Universal Journal of Agricultural Research 10(6): 620-626, 2022 http://www.hrpub.org
DOI: 10.13189/ujar.2022.100603

Exploration and Development of Measurement Items of Innovation for New Technology Adoption among Small Farmers

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Received November 29, 2021; Revised May 22, 2022; Accepted June 21, 2022

Cite This Paper in the following Citation Styles

(a): *[1] Uzairu Muhammad Gwadabe, Nalini Arumugam, Noor Aina Amirah, "Exploration and Development of Measurement Items of Innovation for New Technology Adoption among Small Farmers," Universal Journal of Agricultural Research, Vol. 10, No. 6, pp. 620 - 626, 2022. DOI: 10.13189/ujar.2022.100603.*

(b): *Uzairu Muhammad Gwadabe, Nalini Arumugam, Noor Aina Amirah (2022). Exploration and Development of Measurement Items of Innovation for New Technology Adoption among Small Farmers. Universal Journal of Agricultural Research, 10(6), 620 - 626. DOI: 10.13189/ujar.2022.100603.*

Abstract The current global food challenge necessitates the need to increase agricultural production. Farmers' innovative mindset is unavoidable for successful and sustainable agriculture. Precision agriculture, through novel technology like big data, is an effective solution that can exponentially increase agricultural productivity and quality. Innovativeness among food growers is a significant determinant for adopting new technologies. For this reason, the Exploratory Factor Analysis (EFA) technique was used in this research to construct a reliable and valid instrument that measures innovativeness. Data was collected from small-scale farmers in Terengganu, Malaysia. The questionnaire was developed on a scale of one to ten. With the help of IBM SPSS Statistics version 25.0, the EFA was carried out using the principal component extraction method with Varimax Rotation. The study assessed Bartlett's Test of Sphericity and Kaiser-Meyer-Olkin (KMO) to determine the adequacy of the sample. Bartlett's test revealed a significant result (0.000), and the KMO value was excellent (0.726). The findings of the EFA revealed two components and eight items with Cronbach's Alpha values of more than 0.7, all of which were found to be significant. As a result, the results demonstrated the instrument's accuracy and dependability. This research contributes to developing items that assess innovativeness in the context of small farming in Malaysia.

Keywords Innovativeness, Exploratory Factor Analysis, Small-Scale Farmers, Technology Adoption

1. Introduction

The current global challenge necessitates an increase in agricultural production. The United Nations estimated that global food production needed to increase by at least 60–98% to feed the global population, which would rise to 9.8 billion by 2050. This means that agricultural production should dramatically and sustainably increase. However, farmlands are being taken away by rapid urbanization and climate change. Biodiversity is being rapidly degraded; climate change is increasing pressure on agricultural land, soils, and freshwater. Increased global temperatures and water scarcity have had long-term adverse effects on farm crops [1-4].

The concern is, how can agricultural production be dramatically increased in light of the current situation of exponential population growth versus the depletion of land and other fixed resources? In this regard, the innovative mindset of farmers is inevitable to the well-being of sustainable agriculture [5]. Precision agriculture, through the use of novel technology like big data, is an effective solution that can increase agricultural productivity and

quality [6]. Innovativeness is a construct that influences a person's response to the adoption of new technology like "Big Data." Big data is behind the scenes of precision agriculture, and it is a game-changer with a significant impact on agriculture. Even though there is no prominent theoretical model for technological acceptance that includes innovativeness, it has received support as a critical predictor of novel technology adoption across multiple disciplines [7, 8].

Rogers [9] described novelty as the degree to which the adoption of new ideas by a person or another unit is earlier than any other member of a system. However, Kamaruddeen, Yusof, and Said [10] viewed innovativeness as introducing a new product, process, technology, management, or market that aims to maintain or improve competitiveness while satisfying customers. This introduction is fueled by the learning process that occurs within the firm, between firms, and in the external environment. Likewise, a creative approach to business in purchasing new goods and services has also been described by research as innovativeness [11]. Such concepts indicate that innovative people continually seek a new way of getting things done, not only for a brief period but often continuously. These assertions show that the perception of innovativeness involves both behavior and product-related concepts.

Innovation begins with the determination to try out something new, to master the latest in new products and technological advances. In other words, the innovativeness of an individual describes the propensity of the person to participate in and promote new concepts, novelties, research, and inventive procedures in a business that may lead to something new in the form of a process, service or product. Some researchers, therefore, describe innovativeness as the tendency or propensity to embrace strategies, processes, and systems that are new not only to make a profit but also to meet end-users needs, promote sustainability, and create environmental awareness [12, 13].

