportunities to make a profit. Nonetheless, the focus of sustainable entrepreneurship is not merely on the use of financial resources and it doe not pursue economic benefits. Although economic profits are not the only goal of sustainable entrepreneurship, more emphasis is placed on profits that are more sustainable and less likely to affect biome and other resources (Dixon & Clifford, 2007). In fact, researchers such as Austin, Stevenson and Wei-Skillern (2006) and Hall et al. (2010) have considered a viable economy as a requirement for the survival of entrepreneurial activities, especially in agriculture. On the other hand, Shepherd and Patzelt (2010) view economic gains as one of the perspectives of sustainable entrepreneurship development in the agricultural sector. In addition, Richomme-Huet and Freyman (2011) stress that the value of sustainable entrepreneurship is in economic prosperity as well as social justice and environmental protection. The structural and institutional dimensions are also other factors influencing sustainable entrepreneurship. However, what is certain is that businesses are responsible for future generations and are not allowed to destroy the rights of future generations, including the environment, and other human beings for greater profit. Otherwise, the sustainability of businesses and their sustained profitability will be rendered impossible, while corporate sustainability is influential on the global economic system. Finally, the unsustainability or collapse of businesses and commercial enterprises will cause a recession and even a global economic downturn. Various studies have already presented multiple classifications of indicators for sustainability assessment. A review of the literature shows that sustainable entrepreneurial ecosystems have received less attention and none has dealt with the relationships and importance of these indicators versus one another whereas the knowledge of their relationships and importance can provide decision-makers and planners with critical information.

Methodology

The study is temporally retrospective since data were collected on past events. It is applied in goal as its results can be used by policymakers in agricultural entrepreneurship. This research is a mixed design study in nature conducted using a combination of futures studies methods (literature review, expert panel, and cross-matrix analysis). The futures studies encompass a variety of ways of research methodologies, and a mix of methods is usually used by them. The study first introduced the dimensions of entrepreneurial ecosystem sustainability critically based on the summative content analysis. Then, the criteria and sub-criteria were assigned with weights using the fuzzy analytic hierarchy process (FAHP). So, 25 key experts in sustainable entrepreneurship were identified. There were two criteria for selecting experts. First, the identified individuals had field experience in sustainable entrepreneurship. Second, they had relevant contributions such as research papers, books, and/or research projects. At this stage, criterion and snowball sampling methods were employed. The participants were, then, asked to make pairwise comparisons at the level of criteria and sub-criteria. In the next step, Kong et al. (2005)'s method was used to calculate fuzzy numbers in FAHP.

AHP is widely used in decision-making for actual problems in everyday life. Despite its simplicity and high efficiency, it is often

Table 1
Criteria and sub-criteria of sustainability.

Criteria	Sub-criteria
Cultural domain	Cultural diversity management
	Cultural support for risk-taking, innovation, and creativity
	Organizing hidden opportunities
	Cultural reforms to valuate entrepreneurship
	Media support for sustainable entrepreneurship
Institutional domain	Agricultural business management
	Reforming laws to facilitate entrepreneurship
	Providing legal incentives for entrepreneurship development
	Access to information
	The existence of NGOs
Social domain	Helping the improvement of the quality of social life
	Supporting social solidarity and unity
	Creating equal opportunities for social welfare
	Compatibility and coexistence
	Awareness and understanding of risk
Economic domain	The extent of income distribution and saving
	The extent of employment created
	The extent of demand for entrepreneurship
	Developing science and technology parks and development centers
	Business Ownership and Scale
Technological domain	The growth and application of new technologies
	Equipping entrepreneurship places with modern communications networks
	Supporting new technologies in national and international communications
	Supporting IT and ICT in entrepreneurship
	Accessibility and ease of use of green technologies
Ecological Domain	Reducing the use of irreversible resources
	Support for animal and plant diversity
	Increasing environmental viability
	Alleviating ecological damage
	Preventing the emission of climate pollutants

criticized for neglecting the inaccuracy and inherent unreliability of decision-makers' perceptions and reflecting their opinions as crisp numbers. This problem persisted until fuzzy sets were finally introduced. The integration of these two methods helped overcome the drawbacks of AHP. FAHP paved the way to provide more accurate descriptions and more realistic decisions by clearing human decisions (Yadav, Jain, Shukla & Mishra, 2012). Most studies exploit this method to quantify the evaluation indicators (Dutta, 2012; Lin, Lee & Wang, 2009). In the second phase, a combination of an expert panel and cross-matrix analysis (MICMAC) was used because using only one of these methods could not suffice to address the questions and issues raised in the present study. The cross-matrix method was implemented using the MICMAC software package.

