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Analysis of Knowledge Management Network in the New Agricultural Extension System in Iran

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ABSTRACT

Knowledge management in the agricultural sector is a goal of the agricultural extension system to ensure farmers' access to technical knowledge and research findings. This research analyzed the knowledge management network in Iran's new agricultural extension system (NAES) in which the interaction among contextual (organizational structure, organizational culture, and information and communication technology), process (production, storage, organization, and distribution of knowledge) and performance variables (stakeholders' access to technical knowledge and research findings) were studied. The research sample included all agricultural extension experts in Zanjan province and the supportive researchers in the research centers, amounting to 143 and 28 people, respectively. A questionnaire was the main instrument for data collection. The questionnaire's validity was checked using the average variance extracted, and its reliability was determined by calculating composite reliability and Cronbach's alpha. Data were analyzed by structural equation modeling technique using Smart PLS software. The results showed that only the relationship between information and communication technology and process variables was significant among the contextual factors. Contextual factors accounted for 28.9% of the variance in the process variable. There was a positive and significant relationship between knowledge management and performance. Knowledge management could capture 53% of the variance in performance.

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INTRODUCTION

The agricultural extension system, a sub-system of agriculture with a service and training nature, influences production and income, improves living standards, and enhances the rural communities' social and educational standards by improving agricultural methods and techniques (Swanson & Samy, 2002). During the past four decades, agricultural extension systems in the world have faced many challenges due to not adopting spontaneous and endogenous development approaches and strategies based on the current developments and the needs of rural communities (Shahvali, 2014). Addressing the new and ever-increasing challenges in the agricultural sector requires the involvement of extension services with diverse goals, which is considered necessary to tackle the extension system's inefficient organization (Diab et al., 2020). In recent years, different approaches, such as modernization (reform), decentralization, and privatization, have been proposed in different countries to overcome current challenges (Raanaei Kordshooli & Mortazavi, 2016). According to a survey by FAO, 50 percent of 207 extension organizations in 115 countries have been established or restructured after 1980 (Obiora & Emodi, 2012). Some reforms have been creating new transformative structures, regularly visiting farmers, building capacity for extension agents, increasing the government's commitment to agricultural extension, and assigning adequate budget to agricultural extension (Swanson, 2002; Obiora & Emodi, 2012).

The agricultural extension system was officially established in Iran over 70 years ago, and like many developing countries, it adopted a combined approach focused on state (public) agricultural extension services (Allahyari, 2009). However, it has failed to achieve sustainable agriculture goals (Hayati & Rezaei–Moghaddam 2006; Karamidehkordi, 2013). Because of its governmental nature, agricultural extension in Iran has always been struggling with particular problems and limitations, such as financial issues, human resource management and development malfunctions, and lack of required efficiency and appropriate organizational structure. Some obstacles and challenges are the lack of funds, transportation facilities, and educational equipment (Dinpanah et al., 2009), lack of specialized extension staff (Falaki et al., 2007), inappropriate content of extension messages, lack of in-service training, weak professional qualifications of extension service providers (Nazarzadehzareh et al., 2011), lack of strong communication links between the extension organization and research organizations and universities (Babaei et al., 2013), inappropriate motivation of extension personnel (Yaghoobi Farani et al., 2009), the disperse of the audience and inability to cover a vast majority of users (Nazarzadehzareh et al., 2011), namely smallholders and poor farmers in the transfer of appropriate relevant technology and services (Rezaei et al., 2010), centralized management of the agricultural extension system, poor communication between the farmers and lack of delegating the extension services to private sectors (Alizadeh et al., 2019). To overcome the challenges, agricultural extension can consider different approaches to create a comprehensive image with adequate acceptance by the government sector and the local community. In Iran, some issues, such as changing views on the position and role of agricultural service centers, meeting the increasing need for an agricultural sector that is responsive to the users via public and private sector experts, and designing and developing a comprehensive program based on organizational cohesion between the executive, research, extension, and non-governmental departments to solve the problems of the users and create the capacity to accept new information and communication technologies, needs to be investigated and analyzed (Raanaei Kordshooli & Mortazavi, 2016).

Thus, in an attempt to recognize the existing gaps in the functional and communication dimensions of the extension system, the Iranian Agricultural Research, Education, and Extension Organization (AREEO) of the Ministry of Agriculture analyzed its processes and sub-systems in the field of extension at the macro level. Accordingly, developing a suitable road map to promote development goals and become an efficient, effective, and agile organization has been prioritized since 2013. As a result, a new agricultural extension system (NAES) plan was designed and implemented. The initial pilot was implemented in 2015 and developed nationwide in 2016 to actively intervene in the agricultural extension system and natural resources to increase knowledge and skill, as well as to use favorable extension approaches in improving users' technical and managerial skills working in agriculture and natural resources (Ghasemi et al., 2018). This system considers three main approaches, i.e., (1) zoning production areas, (2) organizing and equipping agricultural centers, and (3) managing knowledge, and three sub-approaches, i.e., (1) interaction with the executive sector, (2) interaction with the research sector, and (3) interaction with and utilization of the non-governmental sector. An essential mission of this system is to establish a knowledge management system to facilitate knowledge and information exchange between knowledge-generating centers, users, and other stakeholders in the agricultural sector based on the needs of this field with a pluralistic extension approach (Agricultural Research, Education and Extension Organization, 2015).

