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Conceptual Article

Exploring Sensitivity Factors Influencing Technology Adoption for Climate Change Adaptation among Agricultural Communities of Kedah and Kelantan, Malaysia

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Abstract: The agricultural sector is exceptionally susceptible to fluctuations in climatic conditions, and such changes significantly impact agricultural productivity as well as the welfare of agricultural communities. Therefore, it is crucial to comprehend the vulnerability and risk of the agricultural communities to these effects. The agriculture ability of the sector to successfully adapt over the long term will depend heavily on the adoption of new technologies. Therefore, the adoption of emerging technologies into agriculture is a key component of climate change adaptation. Nguyen *et al.* (2021) suggest that it would be great for future study to conceptualize the integration of economic, social, and political issues in improving adaptation among agricultural communities. Therefore, current study attempts to determine social vulnerability of the agricultural communities particularly in terms of sensitivity which consist of economic, political, cultural and institutional factors that influence technology adoption for climate change adaptation. The study will be using questionnaire as the main research instrument. A descriptive, correlation and regression analysis will be employed in order to achieve the objectives of the study. A non-probability sampling known as convenient sampling technique will be employed as the sampling technique. The study will be conducted in Kedah and Kelantan as both states are predominantly characterized by an agriculture-based economy which currently have been reported to be affected by climate change. Results of the study will contribute to the making of policy related to agriculture and climate change adaptation as well as for future study related to the field.

Keywords: Sensitivity; climate change adaptation; agricultural communities

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1. Introduction

In Malaysia, agriculture sector involves crop planting, livestock rearing and fishery. Agriculture remains an important aspect of society since it provides food for the inhabitants and is an excellent strategy for alleviating poverty (Shaffril *et al*., 2010). In line with that, agriculture is thus an evergreen sector for those roles mentioned above. However, agriculture is a sector that is vulnerable to climate change as its dependency on the environment and natural resources. Climate change is expected to intensify across the Asian region such as increase in temperature and precipitation, water scarcity, extreme weather and many more disasters. Increasing temperatures are more noticeable over Asia's continental interiors (Mannig *et al*., 2018; Dimri *et al*., 2018). Precipitation increased greatly in northern and central Asia over a 105-year period (1990–2005) but Hijioka *et al.* (2014) noted that in regions of southern Asia, precipitation has decreased. Climate change has been found to impact water shortage by raising the likelihood of extinction for many species of plants and animals as a result of uncertain climate fluctuation and intensified glacier melting (Gampe *et al*., 2016; DeNicola *et al*.,2015). Rising sea levels, on the other hand, have been documented to have an effect on coastal ecosystems. (Perera *et al*., 2018; Phillips, 2018).

The potential impact of climate change on livestock includes an increase in thermal stress, which can lead to a decrease in animal productivity and profitability. This decrease can be attributed to reduced feed efficiency, milk production, and reproduction rates (St. Pierre *et al*., 2003). Furthermore, heat stress affects animal performance and productivity of dairy cows in all phases of production. The outcomes include decreased growth, reduced reproduction, increased susceptibility to diseases, and ultimately delayed initiation of lactation. Heat stress also negatively affects reproductive function (Amundson ***et al***. 2006). Meanwhile, in the context of fishing industries, climate change tends to result in fluctuations of fish populations. The fluctuations of fish populations will result in major economic consequences for numerous vulnerable communities as they rely largely on fisheries (Brander, 2010). Moreover, climate change cause rising sea level which results in increased occurrences of tidal and storm inundation, posing a greater risk to seaports, jetties, and fish storage centres located along the coastal fringes above the mean high tide line (Ibe &

Awosika, 1991). Hence, rising sea level will adversely affect fishery production by subjecting fish stocks as well as impacting fish landing, processing, and marketing facilities.

