Business and Sociological Perspective Review for Smart Farming Application

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***Abstract*— Digitalization in smart farming is becoming a trend with technological developments such as big data, AI/ML, IoT, and blockchain. Objective transformation in the agricultural sector can increase productivity and create sustainable digital agriculture. Parameters from business and sociological aspects are needed to achieve this purpose. An online intervention is required to improve the farmer's mental health and well-being. The starting point must consider the previously existing business models to prepare the business model for digital transformation, such as user demand and the entire supply chain, including stakeholders. There are three approaches to preparing a business model in digital transformation: internal approach, external, and direct approach. This article presents a systematic review of the business and sociological aspects of the implementation of smart farming by applying the PSALSAR (Protocol, Search, Appraisal, Synthesis, Analysis, Report) review method. This study concludes the scope and applications related to business and sociological perspective review of smart farming classified into smart farming service, infrastructure development, business and technology.**

Keywords—smart farming, productivity, transformation

I. INTRODUCTION

Digitalization, the socio-technical process of applying digital innovations, is an increasingly ubiquitous trend. Digitalization comprises phenomena technologies such as big data, the Internet of Things, Augmented Reality, Robotics, sensors, 3D printing, system integration, extreme connectivity, AI/ML, digital twins and blockchain. Digitalization has transformed everyday life and productive processes in agriculture radically. In the agricultural sector, several concepts have emerged to express different forms of digitization in agricultural production systems, such as Smart Farming, Smart Precision, and Decision Agriculture. Regardless of the term used, digitization implies that there are management functions on-farm and out-farm that focus on data types such as location, weather, and energy used to monitor animals, plants, and people. The data is necessary to interpret the history of the past and predict the future to make a more precise and accurate decision [1].

Farming is a dangerous occupation, physically and psychologically. In Australia, the prevalence of mental illness among rural and metropolitan populations is frequently reported. However, farmers' suicide rates also have consistently been higher. What makes agriculture different from other occupations is that a farm is often both a farmer's workplace and home and is seen as a job and a way of life, earning something from work; the roles of the household and family are related. Farmers also experience stress beyond their control caused by prolonged drought and widespread forest fires that negatively impact their well-being. Farmers are also facing unique and structural barriers to accessing healthiness and mental health [2]. Digital agriculture will likely change production processes inside and outside agriculture and broader social and institutional aspects using digital technology. It is also unknown how knowledge about agriculture can support or provide organizations such as advisory and scientific organizations that can understand and respond to digital agriculture [3].

This paper will discuss the recommended parameters to implement smart farming that focuses on business and sociological aspects to create sustainable digital agriculture.

II. MATERIALS AND METHODS

According to Dawn Craig's lecture material from the Institute of Health & Society at Newcastle University, the systematic review includes two words, namely:

1. Systematic which means doing or serving according to a plan or system that has been planned or methodical
2. Review means a critical appraisal of a book, show, or other work (including a journal or research article)

This study considers a systematic review with the following steps, from now on, abbreviated as PSALSAR:

- Protocol: defines the scope of research
- Search: define a search strategy
- Appraisal: assessing the quality of the papers that have been obtained through the filtering process
- Synthesis: processing and categorizing the information that has been obtained
- Analysis: analyze data that has been categorized
- Report: make a report on the results of the analysis in the form of a table or narration

A. Protocol

The scopes discussed in this review paper are the factors related to the business model, technology, infrastructure readiness, and user readiness in adopting the search strategy.

B. Search

The data used for analysis is from the search results in the ScienceDirect database. The search strategy is to use the

2022 3rd International Conference on Applied Electromagnetic Technology (AEMT)
ISSN 3025-4914 ©2023 by PUI Geomagnetik

keyword "Smart Farming" combined with the keywords "business" and "sociology". The search time was on May 29, 2022. Table I shows the results of the complete recapitulation of this step.

C. Appraisal

After obtaining related articles, the next step is to evaluate each article. This step is carried out and declared at the beginning as a form of the selection criteria transparency. Table II lists the requirements; inclusion defines the paper decisions taken, and exclusion represents the paper decisions that are not accepted.

D. Synthesis

After successfully filtering the data in the appraisal step, it moves to the synthesis step. At this step, the selected articles will be categorized iteratively and further to be used in the next step. Articles are categorized based on their relevance to business processes and the sociological situation of the farmers.

TABLE I. SEARCH STRING AND ITS RESULTS

Search String	Result
"Smart Farming" AND "Business"	4,256
"Smart Farming" AND "Sociology"	563
“Smart Farming” AND “Business” AND “Sociology”	419

E. Analysis

After the articles are categorized, the next step is analysis. At this stage, the themes that have been previously tagged are deepened. The result of the analysis form of a narrative or a table. The analysis results will be presented narratively in the next section.