In order to use knowledge management (unified and integrated management in knowledge production, transfer, and application), a knowledge network has been developed and launched so that all units of the Ministry of Agriculture have access to this system up to the rural district (Dehestan) level. The knowledge network means a network that includes human and organizational communities enabling knowledge management processes (creating, storing, changing, retrieving, sharing, and transferring different types of knowledge) at different levels (individuals, groups, and organizations) and various organizational areas to increase productivity and value creation in this sector. Typically, at the beginning of its establishment, every new system faces internal or external challenges that can weaken its outcomes. The results of various surveys and analyses of different components of the modern extension system also show a big gap between the current and optimal situation for this system (Raanaei Kordshooli & Mortazavi, 2016). Now, more than five years after the emergence of the new extension system, analyzing its elements and components can provide planners and policymakers with a proper perspective on this system while identifying possible challenges and problems and providing mechanisms for its improvement.

Zanjan province, located in the northwest of Iran, was one of the first provinces where the new extension system was implemented. The province has taken essential steps in implementing knowledge management for several years. But, the ultimate goal of implementing such a system has not been fully achieved. Although knowledge management is based on the NAES of Iran, in terms of structure, content, and function, there is a need for pathology to tackle existing obstacles and shortcomings and provide improvement solutions as addressed in this research. Accordingly, the present research analyzed the knowledge management network of this system as one of its important components in Zanjan province.

New Agricultural Extension System

The new extension system could rely on the three principles of equipping and renovating the agricultural centers, zoning production areas, and establishing knowledge management, as well as optimally utilizing the capacity of the research department in the form of supportive researchers and senior extension researchers, executive sections, and the non-governmental sector, to considerably improve the effectiveness of extensional activities and the coefficient of knowledge diffusion in production zones. With employing about 8000 agriculture graduates in the Ministry of Agriculture, a new potential was formed to meet farmers' needs and problems. This opportunity can be well grasped by operationalizing the new system plan and labor division in the production zones. On the other hand, the transfer of the research findings and achievements produced in the research institutions, which were available for the target community and the main audience of the programs in a prolonged process before the project implementation, was facilitated and accelerated through a set of defined mechanisms. In addition to the importance of this system, some studies have indicated that it has not been entirely successful in attaining the predicted goals. Inadequate knowledge of experts and provincial officials about the NAES, insufficient organizational cohesion of the Ministry of Agricultural in support of the new extension system, the vague future of agricultural activities, and skepticism about the continuation of activities in fields related to agriculture are among the threats to this new system, which highlights the need to enhance specific extensional programs in pilot areas (Rezaei-Moghaddam & Fatemi, 2019).

Conceptual framework and propositions

Knowledge management, in general, is a dynamic process of knowledge generation, acquisition, dissemination, sharing, and application (McElroy, 2003). The knowledge management process includes knowledge production, storage, processing, and distribution. Knowledge in the modern system is generated for farmers by various methods, including the use of the knowledge of other farmers, especially pioneer producers, the use of mass and accessible media, the use of the knowledge by extension agents, governmental facilitators, or non-governmental organizations provided to farmers based on their needs, the use of the knowledge of local people such as tribal leaders, pioneer farmers, and other local experts and qualified people, agricultural organizations, sellers and distributors of inputs or buyers of products and brochures and books or any available sources. The raw knowledge obtained should be stored in a place where it can be managed, protected, and made accessible to others. An appropriate and sufficient number of databases and proper facilities in information retrieval through the right information technology will influence the retrieval and storage of knowledge (Hendriks, 2001; Sambamurth et al., 2003; Peachey, 2006; Franco & Mariano, 2007). Knowledge storage in the NAES means recording, documenting, coding, and classifying knowledge and experiences acquired, lessons learned, explicit knowledge, and useful documentation. It should be stored in a repository after being created in the knowledge management system and should be categorized and maintained regularly with easy access. Raw knowledge becomes valuable organizational knowledge in the processing stage. Knowledge processing in the NAES means refining and storing the created and acquired knowledge, classifying and making it available to those needing it, and updating the existing knowledge bases in the relevant agricultural organizations. When knowledge is created, it should be transferred to realize its advantages. This transfer can be from one person to another, to other groups, or to working procedures and processes. Therefore, knowledge transfer can contribute to creating new insights (Zack, 1999).

In the NAES, knowledge is transferred by various methods among different actors. Real, complete, and timely information about farms' and farmers' requirements can be the main element of the knowledge distribution system. For this purpose, the production areas have been zoned to identify farmers' knowledge requirements and transfer the required knowledge according to their needs. In general, knowledge transfer through brochures, extension short message services (SMSs), agricultural programs in national media, the extension hall of agricultural knowledge and techniques and agricultural applications, web-based training courses, and extension programs such as visiting model farmers and holding farming days and findings transfer days.

In the present study, after the relevant literature was examined and the most frequent factors were identified, three factors were identified as contextual components influencing the knowledge management process based on the fields considered by the new agricultural extension system for knowledge management. These factors included organizational culture, information and communication technology, and organizational structure.