In the agricultural sector, an imperative for innovation can be observed. As farmers are operating in a dynamic and rapidly evolving environment while others are struggling for survival, it is no wonder that innovativeness is one of the perfect means of achieving sustainability and an increase in revenues. Innovativeness in agriculture worldwide is considered an important aspect [14]. Innovativeness has been the sole solution of the European Union to pressing sustainability questions [15]. In the context of this study, "innovativeness" is viewed as a person's preparedness to try new technology.

Over the years, only limited studies considered innovativeness in technology acceptance research and even fewer in big data adoption. The findings of previous investigations, on the other hand, were inconsistent or contradictory [16-18]. It is possible that the items used in the investigation of the occurrences were responsible for the results' inconclusiveness and inconsistency. As a result, the study was set to investigate and identify appropriate items that can be used to assess innovativeness in the context of small-scale farmers' adoption of new technologies in Malaysia. So, this study is to develop valid items that measure the inventive construct using EFA.

2. Material and Method

To collect data, the study used a self-administered survey questionnaire adapted from previous studies [19-21]. The scale between 1 (strongly disagree) and 10 (strongly agree) was considered to measure the eight items of the instrument [22]. The descriptive statistic in Table 1 shows the measures of each element of innovativeness and provides the standard deviation and mean score for each item.

Table 1. Descriptive Analysis for Items Measuring Innovativeness

	Descriptive Statistics	Mean	Std. Deviation
INN1	I often like trying new and unusual activities that are not common.	8.00	2.017
INN2	I prefer a unique way of learning new things	7.45	2.364
INN3	I prefer a new approach to problem-solving	8.29	1.987
INN4	I prefer the traditional and experimental methods of cultivation to a new and innovative	6.29	2.969
INN5	I have made some changes at any farming process over the past 3 years	8.06	1.652
INN6	The changes I made to my farm were generally exciting.	8.23	2.276
INN7	I constantly try to develop new farming techniques even with no experience	8.55	1.841
INN8	I often seize new opportunities whenever I perceive it.	8.06	1.948

Valid N (listwise)

To minimize measurement error, the researcher conducted a pre-test on the instrument [23, 24]. The researchers requested three agricultural experts and three practitioners to review the items for scrutiny [24]. In the context of this study, experts are the staff of the Malaysian Ministry of Agriculture, while practitioners are farmers who have at least a decade of agricultural experience. The questionnaire was translated into Malay for a better understanding of the respondents. The study employed the services of a professional translator to ensure accuracy. As a result of their thorough examination of the questionnaire's content, face, and criterion validity, the reviewers ensured that it was accurate and precise. The reviewers were given both the English and Malay versions of the instrument to evaluate. Hence, the researchers modified and improved the instrument based on the reviewers' comments. After that, a reviewed version of the questionnaire was made available for data collection. The instruments were physically administered to 39 respondents during a meeting on knowledge sharing at Besut, Terengganu, hosted by the Malaysian Agricultural Research and Development Institute (MARDI), an agency of the Ministry of Agriculture, Malaysia, in November 2019. Due to the outbreak of the 2019 pandemic, the questionnaire was changed to Google Form, where the soft version was sent to different farmers' groups in Johor, Kedah, Kelantan, Pahang, Perak, Selangor, and Sabah through WhatsApp and emails. The data collection lasted until the end of 2020, and 141 small farmers responded to our online survey, which brought the total number of answered questionnaires to 150. The entire data was collected from small-scale farmers who are into agricultural food commodities.

The EFA was explained by Gupta et al. [25] as the technique used to improve research materials, systems, and parameters. It also assists in rectifying methodological defects. The EFA also allows researchers to perform analysis by minimizing errors and ensures that the respondents understand the focus of the study [26]. It also determines the content of questions and their relevance to the research topic [27]. To determine the validity of constructs, EFA practically groups the questionnaire's items into components [28, 29]. In this study, the researcher used the extraction procedure of the Principal Component with Variation Maximisation (Varimax) rotation to perform the EFA.

As is with all scholarly research, the findings of this study include limitations that must be acknowledged when interpreting or generalizing the findings. The study's scope was confined to small-scale farmers. Therefore, the results are also restricted to the agricultural sector in Malaysia. It is particularly important to take into account that the measurement of innovativeness is based on subjective assessments by small-scale farmers alone. Thus, the case might not be similar to other groups of farmers. The issue of respondent biases while filling out the questionnaire is another issue to consider. However, we attempted to minimize this issue through many questions and reverse-worded questions. The quantitative and cross-sectional nature of the current study is also a concern. So, we suggest that future studies use a longitudinal or mixed-method approach to develop the innovativeness construct.