TABLE II. APPRAISAL RULE

Criteria	Decision
While there are keywords related to the search string in the title, keywords or abstract	Inclusion
Paper in English or Indonesian	Inclusion
Paper types of the review article and research articles	Inclusion
Paper cannot be access	Exclusion
Duplicated paper	Exclusion
Paper in the year <2017	Exclusion

E Report

After the article analysis, the next step is the report. The results are concluded and used as recommendations for a more comprehensive reader. Information from this research will be described in this article. Conclusions, potentials, and recommendations will be presented at the end.

III. RESULT AND DISCUSSION

From the search results in the ScienceDirect database and using the search string configuration as in table I, the results obtained are 5,238 articles. The articles that moved to the next step were taken from the combination of the keywords "Smart Farming" AND "Business" AND "Sociology" as many as 419 articles. The appraisal step was done through filtering from the ScienceDirect website, and 170 articles were obtained. Then the abstract, title, keyword, and relevance check steps are carried out manually. The first 20 articles are taken to be classified, analyzed, and reported in the following steps.

TABLE III. FINAL RESULT INCLUSION

No.	Ref.	Summary
1	Klerkx. L., *et al*. 2019. Netherlands [1]	This paper contributes 17 articles that discuss socio-economic dynamics, digital agriculture, and smart farming
2	Shang, L., *et al*. 2021. Germany [4]	This paper develops a conceptual framework that incorporates evidence of adoption rates among farmers with a systematic perspective on technology diffusion
3	Musat, G.A., *et al*. 2018. Romania [5]	This paper presents an intelligent platform that helps farmers manage the greenhouses efficiently and a platform for interacting with other farmers
4	Keshavarz, M. *et al*. 2021. Iran [6]	This paper discusses a survey of 224 families in Iran who work as farmers to show their level of resilience to climate change
5	Kampker, A. *et al*. 2019. Germany [7]	This paper presents a morphological framework based on a literature review and expert interviews to develop a product service system business model
6	Clayton, S. *et al*. 2020. United States [8]	This paper discusses a survey aimed at developing a scale of concern related to climate change
7	Rijswijk, K. *et al*. 2019. Netherlands [3]	This paper discusses the survey through 29 semi-structured interviews with various parties such as agricultural researchers, advisors, science organizations, and technology providers. The result shows that knowledge and innovation of farming systems should be better to support researchers in agriculture to understand digital and developing digitalization
8	Jerhamre, E. *et al*. 2022.Sweden [9]	This paper presents a literature review and interview study that discusses the opportunities and obstacles when implementing Artificial Intelligence (AI) in agricultural business
9	Janker, J. *et al*. 2021. Finland [10]	This paper examines the relationship between farmer well-being and entrepreneurial identification
10	Bagheri, A. *et al*. 2022. Iran [11]	This paper discusses a study that uses the theory of planned behavior to model the adoption of SWC (Soil and Water Conservation) practices by farmers in the HERIS District in Iran

TABLE III. FINAL RESULT INCLUSION (*CONT.*)

No.	Ref.	Summary

11	Barun, A.T., *et al*. 2018. Germany [12]	This paper discusses how innovative supply chain management in the industrial era 4.0 provides a way to solve problems and provides a key for developing new forms of work and business models for the Agriculture 4.0 sector.
12	Vaz, E.D., *et al*. *2020*. Germany [13]	This paper provides a solution to increase grain storage capacity in areas of Brazil that don't have adequate storage capacity. A survey was conducted on farmers to identify the impact of attitudes, norms, and perceived behavioral control on farmer's intention to adopt a silo-on farm
13	Oostendorp, R. *et al*. 2019.[14]	This paper provides a quick overview of the part of financial inclusion as an inherent component and synergy of the inclusive agribusiness model
14	Rodriguez, J.P., *et al*. 2021. Columbia [15]	This paper implements a Smart Farming System based on 3 layers of architecture (Agriculture Perception, Edge Computing, and Data Analytics).
15	Castillo, G.M.L., *et al*. 2021. [16]	This paper proposes a socio-psychological model that is built on the Theory of Planned Behavior and social capital variables to examine how psychological construction and its interaction with the environment and farmer's background influence the adoption of irrigation technology
16	Ayre, M. *et al*. 2019. Australia [17]	This paper shows how to design a process to support expert farmers in adapting digi-ware smart farming practices to their work in providing agricultural consultancy
17	Gerli, P., *et al*. 2022 [18]	This paper explains how psychological factors such as emotions, attitudes, beliefs, and information seeking influence skill development in the context of smart farming
18	O'Shaughnessy, S.A., *et al*. 2021 [19]	This paper compares the smart farming approach in the US and Korea in terms of agricultural productivity and technical aspects/social challenges related to agricultural production
19	Adnan, N., *et al*. 2020.[20]	This paper examines the ability of rice farmers in terms of productivity in Malaysia
20	Gunn, K.M., *et al*. 2021. Australia [2]	This paper aims to determine farmers' preferences, especially in internet use, in the context of online delivery, mental health, and interventions that focus on well-being.