Organizational culture is one of the most important success factors of knowledge. Several factors can be included in the organizational culture category, such as employee engagement and perception, continuous learning, risk-taking organizational environment, communication and cooperation, valuing employees and management of organizational resources, and employee motivation (Chin, 2009). Organizational culture is considered a source facilitating the process of knowledge management given that the literature emphasizes a positive and significant relationship between these two factors (Rouniasi & Movahedi, 2013; Mohammadi Moghadam et al., 2015; Roshan Meidan et al., 2016; Hejazi et al., 2017; Pourfateh et al., 2020). As it was mentioned, the following proposition is suggested:

Proposition 1: *There is a positive relationship between organizational culture and knowledge management success in NAES.*

The main platform of the knowledge management flow in the organization is information and communication technology. Information technology is seen in the organization as a neural network that allows for storing and retrieving information and acquired knowledge by creating knowledge repositories in addition to establishing a link between departments and facilitating the flow of information between them. Furthermore, it plays an effective role in supporting and improving learning. Organizations should categorize their information and knowledge before placing them in knowledge repositories and arrange them appropriately (Sigala & Chalkiti, 2014). Technology, which is part of the knowledge management infrastructure, includes the dimensions of business intelligence, collaboration, shared learning, knowledge discovery, knowledge map, and opportunity creation, as much as it encompasses the security dimension (Jamrog, 2004). In the NAES, the capacity of information and communication technology is grasped to implement knowledge management. Creating agricultural knowledge and techniques extension hall as an electronic system containing a wide range of written, audio-visual, and electronic media with open access to the public, producing various types of extension media, and creating a virtual network of agricultural education are some of the measures that have been taken in this field. Various researchers have emphasized the positive relationship between the application of information technology and knowledge management success in the agricultural sector (Mouvahedi et al., 2015; Pourfateh et al., 2020; Yadav et al., 2015; Mohammadi Moghadam et al., 2015; Vangala et al., 2015; Chandra¬ ¬Ray, 2017; Vangala et al., 2017). As mentioned, the following proposition is proposed:

Proposition 2: *There is a positive relationship between application of information and communication technology and knowledge management success in NAES.*

In addition to directing the behavior of employees, the organizational structure describes which behaviors are acceptable and which aren't (Radding, 1998). Today's organizations need non-hierarchical and flat structures that are dynamic and process-oriented, not task-oriented. Informal relationships, inclusive emotional relationships, and extroverted interactive relations are among the characteristics of modern organizational structures that enable the creation and sharing of knowledge inside and outside the organization. Since knowledge acquisition, creation, and sharing are some of the key processes of knowledge-based organizations, informal relations are an important aspect of the structure of these organizations (Peachey, 2006). The informal structure better displays the real activities of the organization and reflects the dynamic interactions that play a crucial role in creating and sharing knowledge (Sharifuddin & Rowland, 2004).

Determining the knowledge management team, developing knowledge and management regulations, and supporting the knowledge network in Iran are some measures predicted in the new extension system for the implementation of knowledge management in the context of organizational structure. The relationship between organizational structure and knowledge management has been emphasized in various studies (Dinpanah & Amouei, 2012; Mohammadi Moghadam et al., 2015; Seifu et al., 2019; Pourfateh et al., 2020; Riyadh et al., 2021). As mentioned, the following proposition is recommended:

Proposition 3: *There is a positive relationship between organizational structure and knowledge management success in NAES.*

Finally, a question is raised here: What is the relationship between the knowledge management process and performance improvement? Performance is a multidimensional concept that defines the status of the organization compared to competitors (Lopez et al., 2011). The improvement of organizational performance (Rezaei et al., 2015; Seifu et al., 2019), organizational entrepreneurship (Korani, 2018), promoting organizational innovation (Kabbi & Roosta, 2018), and adoption of agricultural innovations (Pius Mtega & Ngoepe, 2019) are among the impacts of knowledge management in agricultural organizations. In this research, according to the regulations of the NAES, the purpose of improving the performance arising from the knowledge management process is to improve the access of beneficiaries (experts, extension providers and farmers) to technical knowledge and research findings. Therefore, we can say:

Proposition 4: *There is a positive relationship between knowledge management and stakeholders' access to technical knowledge and research findings.*

As mentioned, the conceptual framework of the research is presented in Figure (1).

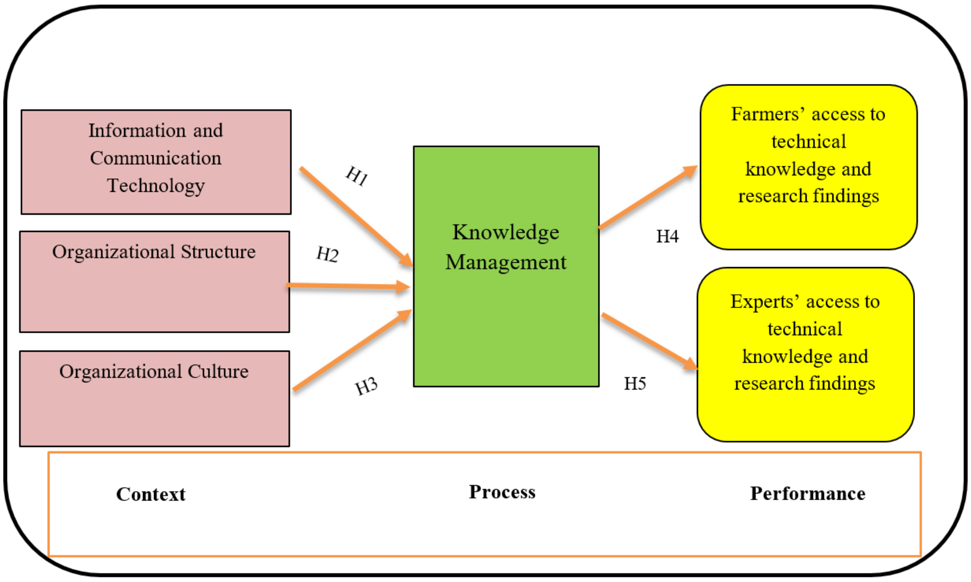

Figure 1. The conceptual framework of the research

Study Area

The research was conducted in Zanjan province. With an area of 22164 km2, Zanjan occupies about 1.34% of Iran's total area, while the province's share of the total cultivated land is more than 3.6%. According to official statistics and information, the average land use is 8.5% and 1.24% in Iran and Zanjan province, respectively, indicating the province's potential in the agricultural sector. According to the latest national divisions, Zanjan has 8 counties, 17 districts, 48 sections, and 21 cities (Figure 1). According to the results of the 2016 census, the province's population is 1057461 people, of which 67% live in urban areas and 33% live in rural areas. According to the latest statistics of the comprehensive zoning system in 2022, this province has 27 active agricultural centers, 122 extension providers responsible for zoning, and 100516 beneficiaries.