3. Results and Discussion

Innovativeness was subjected to EFA in order to determine the dimensionality of items that may have been modified from previous research. This study has made changes to instruments that have been used in other studies. Some of the items have been changed to meet the needs of current research [30]. The result of Bartlett's Test of Sphericity, as shown in Table 2, was highly significant (sig. 000). In addition, the suitability of sampling in KMO was impressive because it was above the minimum threshold of 0.5 [31, 32]. The results of Bartlett's Test of sphericity and KMO indicated the suitability of the data to continue with the data reduction process in EFA. The results were consistent with the finding of Hoque, Awang, & Gwadabe [31] and Win [32].

Table 2. The Values for KMO and Bartlett's Test

KMO and Bartlett's Test		
KMO Measure of Sampling Adequacy.		.726
Bartlett's Test of Sphericity	Approx. Chi-Square	206.512
	df	36
	Sig.	.000

'Figure 1 presents the scree plot, indicating that two components have evolved from the EFA process. Each component is attached to its respective item. The number of items to be extracted was determined by the rotated component matrix [33, 34].

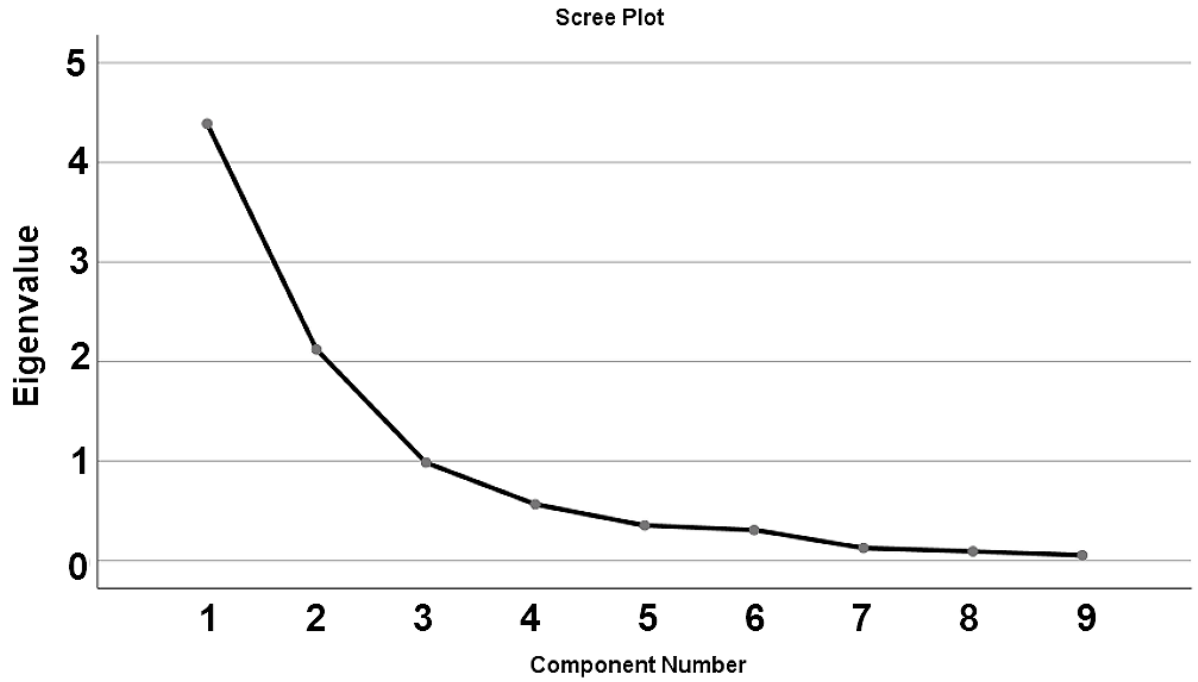

Figure 1. Two Components Extraction

Table 3. The Total Variance (Var) Explained for Innovativeness

Component							Rotation Sums of Squared Loadings		
	Total	% of Var	Cumulative %	Total	% of Var	Cumulative %	Total	% of Var	Cumulative %
1	4.389	48.766	48.766	4.389	48.766	48.766	4.008	44.529	44.529
2	2.121	23.568	72.334	2.121	23.568	72.334	2.502	27.805	72.334

"Extraction Method: Principal Component Analysis."

'Table 4. The Rotated Components Matrix

	Component	
	1	2
INN1	.863	
INN2	.846	
INN3	.942	
INN4		.779
INN5		.882
INN6		.893
INN7		
INN8	.863	
INN9	.853	

"Extraction Method: Principal Component Analysis. Rotation Method: Varimax with KMO Normalization.