As noted, the summative content analysis was used to identify the criteria and sub-criteria of a sustainable entrepreneurship ecosystem. Accordingly, six criteria including cultural, institutional, social, economic, technological, and ecological were derived, each with its own sub-criteria (Table 1).

Results

Table 2 presents the fuzzy comparison matrix and sub-criteria weighting matrices for the criteria that measure entrepreneurial ecosystem sustainability in agricultural startups. The weighted importance of the sub-criteria was multiplied by the criteria to find out the final importance of each criterion. The consistency ratio test shows that in all cases, the calculated rate is less than 0.1. In other words, the index of inconsistency ratio shows whether there is consistency between pairwise comparisons in questionnaires. This index can be used to measure the consistency of the responses provided by experts for pairwise assessments and comparisons. The results showed that the ecological and economic domains had the highest weights of 0.326 and 0.245, respectively. Based on the findings,

Table 2
Weights and inconsistency rates of criteria and sub-criteria.

Criteria	Criteria's weight	Sub-criteria	Sub-criteria's weight	Final weight	CR (sub-criteria)	CR (criteria)
Cultural domain	0.118	Cultural diversity management (C1)	0.194	0.082	0.02	0.001
		Cultural support for risk-taking, innovation, and creativity (C2)	0.246	0.104		
		Organizing hidden opportunities (C3)	0.351	0.148		
		Cultural reforms to valuate entrepreneurship (C4)	0.142	0.059		
		Media support for sustainable entrepreneurship (C5)	0.241	0.101		
Institutional domain	0.208	Agricultural business management (C6)	0.331	0.134	0.04	0.001
		Reforming laws to facilitate entrepreneurship (C7)	0.208	0.078		
		Providing legal incentives for entrepreneurship development (C8)	0.189	0.131		
		Access to information (C9)	0.185	0.080		
		The existence of NGOs (C10)	0.139	0.143		
Social domain	0.144	Helping the improvement of the quality of social life (C11)	0.271	0.084	0.01	0.001
		Supporting social solidarity and unity (C12)	0.149	0.046		
		Creating equal opportunities for social welfare (C13)	0.251	0.078		
		Compatibility and coexistence (C14)	0.153	0.047		
		Awareness and understanding of risk (C15)	0.137	0.042		
Economic domain	0.245	The extent of income distribution and saving (C16)	0.194	0.050	0.01	0.001
		The extent of employment created (C17)	0.146	0.038		
		The extent of demand for entrepreneurship (C18)	0.251	0.065		
		Developing science and technology parks and development centers (C19)	0.182	0.047		
		Business ownership and scale (C20)	0.221	0.057		
Technological domain	0.122	The growth and application of new technologies (C21)	0.294	0.062	0.01	0.001
		Equipping entrepreneurship places with modern communications networks (C22)	0.246	0.055		
		Supporting new technologies in national and international communications (C23)	0.151	0.032		
		Supporting IT and ICT in entrepreneurship (C24)	0.342	0.072		
		Accessibility and ease of use of green technologies (C25)	0.281	0.058		
Ecological domain	0.326	Reducing the use of irreversible resources (C26)	0.189	0.051	0.01	0.001
		Support for animal and plant diversity (C27)	0.218	0.068		
		Increasing environmental viability (C28)	0.165	0.047		
		Alleviating ecological damage (C29)	0.142	0.041		
		Preventing the emission of climate pollutants (C30)	0.133	0.037		

Table 3
Degree of utility and optimization of the matrix.

Rotation	Influence	Independent
First rotation	92%	89%
Second rotation	100%	100%

among the cultural sub-criteria, "organizing hidden opportunities" with weighted importance of 0.148 was ranked first among the sub-criteria influencing the determination of the entrepreneurial ecosystem sustainability of agricultural startups in the cultural dimension. Weight assignment to the institutional sub-criteria of the sustainable entrepreneurial ecosystem revealed that the sub-criterion of "the presence of NGOs" was ranked first with weighted importance of 0.143. The social domain was composed of five sub-criteria. According to the results, the sub-criterion of "the quality of social life" had the highest weight of 0.084. Based on the weighting of the sub-criteria of the economic domain, the sub-criterion of "the extent of demand for entrepreneurship" was ranked first with weighted importance of 0.065. The results of the technological domain indicated that the sub-criterion of "supporting IT and ICT in entrepreneurship" was in the first rank among all sub-criteria. The ecological criterion was composed of five sub-criteria among which "supporting animal and plant diversity" was at the top of the list with weighted importance of 0.068.