Figure 2. The geographical map of the study area

Methodology

The current research is a quantitative study conducted using a survey method. The samples consisted 171 people, including all line (133 people) and staff (10 people) experts of agricultural extension, and the province's agricultural and natural resources research and education center (28 people) who were selected and studied by census method. The main instrument for data collection was a researcher-made questionnaire. The appropriate components and items that could meet the research objectives were selected based on the opinions of key agricultural managers and experts in the agricultural organization of Zanjan province. The reliability of the questionnaire was measured by Cronbach's alpha and composite reliability (CR), and its validity was determined by the average variance extracted (AVE) to find out the convergent validity in addition to asking the experts' opinions (face validity). Also, cross-factor loadings and the Fornell-Larcker criterion were used to determine the diagnostic validity (Fornell & Larcker, 1981). Table (1) shows the different sections of the questionnaire, the number of items in each section, and their validity and reliability. In addition, the research variables were measured and coded on a five-point Likert scale from "very low = 1" to "very high = 5". The study used descriptive statistics such as percentage, mean, and standard deviation. For this purpose, SPSS software (version 22) was used. The hypotheses were tested by the confirmatory factor analysis method with the partial least squares approach and Smart PLS software (version 3).

Table 1
Different sections of the questionnaire, along with their reliability and validity values.

Component	Variables	Number of Items	Cronbach's alpha	AVE	CR
Contextual	Information and communication technology	10	0.936	0.627	0.944
	Organizational structure	10	0.936	0.619	0.942
	Organizational culture	9	0.965	0.769	0.967
Process	Knowledge production	7	0.857	0.538	0.890
	Knowledge storage	8	0.883	0.555	0.908
	Knowledge organizing and processing	3	0.908	0.844	0.942
	Knowledge distribution or transfer	11	0.931	0.595	0.941
Performance	Beneficiaries' access to technical knowledge and research findings	Beneficiaries 10	0.943	0.564	0.951
		Experts 9	0.902	0.661	0.920

Results

Among the 133 line experts, 62 (47%) were men and 71 (53%) were women. Their average age was 38.33 years, and their mean work experience was 9.05. The highest frequency was related to individuals with a bachelor's degree. All the staff experts studied were male, with an average age of 46.40 years and a mean work experience of 20 years. Most of these people had a bachelor's degree. Among the 28 identified researchers, 27 (96%) were men, and 1 (4%) was woman. The mean age of these people was 43.82 years, and their mean working experience was 16.11. Most of these people had doctorate degrees.

Evaluating the research's measurement model

The convergent validity of the research model was determined by the average variance extracted (AVE). The results in Table (1) indicate that the AVE value of all categories of the research model was higher than 0.5, so this measurement instrument had convergent validity and measured what it claimed to measure (Fornell & Larcker, 1981). The reliability of the measurement model was determined by Cronbach's alpha and composite reliability criteria. As shown in Table (1), Cronbach's alpha and composite reliability were acceptable, so it could be concluded that the measurement instrument and its categories could provide reliable results.

The discriminant or diagnostic validity of the research model was evaluated by cross-factor loadings and the Fornell-Larcker criterion. It showed that the items related to different categories were not strongly correlated with each other, so it could be concluded that the two categories measured different topics. As shown in Table (2), based on this criterion, the selected items were good for measuring the desired constructs with diagnostic validity because the diameter of the matrix was higher than all correlations of other constructs.

Table 2

Diagnostic validity of the knowledge management network model in the NAES based on the Fornell-Larker (1981) criterion.

Construct	1	2	3	4	5	6	7	8	9
Experts' access to knowledge (1)	0.751								
Farmers' access to knowledge (2)	0.809	0.813							
Information and communication technology (3)	0.646	0.622	0.792						
Knowledge organizing and processing (4)	0.542	0.528	0.428	0.919					
Knowledge storing (5)	0.620	0.640	0.486	0.504	0.745				
Knowledge distribution or transfer (6)	0.693	0.639	0.499	0.621	0.662	0.771			
Organizational culture (7)	0.466	0.503	0.734	0.312	0.374	0.358	0.877		
Organizational structure (8)	0.531	0.533	0.746	0.383	0.430	0.389	0.467	0.787	
Knowledge production (9)	0.506	0.567	0.327	.0612	0.522	0.602	0.351	0.355	0.733

In the following, the confirmatory factor analysis method was used with the partial least squares approach and Smart PLS software to verify the presented components and items for measuring different concepts and variables. Accordingly, the accuracy of the indicators or measures selected for each category was examined to consider whether the measures had adequate accuracy to measure their structure. Figure (3) shows the significant values of the knowledge management network model in the NAES in the standard estimation mode. Figure (4) displays the t-values for the items of each construct, and Table (3) presents both of these values obtained for this model. As shown, all items have factor loading values higher than 0.5 and are significant. Thus, it can be said that the measurement model was homogeneous, and the reliability of the indicator or measures was verified. It is worth mentioning that a significant level of 1% was obtained for all indicators.