Additionally, while the ecological damage of extreme weather events is being studied, the consequence for human livelihoods is far more intense, especially for those who depends on the environment and climatic stability, such as agricultural communities (Arouri et al., 2015). For example, heatwaves and heavy precipitation cause seasonal flooding, drought, and saltwater intrusion in coastal regions, all of which have a negative impact on agricultural output and livelihoods (Nahar *et al*., 2018; Yadav *et al*., 2020; Assefa *et al*., 2021). Al-Amin *et al*. (2011) highlighted the interconnection between climate change situation in Malaysia which is the impacts results in a decline in productivity, food security vulnerabilities, rise of air and water temperatures, a reduction in plant capacity and energy resources which leads to increase of economic costs. As climate change impacts getting deteriorating, adaptation is seen to be the greatest solution (Shaffril *et al*., 2017). Adaptation is defined as the implementation of measures aimed at helping local populations and ecosystems effectively manage and mitigate the present and anticipated consequences of climate change (National Policy on Climate Change, 2009).

Adaptations to climate change is critical for increasing agricultural resilience and livelihoods through enhanced management methods and adoption of technologies (Ahmed *et al*., 2022). Technology is defined as a significant innovation that reduces interconnected uncertainty in order to achieve a desired result (Rogers, 2003). Meanwhile, Rogers (2003) defined adoption as the "complete implementation of an innovation as the most optimal course of action". In the agricultural sector, technology is crucial in improving farm efficiency and production (Mwangi & Kariuki, 2015). Technology adoption in smallholder agriculture stimulates the increase in the farm level productivity and it is expected to sought-after transformation of the agricultural sector (Adesugba & Mavrotas, 2016; Bachewe *et al*., 2018). Thus, significant efforts have been undertaken to encourage technological adoption among agricultural communities (Adnan *et al*., 2018). For example, farmers have been introduced to the use of controlled-release fertilizer as an alternative to conventional chemical fertilizer. It is anticipated that the application of the fertilizer will enhance paddy production through improved efficiency, concurrently mitigating fertilizer loss resulting from leaching and volatilization (Burke & Sewake, 2008; Fahmi *et al*., 2013). Probably, with the latest and modern technology in the agriculture sector, it can substantially improve the yield of production and sustainability. Thus, adaptation to climate change among agricultural communities can be achieved.

This paper reviews the concept of technology adoption for climate change adaptation among agricultural communities through assessing their vulnerability. In the context of the study, sensitivity of a system will be measured as an indicator in order to understanding their

vulnerability towards climate change. According to Fenton *et al*. (2007), economic, political, cultural and institutional factors are the factors that influence sensitivity of social systems. This is in line with recommendation by Nguyen *et al*. (2021), where the authors propose that a systematic thinking approach may assist future research in conceptualizing and addressing the integration of economic, social, and political issues to enhance the adaptation capacity of the farmers. Additionally, a climate adaptation plan should look on how sensitive the local community and resources are to changes in the climate (Shaffril *et al*., 2017). Hence, this paper aims to explore the association between sensitivity factors and technology adoption for climate change adaptation plans among agricultural communities.

2. Method

The study will be using questionnaires as the main research instrument. The instrument will be designed to cover six aspects namely the demographic data and farm profile of the respondents, economic sensitivity, political sensitivity, cultural sensitivity, institutional sensitivity and technology adoption. In the context of sensitivity factors, items will be developed based on the idea of the International Union of Conservation for Nature (IUCN; 2009). Meanwhile, in the context of technology adoption, items will be adopted and adapted based on Diffusion of Innovation Theory by Rogers (2003) as it is the theoretical underpinning for the current study. To ensure that the content of the instrument can be understood, language and options of answers will be pretested first among 10 potential respondents for the purposes of validation. Subsequently, the instrument will go through a pilot test among 40 respondents to test its reliability. The reliability of the instruments will be determined by evaluating the Cronbach's alpha. The Cronbach's alpha value should be more than 0.7 or higher indicating an acceptable internal consistency of the research instrument.