Effective indicators to measure sustainable entrepreneurial ecosystems using MICMAC

Based on the MICMAC method, 30 indicators were identified in six domains as effective indicators for measuring sustainable entrepreneurial ecosystems in agricultural startups. They were, then, analyzed by the structural/cross-impact analysis method. The matrix was in the 30 × 30 dimensions given the number of variables. The number of iterations was considered to be two, and the matrix filling rate was 62.87%, showing a good coefficient, which is related to the dispersion of variables affecting the sustainability of agricultural startups. Of the 1257 measurable relationships in this matrix, 1245 were zero, 142 were one, 103 were two, and 12 were three. On the other hand, after two rotations of the matrix, the data became 100% desirable and optimized, implying the appropriate validity of the questionnaire (Table 3). In the next step, the influence and dependence plane of the variables and the ranking and mobility of the variables were explored for the overall analysis of the system environment and finally, the identification of the drivers and key factors.

How variables are distributed across the distribution plane shows the degree to which the system is sustainable or unsustainable. In the structural/cross-impact analysis by the MICMAC software, two types of dispersion are defined: sustainable systems and unsustainable systems. In sustainable systems, the dispersion of variables is L-shaped; this means that some variables have a strong influence and some have strong dependence. In these systems, a total of three variables can be seen: (a) highly influential variables on the system (key factors), (b) independent variables, and (c) system output variables (outcome variables). The position of each factor is clearly defined and its role can be clearly presented. On the contrary, unsustainable systems are much more complicated than sustainable systems. In these systems, the variables are scattered around the diagonal axis of the plane and they most often exhibit an intermediate state between influential and dependent, making it very difficult to evaluate and identify key factors. However, there are also ways for these systems to guide through selecting and identifying key factors. Unsustainable systems have influential variables, dichotomous variables (risk variables and target variables), regulatory variables, dependent variables or output variables of the system, and independent variables. What is understandable from the status of the dispersion plane of the variables affecting the sustainability of an entrepreneurial ecosystem is the

Table 4
The direct and indirect effects of indicators and variables on each other.

Criteria	Indicator	Direct effects				Indirect effects			
		Influence		Independent		Influence		Independent	
Economic domain	(C16)	83	205	52	138	66,565	294,578	47,514	256,584
	(C17)	81		48		63,555		44,235	
	(C18)	59		51		46,242		41,025	
	(C19)	64		46		37,085		38,124	
	(C20)	58		41		68,665		42,153	
Social domain	(C11)	55	274	62	244	39,412	223,241	32,415	134,526
	(C12)	82		58		55,102		32,652	
	(C13)	40		56		35,412		33,393	
	(C14)	66		59		51,007		29,442	
	(C15)	51		49		39,852		21,453	
Institutional domain	(C6)	69	292	43	217	41,023	303,541	36,412	237,412
	(C7)	71		37		64,123		31,240	
	(C8)	11		45		38,012		28,651	
	(C9)	82		41		66,012		36,521	
	(C10)	74		55		65,423		45,121	
Cultural domain	(C1)	35	185	31	138	46,205	321,244	47,514	184,522
	(C2)	32		26		66,577		47,514	
	(C3)	38		32		46,205		47,514	
	(C4)	41		27		66,577		47,514	
	(C5)	38		22		46,205		47,514	
Technological domain	(C21)	58	185	34	138	55,214	253,741	51,230	165,231
	(C22)	51		31		48,512		41,236	
	(C23)	38		29		38,412		29,851	
	(C24)	33		24		39,124		37,424	
	(C25)	28		21		38,412		37,426	
Ecological domain	(C26)	18	58	35	175	1542	201,231	31,011	162,143
	(C27)	9		31		865		37,120	
	(C28)	6		41		9511		31,245	
	(C29)	28		59		60,123		32,142	
	(C30)	21		44		4851		34,125	

Table 5
The distribution of the variables by category.