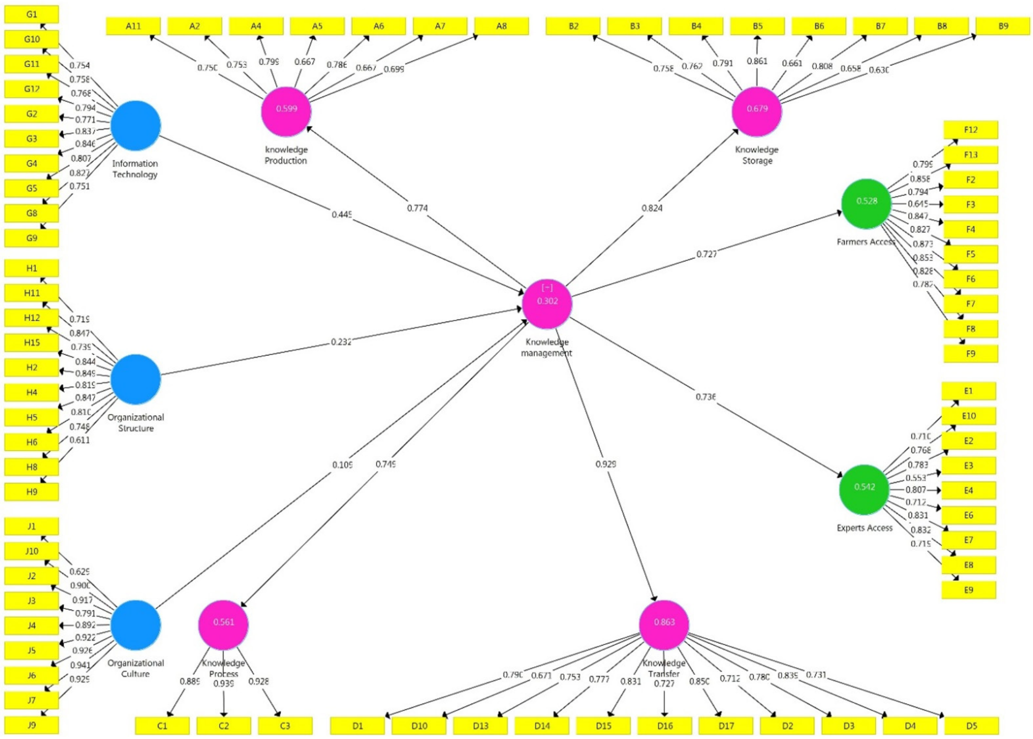

Figure 3. The factor loadings of the knowledge management network model in the NAES

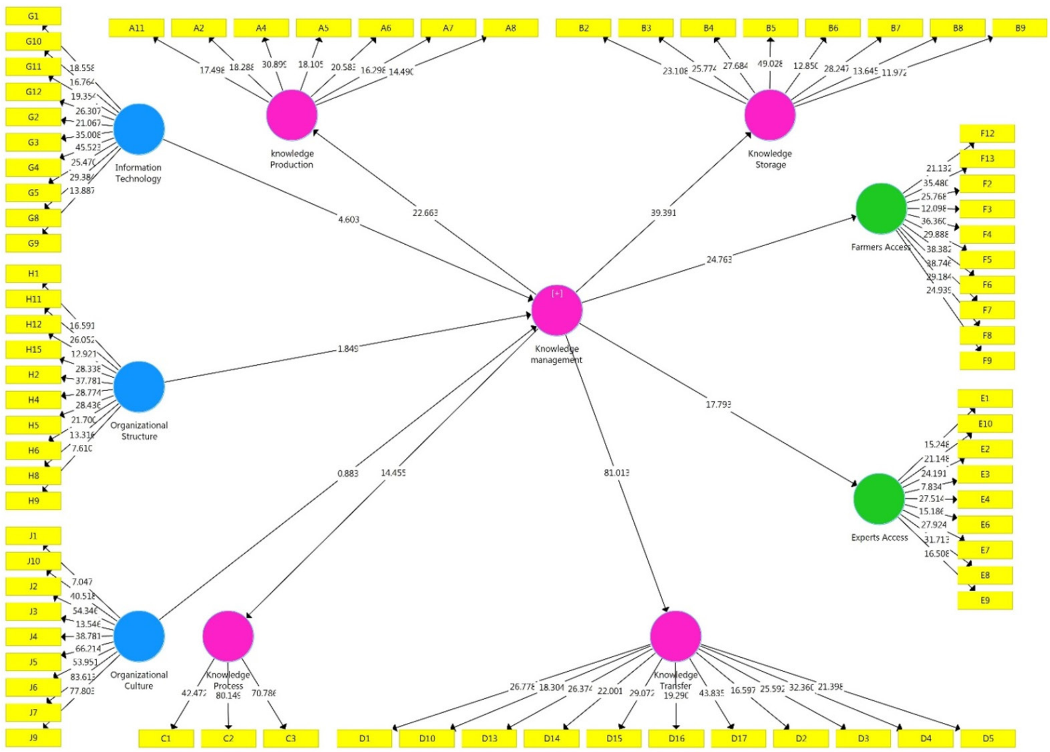

Figure 4. The t-values in the knowledge management network model in the NAES

Table 3
Factor loadings and t-values for the indicators of each construct in the form of the knowledge management network model in the NAES.