Also, the total variance explained two components, as shown in Table 3. The calculation of the number of components to be derived was based on the scale of the equivalents, and the percentage of variation explained. In this analysis, only components with an Eigenvalues equal to or greater than one were considered significant. At least 60% of the total variance was considered acceptable, as Hair et al. [35] recommended. The table revealed that there were two components with Eigenvalues greater than 1, representing 44,529% for component 1 and 27,805% for component two. The factor explained 72.334% of the total variance, with an eigenvalue of approximately 23.568, which is consistent with the study by Fuad et al. [36].

Table 4 shows the respective items that produce the two

components and their separate items. For any item to be considered fit for this study, its factor loading should exceed 0.6. [35].

3.1. Internal Reliability

Lastly, the analysis requires calculating Cronbach's Alpha, indicating the reliability of the measurement items that were retained in the model. The internal reliability or consistency of items shows the strength of items held together in the measurement of the construct. Cronbach's Alpha is supposed to be higher than 0.7 for items to achieve internal reliability [35]. Table 5 indicates that Cronbach's Alpha test resulted in a 0.894, which is higher than 0.7, indicating that the items in question are reliable, which is in line with Awang [22].

Table 5. Internal Reliability

Reliability Statistics			
Component	Name	No. of Elements	Cronbach's Alpha
1	Process	5	0.925
2	Marketing	3	0.787
All items		8	0.894

3.2. Dimensions of Innovativeness

The primary classification of innovation emerged from the works of Utterback [37], who developed the '4 Ps of innovation', which depict the space in which the innovation happens. The first P is product innovation, which relates to introducing a new product to the market or making changes to an existing product, like enhancing its performance, reducing the cost of production, or any other upgrade [38]. Secondly, process innovation is defined as the creation, changes, or modifications to how services or products are made or delivered to customers. The third type of innovation is positioning innovation, which entails creating, changing, or modifying the environment in which the business or services are conducted. Fourth is paradigm innovation, which refers to the mental models on which a business is based. That is the kind of innovation that makes, changes, or improves the structure of a project that hasn't started yet. However, Alimo [39] classified innovation as a product, process, marketing, and organization. These are among the essential components of business survival and growth. These innovative activities generate competitive value and benefits for a successful business. The literature shows that businesses need a lot of different types of innovation in order to achieve their goals, too.

After going through different definitions, it becomes evident that picking an appropriate classification of innovativeness appears to rely on a contextual point of view. So, considering the perishable nature of most agricultural commodities, the importance of good quality and marketing of agricultural produce cannot be overemphasized [40]. So, process and market innovation are of utmost importance in determining the survivability of small-scale farming businesses [41-44]. As per consideration of the current study, innovation is concerned with the process and market innovations of small-scale farmers.

4. Conclusions

Innovation diffusion studies have long recognized highly innovative people as proactive about perceived new ideas. The technology adoption literature indicates that novel technology acceptance is driven by individual innovativeness. Therefore, in order to overcome the global agri-food challenges, this study contributes to measuring the innovativeness construct, particularly among small-scale farmers in Malaysia. The outcomes of the EFA produced a construct that was extracted based on two components to measure innovativeness. Process innovativeness and marketing innovativeness are the dimensions of innovativeness in this context. These dimensions were measured by eight items developed in this study since all the items of the two constructs explained that the variance was above 60 percent. However, all two constructs demonstrated Cronbach's Alpha values above 0.7, delivering high reliability. In addition, the value of Cronbach's Alpha for the eight items combined is 0.894, which also exceeds the verge value of 0.7.

Consequently, the study has justified that the innovativeness instruments have sufficient internal reliability [35, 22]. Such findings show that reliability tests surpass the minimum threshold value for the two components of innovativeness. As a result, the extracted components and their corresponding items are precise and reliable for measuring the new innovative construct. All agricultural food stakeholders, such as small farmers, the government, and non-governmental organizations, can use the tools to deal with the problem of increasing global food production before 2050.

However, the current research has its limitations. The first constraint relates to the methodologies utilized, the EFA, and the reliability study. These two stages are insufficient for assessing the theoretical foundation of the instrument. As a result, this study advises that further research be undertaken utilizing Confirmatory Factor Analysis (CFA) to contribute to and improve the concept of innovativeness among small farmers. The generalizability of this research is limited by certain limitations in its findings. For example, the survey only covers small farmers rather than estate farmers. Based on research constraints in terms of generalizability, this study suggests that future investigations to include all farmers in Malaysia rather than only small farmers might be viable. For future research, it is suggested that the number of states used as a sample be increased. This would broaden the findings in the same area and make it easier to generalize.

Acknowledgements

This work is part of the RR261 Fundamental Research Grant Scheme initiative (FRGS). Our appreciation goes to the Malaysian Ministry for Higher Education and Universiti Sultan Zainal Abidin for their support.

Conflict of Interest Statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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