Category	Indicators
Influential variables	The extent of employment created, business ownership and scale, the extent of income distribution and saving, reforming laws to facilitate entrepreneurship, access to information, the existence of NGOs, and awareness and understanding of risk.
Dichotomous variables	Supporting social solidarity and unity, compatibility and coexistence, media support for sustainable entrepreneurship, accessibility and ease of use of green technologies, and creating equal opportunity for social welfare.
Regulatory variables	Support for animal and plant diversity, the growth and application of new technologies, equipping entrepreneurship places with modern communications networks, supporting new technologies in national and international communications, supporting IT and ICT in entrepreneurship, providing legal incentives for entrepreneurship development, developing science and technology parks and development centers, and cultural diversity management.
Dependent variables	Helping the improvement of the quality of social life, reducing the use of irreversible resources, increasing environmental viability, alleviating ecological damage, and preventing the emission of climate pollutants.
Independent variables	Cultural support for risk-taking, innovation, and creativity, organizing hidden opportunities, cultural reforms to valuate entrepreneurship, and the extent of demand for entrepreneurship.

status of system sustainability. Most variables were found to scatter around the diagonal axis of the plane except for some factors, which showed that they had a strong influence on the system, but the other variables had almost similar statuses. Variables also had two types of influences: direct impacts and indirect impacts.

To analyze the effects of variables, the relationships of the individual variables were measured by the MICMAC software. Table 4 shows the extent and degree of direct and indirect impacts of the variables on one another. The distribution of the variables influencing the status of the sustainable entrepreneurial ecosystem in agriculture startups on the distribution plane reflected its unsustainability in which five categories – including influential factors, dichotomous factors, regulatory factors, dependent factors, and independent factors – could be identified (Table 5).

Risk variables are the key factors for success. These variables were analyzed by the MICMAC software to apply conditions, determine inconsistencies, and remove ineffective variables. Since the system was identified to be unsustainable, the existence of highly influential variables in the extreme end of Fig. 1 on the top-left side seemed unlikely because this part mostly has variables in sustainable systems. Only the variable of IT development that is strongly influential was located in this part. Out of 18 variables, 9 variables were risk variables, including legal incentives for entrepreneurship development, equal opportunities for well-being, adaptability, and coexistence. These variables were highly capable of becoming key variables and had the potential to become passive due to their unsustainable conditions. The influential variables of the distribution showed that eight variables were strongly influential, so they were the most critical indicators upon which the system variations were dependent. They included employment, business ownership and scale, income, and savings from the economic domain, reforming laws, access to information, the existence of NGOs from the institutional domain, and awareness and perception of risk from the social domain. Three indicators of quality of life, participation and social solidarity, and adaptation and coexistence from the social domain and two indicators of management and reforming laws from the institutional domain were classified as dichotomous variables.

Twelve main factors were selected as key influential factors and all of them were repeated in both direct and indirect methods (Fig. 2). These included income and savings, employment rate, the application of new green technologies, social participation and solidarity, adaptation and coexistence, readiness and management, law reform, access to information, the existence of NGOs, cultural diversity management, media support, and awareness and understanding of danger. These 12 factors were selected by the direct and indirect methods out of the studied 30 factors. They are listed in Table 6.

Discussion

The results indicated that among the six components of sustainable entrepreneurship ecosystems in agricultural startups, the ecological, economic, and institutional components were the most important. This implies that ecological and economic dimensions can