Model dimensions	Construct	Items	Symbol	Factor loading	T statistics
Infrastructures of knowledge management	Information and communication technology	Information management and elimination of spatial and temporal distances	G1	0.754	18.55
		Helping experts, extension providers, researchers, and users for cooperation and mutual interaction within the organization	G2	0.771	21.06
		Creating new opportunities in collaboration with other institutions	G3	0.837	35.00
		Access of experts, extension agents, and users to experts	G4	0.846	45.52
		Identification and acquisition of new knowledge and information by experts, extension agents, researchers, and users	G5	0.807	25.47
		Easy knowledge and information searching	G8	0.827	29.38
		Reusing knowledge and information several times	G9	0.751	13.88
		Assessment of knowledge and information needs	G10	0.758	16.76
		Development of knowledge and information	G11	0.768	19.35
		Knowledge and information storing	G12	0.794	26.30
	Organizational structure	The existence of an organizational structure facilitating interaction and knowledge sharing	H1	0.719	16.59
		The existence of an organizational structure that facilitates and enhances collective behavior	H2	0.849	37.78
		Reducing organizational hierarchy and strengthening horizontal communication between employees	H4	0.819	28.77
		The existence of an organizational structure facilitating and enhancing informal communication among employees	H5	0.847	28.43
		The existence of an organizational structure facilitating the delegation of authority to individuals	H6	0.810	21.70
		Knowing the strengths and weaknesses, opportunities and threats, and existing potentials to start the implementation of knowledge management	H8	0.748	13.31
		Presence of motivational solutions (promotion, reward, and punishment)	H9	0.611	7.61
		The existence of an organizational structure facilitating access and interaction with experts, extension agents, and researchers inside the organization	H11	0.847	26.05
		The existence of a flexible organizational structure that adapts to environmental changes	H12	0.739	12.92
		Organizational structure facilitating learning and training while serving experts and extension agents	H15	0.844	28.33
	Organizational culture	Perceiving the importance of knowledge by employees to achieve success	J1	0.629	7.04
		Understanding the needs and real conditions of users	J2	0.917	54.34
		Clarity of the vision and objectives of agricultural extension	J3	0.791	13.54
		Valuing the individual specialties of individuals	J4	0.892	38.78
		Having a sense of belonging to the organization	J5	0.922	66.21
		The existence of a learning culture in the organization	J6	0.926	53.95
		The existence of an organizational culture based on participation and interaction with each other	J7	0.941	83.61
		The existence of a culture of sharing knowledge and experiences among individuals in the organization	J9	0.929	77.80
		The existence of a trust-oriented culture in the organization	J10	0.900	40.51

Model dimensions	Construct	Items	Symbol	Factor loading	T statistics
Knowledge management process	Knowledge production	The local knowledge and the experiences of farmers	A2	0.753	18.28
		Pioneer and exemplary farmers	A4	0.799	30.89
		Executive section experts (subject-matter experts)	A5	0.667	18.10
		Extension agents responsible for production zones	A6	0.786	20.58
		Agricultural and rural organizations and cooperatives	A7	0.667	16.29
		Producers and sellers of inputs	A8	0.699	14.49
		Technical and engineering consulting service companies	A11	0.750	17.49
	Knowledge storing	Written information sources	B2	0.758	23.10
		Digital information resources (e.g., compact discs)	B3	0.762	25.77
		Electronic publications	B4	0.791	27.68
		Electronic databases and websites	B5	0.861	49.02
		Hall for the extension of agricultural knowledge and techniques	B6	0.661	12.85
		Specialized databases	B7	0.808	28.24
		Agriculture and natural resources research and education centers	B8	0.658	13.64
		Agricultural organizations	B9	0.630	11.97
	Knowledge organizing and processing	Simplifying specialized content	C1	0.790	42.47
		Classification and thematic separation of content	C2	0.712	80.14
		Content media separation (written, electronic, applications)	C3	0.780	70.78
	Knowledge distribution or transfer	Written media knowledge	D1	0.850	26.77
		Extension SMSs	D2	0.712	16.59
		Radio programs	D3	0.780	25.59
		TV programs	D4	0.839	32.36
		Extension movies	D5	0.731	2139
		Comprehensive model sites	D10	0.671	18.30
		Day and week of transferring findings	D13	0.753	26.37
		Demonstration units	D14	0.777	22.00
		Extension workshops and courses	D15	0.831	29.07
		Individual training	D16	0.727	19.29
		Extension visits	D17	0.850	43.83

Model dimensions	Construct	Items	Symbol	Factor loading	T statistics
Beneficiaries access to knowledge	Farmers' access to technical knowledge and research findings	Degree of access to technical knowledge and research findings (via various electronic media)	F2	0.794	25.76
		Access to technical knowledge and research findings (through agricultural software such as applications)	F3	0.645	12.09
		The degree of conformity of the produced content with real requirements	F4	0.847	36.36
		Speed of access to technical knowledge and research findings	F5	0.827	29.88
		Ease of access to technical knowledge and research findings	F6	0.873	38.38
		The quality of technical knowledge and available research findings	F7	0.853	38.74
		Access to knowledge and technical information with easy implementation	F8	0.828	29.18
		The quality of information about how to access information sources	F9	0.782	24.93
		The degree of face-to-face interaction with sources of knowledge production (e.g., researchers)	F12	0.799	21.13
		The possibility of virtual interaction with knowledge production sources (e.g., researchers)	F13	0.858	35.48
	Expert's access to technical knowledge and research findings	The degree of access to technical knowledge and research findings (through various written media)	E1	0.710	15.24
		Access to technical knowledge and research findings (via various electronic media)	E2	0.783	24.19
		Access to technical knowledge and research findings (through agricultural software such as applications)	E3	0.553	7.83
		The degree of conformity of the produced content with real needs	E4	0.807	27.51
		Easy access to technical knowledge and research findings	E6	0.712	15.18
		The quality of technical knowledge and available research findings	E7	0.831	27.92
		Access to knowledge and technical information with easy implementation	E8	0.832	31.71
		The quality of information about how to access information sources	E9	0.712	16.50
		The degree of face-to-face interaction with knowledge production sources (e.g. researchers)	E10	0.768	21.14