The classification results revealed that the scope of smart farming services is more concerning to the researchers, with a presentation of 55%. Research related to the adoption of smart farming technology can be seen in the table with a percentage of 30%; this condition shows that the factors that encourage people/farmers to use smart farming are the things researchers study. Then smart farming application in terms of the attitude of the farmers towards the change in the way of working has the same percentage as the business and technology aspects, which is 25%.

TABLE IV. CLASSIFICATION RESULTS TABLE OF SCOPE AND APPLICATION

Scope	Application	References	Total	Percentage (%)
Smart Farming Service	Attitude toward Change	[2], [6], [8], [18], [20]	5	25
	Technology Adoption	[1], [3], [11], [13], [16], [19]	6	30
Infrastructure Development	Platform Creation	[5], [7], [15], [17]	4	20
Business and Technology	Business Development Potential	[4], [9], [10], [12], [14]	5	25

A. Effects of Digitization on Identity, Farmer Skills, and Psychological Aspects

Digitalization in smart farming has an impact on farming methods. The old ways are no longer applied as there is digitization. This condition requires farmers to have different knowledge, skills, and job management [2]. Digital literacy and innovation are also needed for researchers in agriculture, institutional organizations, and advisors/experts to understand and support digitalization in agriculture [8]. The decision-making process for adopting smart farming technology is also supported by the intention and actions taken by farmers. The comprehension related to technology adoption by farmers also leads to the suggestion of incentives related to more targeted policies to accelerate the technology adoption process by farmers in a more inclusive manner [16]. Climate change, human resources entering unproductive age, and environmental problems are challenges for applying smart farming technology [19]. This condition is the right moment to offer farmers online interventions to improve their well-being and mental health. To achieve and cover the maximum coverage, website developers also need to pay attention to diverse internet access and the need for fast resources [2].

B. Smart Farming Business and Infrastructure

Technology in the agricultural sector has evolved over the last few decades, but the shift from smart farming to data-driven agriculture is a significant transition. The application of Artificial Intelligence in agriculture has the potential to optimize and streamline agricultural activities. Data-based decision-making can help farmers increase agricultural yields in quantity and quality. This solution has the effect of reducing carbon emissions, reducing working hours, and increasing profits. For the commercial enterprise sector and government agencies, this transition makes it possible to update supply chain and planning models and improve the agricultural industry at a macro level. Companies, regulatory authorities, and research institutions have an important role in increasing the use of AI in agriculture in the future. From a business perspective, the development of smart farming is no longer a problem but how to solve the challenges and which stakeholders will benefit from this transformation [9]. An association was found between a strong entrepreneurial identity and higher well-being. The design of digital transformation business models in agriculture requires a combination of sustainable economic benefits. The starting point must consider the previously existing business models to prepare the business

model for digital change, such as user demand and the entire supply chain, including stakeholders. From this point of view, three basic approaches can be described, namely:

1. The internal approach defined that products, services, and internal value creation would change. Expansion of product offerings on digital platforms such as online sales of agricultural products or use of technology to reduce costs across each supply chain.
2. The external approach to digitizing agricultural business models involves digital transformation channels, customer relations, and partner collaboration. Improved customer experience is also considered through consumer behavior analysis using various channels such as smartphones and social media.
3. The direct approach defined that the two paths are carried out in parallel. This business model is digitally transformed in all aspects

Collaboration using the new ways along the agricultural supply chain allows the development of synergies and symbiotic effects between stakeholders. It creates a competitive advantage for all partners involved [12].

IV. CONCLUSIONS

From this research, various factors influence the adoption of smart farming technology. There are challenges to applying smart farming technology such as climate change, human resources entering an unproductive age, and environmental problems, especially climate change. It is the right momentum to offer online interventions to improve farmers' well-being and mental health. Farmers also need various aspects, especially digital literacy related to the implementation of smart farming, so that they can propose more targeted policies. From a business perspective, the development of smart farming is no longer become a problem. Still, how to solve the challenges and which stakeholders will benefit from this transformation. The starting point must consider the previously existing business models to prepare the business model for digital change, such as user demand and the entire supply chain, including stakeholders. From this point of view, three basic approaches can be described: internal, external, and direct. Collaboration using the new ways along the agricultural supply chain allows the development of synergies and symbiotic effects between stakeholders. It may create a competitive advantage for all partners involved.

ACKNOWLEDGEMENT

Universitas Indonesia supports this research through International Indexed Publication (PUTI) Q1 Grant, the year 2022, number: NKB-501/UN2.RST/HKP.05.00/2022

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