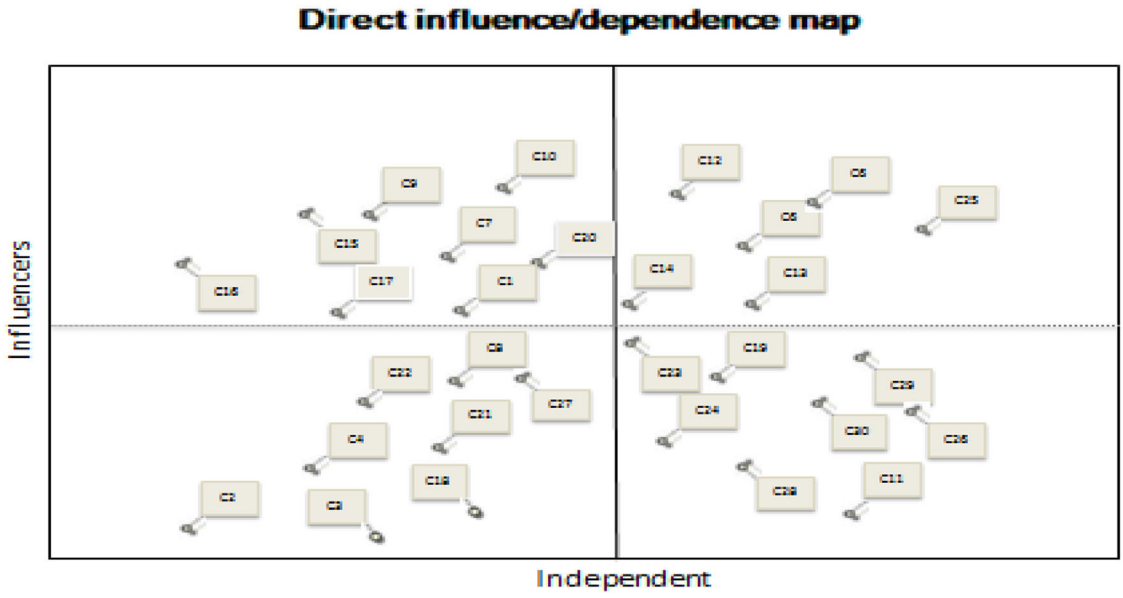

Fig. 1. The distribution of influential variables.

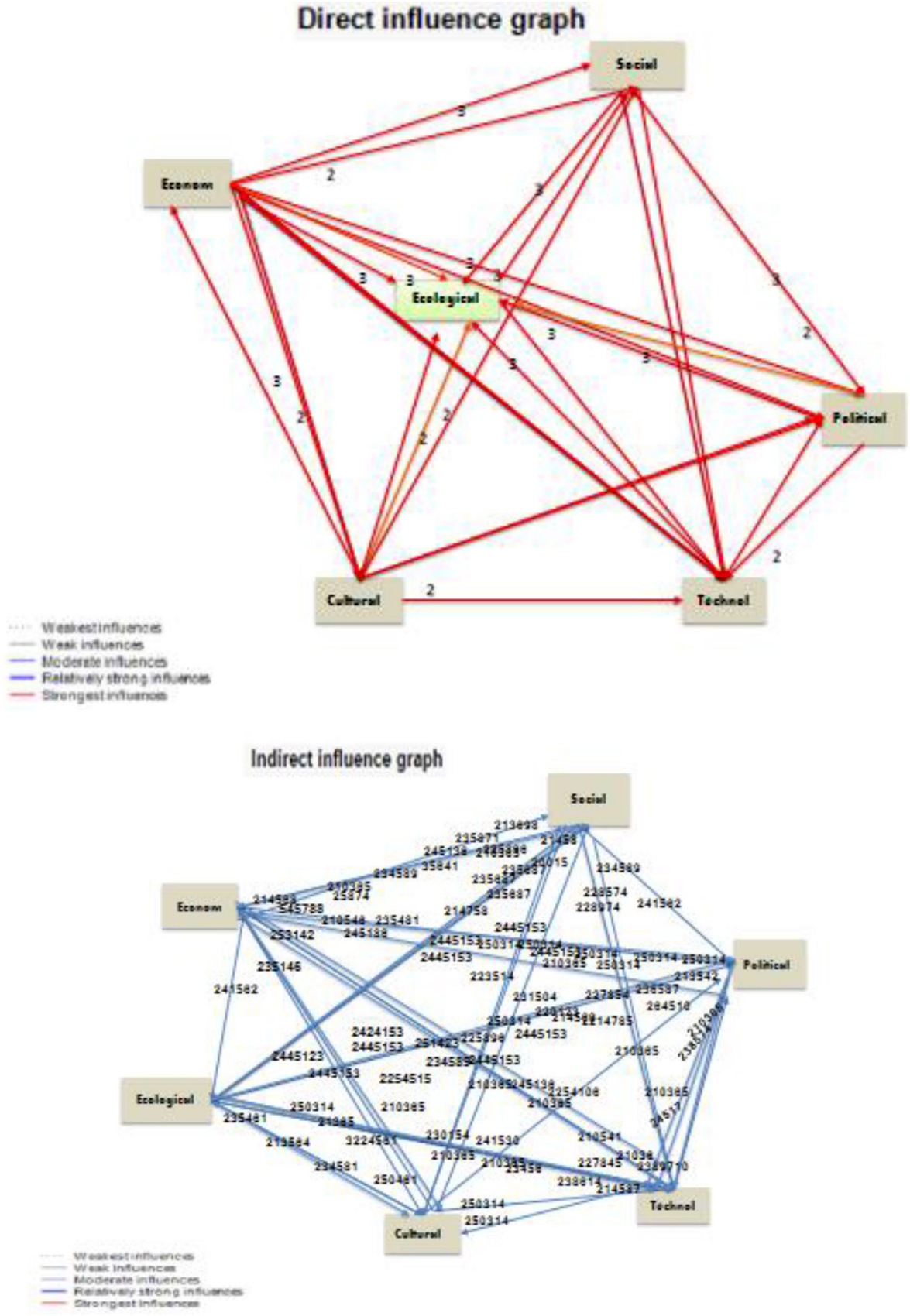

Fig. 2. The direct and indirect effects of the variables from very strong to very weak.