Evaluation of the structural model

The quality of the selected structural model was evaluated to choose the best explanatory model for the knowledge management network in the NAES. The model has three sections: knowledge management infrastructure (contextual), knowledge management process, and access to knowledge. The findings showed that based on the values of the path coefficients (beta), among the three infrastructure variables, this coefficient was significant only for information and communication technology at the 99% confidence interval, but it was not significant for the other two variables, namely organizational structure and organizational culture, and could predict 28.9% of the variations (R2) in the knowledge management process. On the other hand, based on the significance of the knowledge management path coefficient values in farmers and experts' access to knowledge at the 99% confidence interval, knowledge management could predict 52.6% and 53.9% of the variations (R2) in farmers and experts' access to knowledge, respectively. According to the three values of 0.19, 0.33, and 0.67 proposed by Hair et al. (2014) as the criteria of weak, medium, and strong values obtained in the current model, the construct of information technology was below average, whereas knowledge management in the access of farmers and experts to knowledge was above average and nearly strong.

In addition to evaluating the magnitude of the R2 as a measure of prediction accuracy, Stone-Geisser's Q^2 value was investigated. In the structural model, the value of Q2 greater than zero for a certain reflective endogenous variable indicates the appropriateness of the path model prediction for this specific construct. On the other hand, zero and lower values show the predictor's lack of fit. As a predictive fit measure, the values of 0.02, 0.15, and 0.35 indicate that an exogenous construct has a small, medium, or large predictive fit for a certain endogenous construct, respectively (Hair et al., 2014). The value of Q2 for the endogenous constructs of knowledge management infrastructures and knowledge management in farmers and experts' access to knowledge was obtained as 0.122, 0.338, and 0.292, respectively, based on which we can conclude these values of the predictive fit of the model in the case of endogenous constructs for the first case were at a lower than average level and at a higher than average level and close to strong for the next two cases (Table 4).

Table 4

The linear effect of research variables to test general research hypotheses.

The studied linear effect	Beta	T statistics	Sig.	Result	R^2	f^2	Q^2
Information and communication technology - Knowledge management	0.445	4.60	0.00	Supported		0.119	
Organizational structure - Knowledge management	0.232	1.85	0.06	Rejected	0.289	0.015	0.122
Organizational culture - Knowledge management	-0.109	0.88	0.37	Rejected		0.003	
Knowledge management - Farmers' access to knowledge	0.727	24.76	0.00	Supported	0.526	1.120	0.338
Knowledge management - Experts' access to knowledge	0.736	17.79	0.00	Supported	0.539	1.183	0.292

The model's overall fit was checked by the indicators presented in Table (5). The squared Euclidean distance (dULS) and the geodesic distance (dG) indices were significant at the 0.05 level, implying that the model estimation was done efficiently. The SRMR value was equal to 0.087, which indicates an acceptable measurement error in the correlation matrix.

Table 5

The fit indices of the knowledge management network model in the modern agricultural extension system.

Fit index	SRMR	d-ULS	d-G	NFI	RMS-Theta
The proposed value	0.1 >	0.05<	0.05<	0.80<	0.12≥
The estimated value	0.087	10.32	3.124	0.75	0.11

The Tenenhaus Goodness of Fit (GOF) is another index used to measure a model's fit and it is generalized to society. This index shows the model's overall fit and is calculated by the following equation:

$$GOF = \sqrt{Communlity * R^2}$$

As shown in Table (6), this index was 0.187, 0.421, and 0.397 for knowledge management infrastructure, farmers' access to knowledge, and experts' access to knowledge, respectively. Based on the values of 0.01, 0.15, and 0.36 proposed by Hair et al. (2014) as a criterion for weak, medium, and strong values, it can be concluded that the model had strong and acceptable GOF and could be generalized to the research population.

Table 6
The evaluation index and structural model's fit.

Construct	R^2	Q^2 (Communality)	GOF
Knowledge management infrastructures	0.289	0.122	0.187
Farmers' access to technical knowledge and research findings	0.526	0.338	0.421
Experts' access to technical knowledge and research findings	0.539	0.292	0.397

Discussion and Conclusion

A concern of the agricultural sector planner is that despite the production of science in the scientific communities of universities and research centers, its transfer to the field and its use by the operators have not been done appropriately, and this gap has always existed. On the other hand, sometimes the production knowledge is not based on the actual needs of the sector, which causes a considerable amount of waste of resources. Thus, knowledge management as one of the goals and main elements of the NAES is on the agenda of the Agricultural Research, Education and Extension Organization to increase the rate of knowledge distribution in the agricultural sector, update farmers' knowledge and job skills, and improve productivity in this sector (AREEO, 2015). Accordingly, the present study aimed to investigate the knowledge management network in the NAES in Zanjan province, in which three dimensions of contextual factors, knowledge management process, and performance factor, as well as the relationships between them, were examined. Based on the review of the literature, among the contextual factors, three categories of information and communication technology, organizational culture, and organizational structure were selected as the most important factors. The process of knowledge management was examined in four dimensions: knowledge production, knowledge storage, knowledge organization and processing, and knowledge distribution or transfer. The performance section was based on the structure and objectives of the agricultural extension system, including experts' and farmers' access to knowledge and research findings, and efforts were made to examine and evaluate its structural and measurement criteria with a comprehensive and process view.