A descriptive, correlation and regression analysis will be employed in order to achieve the objectives of the study. Descriptive analysis will provide brief overviews of the data collected, necessitating the computation of basic statistical and variable distribution measures across different population groups. Additionally, the metrics used will be varied depending on the type of data, and may include proportions, rates, ratios, or averages. A correlation analysis will be used to examine the relationship between sensitivity factors (independent variables) and technology adoption for climate change adaptation (dependent variable). Meanwhile, a regression analysis will be utilized in order to determine the most contributed factors among the sensitivity towards technology adoption for climate change adaptation. To analyze those analysis, Statistical Package for the Social Sciences (SPSS) will be utilized. SPSS is a complete package for quantitative data analysis (Rahman & Muktadir, 2021). Ethical consideration should be considered in ensuring the integrity and accuracy of their study results. Thus, ethical approval was applied prior to conducting the study.

A non-probability sampling known as convenient sampling technique will be employed as the sampling technique. The key advantages of convenience sampling are that it is cheap, efficient, and simple to implement. However, a convenience sampling could lead to lack of clear generalizability among samples. Therefore, this study implemented homogeneous convenience sampling technique in order to provide clearer generalizability. A homogeneous samples are samples that are intentionally limited to specific sociodemographic subgroup (Rashighi & Harris, 2017). The study will be conducted in Kedah and Kelantan as both of the state are predominantly characterized by an agriculture-based economy which currently has been reported to be affected by climate change. The targeted population will be the agricultural communities settled around the Muda River Basin in Kedah and Kelantan River Basin in Kelantan. Thus, the respondents will be chosen from selected climate change affected areas namely, agricultural communities living in the flood and water stress risk area. Based on the suggested number from an online sampling calculator Raosoft.com, the minimum number of samples is 384, the study however will cover a total of 800 respondents and each area will be represented by 400 respondents.

3. Results and Discussions

Climate change has already had profound effects on the agricultural sector and is expected to worsen further. Therefore, adaptation plans should be implemented in enhancing the livelihood resilience of the agricultural communities. Resilience is defined as the opposite of vulnerability (Gallopin, 2006). Resilience to climate change refers to the capacity of ecological or human systems to adapt and manage alterations in the surrounding environment (Marshall *et al*., 2010). Practically, it is often appropriate to view vulnerability as a measure that is opposite to resilience.

Intergovernmental Panel on Climate Change (IPCC) defined vulnerability as a function of three elements (as shown in Figure 1). Understanding all of these elements helps in assessing the nature and scope of the climate change impacts, pinpointing the principal origins of vulnerability and determining measures to mitigate or address the risk associated with each component. However, the current study will focus on the sensitivity factors that influence technology adoption for climate adaptation among agricultural communities. According to Shaffril *et al*. (2017) A climate adaptation plan should consider on how vulnerable the local community and resources are to climate change.

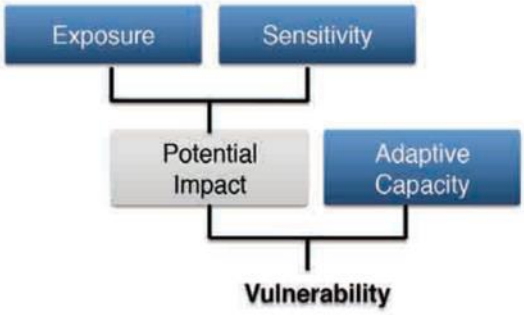

Figure 1. The basis of a framework for social adaptation. The framework describes the measurable components of vulnerability.

In the context of the study, sensitivity of systems, particularly agricultural communities will be measured as indicator in order to understand their vulnerability towards climate change. According to Fenton *et al*. (2007), economic, political, cultural and institutional factors are the factors that influence sensitivity of social systems. Meanwhile, technology adoption will be the adaptation plan. Hence, this study will attempt to determine the sensitivity factors that will influence agricultural communities to adopt technology as their climate adaptation plan.