Table 6
The key factors affecting the sustainable entrepreneurship ecosystem in agricultural startups.

Indicator	Direct effect		Indirect effect	
	Influencing direct	Influencing indirect	In depending direct	In depending indirect
The extent of income distribution and saving	344	430	1	1
The extent of employment created	364	338	2	4
The growth and application of new technologies	345	351	3	2
Supporting social solidarity and unity	334	289	4	8
Compatibility and coexistence	334	341	5	3
Alleviating ecological damage	331	305	6	6
Reforming laws to facilitate entrepreneurship	317	305	7	5
Access to information	316	289	8	9
The existence of NGOs	305	279	9	10
Cultural diversity management	304	278	10	11
Media support for sustainable entrepreneurship	303	289	11	7
Awareness and understanding of risk	301	304	12	12

be the source of many activities that contribute to a sustainable startup entrepreneurial environment. In fact, in an entrepreneurial ecosystem, the next cannot be eliminated, but a cycle can be devised with respect to the importance of dimensions and the studied context to improve a sustainable ecosystem. Other researchers (Aliabadi, Ataei, Gholamrezai & Aazami, 2019; Groth, Esposito & Terence Tse, 2015; Mendes et al., 2022; Spigel, 2015; Tiwari et al., 2021) have also stated that ecological and economic dimensions are among the factors that play an important role in shaping sustainable entrepreneurial ecosystems. So, this finding is consistent with the results of other studies.

The results showed that the cultural dimension has received less attention than other dimensions, while among the factors that enhance or weaken entrepreneurial sustainability, culture is considered a very important and critical factor so that community values and norms are largely influential on the development of sustainable entrepreneurship. Consequently, it determines the type of attitudes, values, and norms of culture and thereby determines how they grow and develop and lead to innovation. Therefore, the creation and promotion of sustainable entrepreneurial values and behaviors, which are called entrepreneurial culture, should be one of the key components of sustainable entrepreneurship development and should be pursued through promotional policies and programs at all levels and social structures. Other researchers (Ataei, Aliabadi, Norouzi & Sadighi, 2019; Batjargal & Liu, 2004; Gholamrezai, Aliabadi & Ataei, 2021; Jawahar & Nigama, 2011; Kwon & Arenius, 2010; Lindstrand, Melén & Nordman, 2011) have supported this finding too. In this context, organizing hidden opportunities, cultural support for risk-taking, innovation, and creativity, and media support for sustainable entrepreneurship play an important role.

Conclusion

Based on the nature of many of the abovementioned components, each entrepreneurial ecosystem combines the factors existing in the region in a specific way. Therefore, the key components of the ecosystems are the same, but since regions and business types have their own contextual conditions, trying this ecosystem in different countries is risky. It is of crucial importance for the sustainable development of entrepreneurial activities, including agricultural startups, to identify a set of indicators and their implications as the dimensions of the entrepreneurial ecosystem.

What can be understood from the status of the scattering plane of the variables affecting the measurement of sustainable ecosystems is that the system is unsustainable. Most variables are scattered around the diagonal axis of the plane. With the exception of a few factors that indicate that they are highly influential on the system, the other variables have a similar status with respect to one another. Therefore, five categories can be identified – i.e. influential factors, dichotomous factors, regulatory factors, dependent factors, and independent factors. Based on the results, it is recommended that each of the criteria and sub-criteria be evaluated separately and the weaknesses of sustainable entrepreneurial ecosystems be specified. Then, executive policies are developed accordingly to promote them. These policies can be considered at five different levels: regulatory, effective, dependent, independent, and dichotomous.

This study, like many other studies, had its limitations. One of the most important limitations was the accurate assessment of the sustainability of agricultural startups. In other words, measurable indicators were not set to assess the sustainability of agricultural startups. It is suggested that future research define indicators for measuring the sustainability of agricultural startups. It can help to find out to what extent an entrepreneurial ecosystem is based on the principles of sustainability.

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