For this purpose, five hypotheses were developed and tested using the structural equation modeling, with Smart PLS software (version 3). In the analysis of the impact of three contextual components, i.e. organizational structure, organizational culture, and information technology on knowledge management, only a positive and significant relationship was observed between information and communication technology and knowledge management. This finding is consistent with some studies (Mouvahedi *et al*., 2015; Pourfateh *et al*., 2020; Yadav *et al*., 2015; Mohammadi Moghadam *et al*., 2015; Vangala *et al*., 2015; Chandra Ray, 2017; Vangala *et al*., 2017). Indeed, it is worth mentioning that based on R^2, the percentage of the variance in the knowledge management process captured by this variable was not high. This can have various reasons. First, the development of a knowledge network based on information technology that can provide access to all elements of this network, from the staff level to various users and activists from the research, extension, and executive sector's experts, organizations and cooperatives, non-governmental sectors etc., is necessary and has hardware and software requirements. Second, facilities and infrastructure of information technology are not completely developed in all agricultural centers. Therefore, access to high-speed internet and adequate number of tablets and computers and the training of extension agents responsible for production zones as a link with beneficiaries can solve the problem to a large extent in the information technology field. It is worth noting that the multiplicity of systems related to different sectors is a problem that wastes the time of the extension agents responsible for the zone. Therefore, it seems necessary to remove unnecessary systems and integrate them. Thirdly, according to the characteristics of Iran's agricultural sector beneficiaries, they still do not have the necessary abilities and skills to use these technologies. Then, providing electronic media can be easily used by them, and necessary training in this regard can be effective, especially for younger beneficiaries.

However, one of the most important findings of this research was that organizational culture and organizational structure had no significant relationship with knowledge management. In most previous studies, a positive and significant relationship has been found between these two variables and knowledge management. The findings of this research on the lack of a relationship between organizational culture and knowledge management are inconsistent with the findings of previous studies (Rouniasi & Movahedi, 2013; Mohammadi Moghadam *et al*., 2015; Roshan Meidan *et al*., 2016; Hejazi *et al.*, 2017; Pourfateh *et al*., 2020). In addition, the lack of a relationship between organizational structure and knowledge management is inconsistent with some previous studies (Dinpanah and Amouei, 2012; Mohammadi Moghadam *et al*., 2015; Seifu *et al.*, 2019; Pourfateh *et al*., 2020; Riyadh *et al*., 2021).

In general, this section showed that the three variables of information technology, organizational structure, and organizational culture explained a small percentage of the variance in the knowledge management process, which indicates the lack of necessary conditions and support regarding these dimensions. In fact, the development of knowledge management needs the improvement and strengthening of its infrastructure, including organizational structure, organizational culture, and information and communication technology, which has been emphasized in various studies.

Considering employee motivation, training, and empowerment, ensuring flexibility in adaption to environmental changes, continuously evaluating the implementation of knowledge management and organizational structure facilitating interaction and knowledge sharing, briefing employees to understand the importance of knowledge, and developing soft and hard infrastructures to remove the spatial gap are some proposed solutions. Besides, considering the extent of the extension network at the country level and the diversity of different dimensions of beneficiaries in knowledge management, organizational cohesion and continuous interaction between the elements can play a crucial role, especially through the development of communication and information technology platforms.

The second section of the model was dedicated to examining the impact of knowledge management on performance variables. The findings showed that knowledge management as a process variable could predict 52.6 and 53.9 percent of the variance in farmers' and experts' access to technical knowledge and new research findings (as performance variables), respectively. This result confirmed the findings of other researchers (Rezaei *et al.*, 2015; Seifu *et al.*, 2019). Based on the values obtained regarding the impact of knowledge management on performance improvement, which was evaluated as medium to high and nearly strong for farmers and experts, respectively, it can be said that the indicators of knowledge management in the NAES, including knowledge production, storing, organizing, processing, distributing, and transferring, have been able to play its role in improving the knowledge of these two groups. Considering the high value of the average criterion in all components, the current condition of knowledge management in agricultural centers has been evaluated as partially favorable and these centers have a suitable environment for knowledge exchange between extension providers and beneficiaries, which can be a great contribution in improving performance and increasing productivity. Although the infrastructural and contextual conditions, such as organizational culture and organizational structure for the development of knowledge management, have not been considered in the expected conditions, knowledge management can show its positive effects in terms of access to technical knowledge and new research findings. Therefore, according to the results of the second dimension of the model, the necessity to pay more attention to the contextual dimensions is felt more and more.

Considering the relatively short life of the NAES and the measures taken in the knowledge management dimension, it is required to make a comprehensive assessment of its various dimensions, based on the achievements and existing shortcomings, using the existing legal capacities, as "Article 59 of the Law of Permanent Orders on the Development Plans of Iran", which is about empowering producers and creating a suitable platform for the transfer of knowledge and research findings in the form of a new extension system plan, as well as "Article 22 of the Law of Productivity in the Agricultural Sector" regarding the establishment of knowledge and information management network, to develop the knowledge management network in the agricultural sector as much as possible.

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