Adoption of technologies can help agricultural communities to combat the consequences of climate change, increase productivity, increase producer incomes, and improve household welfare (Ali *et al*., 2010; Tufa *et al*., 2019). A study from Nepal revealed that farmers who adopted tunnel technology increases their productivity by 32 tons per year and hectares compared to nonadopters (Diwakar *et al*., 2021). Furthermore, according to Ahmed *et al*. (2022), by implementing advanced management techniques and adoption of innovative technology, it will help agricultural communities to address climate change as it is crucial for improving their resilience and livelihoods. However, the sensitivity of agricultural communities should be considered when implementing technology adoption as a climate change adaptation strategy.

Economic sensitivity refers to the potential economic impact of exposure towards the agricultural communities to a particular climate event or ecosystem change that are associated with production, consumption and distribution of agriculture goods and services. The factors could lead agricultural communities to adopt technologies as their climate change adaptation plan. Numbers of studies have reported that economic sensitivity influence farmers decision to adopt technologies as their adaptation towards climate change includes cost of capital, source of income and assets as well as the size of land owned by the farmers (Ahmed *et al*., 2022; Mashi *et al*., 2022; Mairura *et al*., 2021; Diwakar *et al*., 2021).

Political sensitivity refers to the potential impact of exposure to a particular climate event or ecosystem change that are associated with making decision in groups, or other forms

of power relations among individuals such as the distribution of agricultural resources. According to Thomas *et al*. (2007), the political-economic context, particularly agricultural regulations and market development, seems to exceed climatic considerations, including main limits such farm equipment, seed, and fertilizers availability and affordability. Thus, the factors may prompt agricultural communities to adopt technologies as part of their strategy for adapting to climate change.

Cultural sensitivity refers to the potential impact of exposure to a particular climate event or ecosystem change that are associated with the way of life of a community such as their behaviors, beliefs, values and symbols that they accept and that are passed along from one generation to the next. Farmers belonging to community groups have a higher propensity to adopt sustainable intensification practices, which suggests farmer networks play a strong role in adaptation (Ahmed *et al*., 2022). Also, Diwakar *et al*. (2021) in their study found that ethnicity strongly influences the technology adoption amongst small- holder farmers. However, tribal inclination and religion have no significant influence on the farmer's awareness to adopt technologies as climate change adaptation (Mashi *et al*., 2022).

Institutional sensitivity refers to the potential impact of exposure to a particular climate event or ecosystem change that is associated with organization, which is set up for an educational, religious, social or professional cause. For example, group membership, credit access, agricultural training attendance, and extension visitation, access to climate information and membership in social or agricultural group influenced the adoption of agricultural technologies and practices as climate change adaptation strategies among farmers (Mairura *et al*., 2021; Tran *et al*., 2020). Also, farmers that are more educated have higher awareness to adopt climate smart agriculture technologies towards climate change impacts (Mashi *et al*., 2022 ~~2020~~).

4. Conclusions

To conclude, the degree to which the agricultural communities are impacted or susceptible to climate change is referred to as their sensitivity. The sensitivity of the agricultural communities depends on their economic, political, cultural and institutional factors. To illustrate, if they are highly dependent on a climate vulnerable natural resources, they are more susceptible to climate change (Marshall *et al*., 2007). These factors can ameliorate the effect of climate exposure in terms of economic sensitivity. Thus, technology adoption for climate adaptation strategy might be implemented in order to the agricultural communities to become resilience to climate change. The study expected that the level of sensitivity factors influencing technology adoption will be moderate to high; there will be a relationship between sensitivity factors and technology adoption for climate change adaptation among agricultural communities; and there is at least one factor that contribute most to the technology adoption. Therefore, the findings of the study will contribute to the

making of policy related to agriculture and climate change adaptation as well as for future study related to the field.

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