Research Paper

Bridging Youth Technology Readiness and Internet of Things (IoT) Adoption in Agriculture: Perceived Benefits and Risks as Mediators in the TRI Framework

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Abstract

The integration of Internet of Things (IoT) technologies in agriculture offers transformative potential for enhancing productivity, efficiency, and sustainability. However, adoption remains limited, particularly among small and medium-scale farmers in Malaysia, due to economic and technological barriers. This study examines youth readiness to adopt IoT in agriculture, emphasizing the mediating role of perceived benefits and perceived risk within the framework of the Technological Readiness Index (TRI). Tertiary-educated youth are considered pivotal in accelerating digital transformation within the agricultural sector due to their exposure to emerging technologies. A quantitative research design was employed, utilizing structured questionnaires distributed to students across tertiary institutions in Melaka. Stratified sampling and simple random sampling techniques were employed to ensure the collection of representative data. The data were analyzed using SPSS and Structural Equation Modeling with Partial Least Squares (SEM-PLS). The results indicate that optimism and innovativeness have a positive influence on perceived benefits, which in turn enhance youth readiness to adopt IoT. Conversely, insecurity and discomfort significantly increase perceived risk, reducing readiness. Mediation analysis confirmed that perceived benefits and perceived risk significantly mediate the relationship between TRI dimensions and youth readiness. Perceived risks moderate the relationship between insecurity, discomfort, and youth readiness to adopt IoT in the the agricultural sector. Higher perceived risks amplify feelings of insecurity and discomfort among youth, inhibiting their readiness to adopt IoT technologies in agriculture. The findings underscore the importance of addressing both cognitive and emotional factors in promoting IoT adoption, providing empirical evidence for policymakers and educational institutions to design targeted interventions that foster a technology-driven agricultural workforce.

Keywords *Bridging, Youth Technology Readiness, Internet of Things (IoT), Agriculture, Perceived Benefits, Perceived Risk and TRI Framework*

INTRODUCTION

Agriculture is a vital pillar under Malaysia's National Key Economic Area (NKEA), contributing significantly to national GDP, food security, and employment. The emergence of smart agriculture also referred to as Smart Farming or Precision Agriculture (PA) has introduced the use of advanced technologies, including the Internet of Things (IoT), big data, cloud computing, robotics, and artificial intelligence, to enhance efficiency, productivity, and sustainability. IoT in agriculture enables real-time monitoring and data-driven decision-making through sensors, cameras, and interconnected devices. However, the adoption of these technologies remains limited among Malaysian farmers, particularly smallholders, due to financial constraints, technological complexity, and lack of infrastructure. This digital divide is further widened by generational differences, where older farmers are less inclined to adopt new tools. At the same time, the youth, especially those with tertiary education and a background in agriculture, possess higher digital literacy and adaptability. Malaysian youth, often described as digital natives, are naturally attuned to digital technologies and possess strong potential to drive agricultural transformation. Their familiarity with digital tools, openness to innovation, and entrepreneurial spirit position them as early adopters of technology in the farming industry. Despite this, youth participation in agriculture remains low, and their perspectives on IoT applications are underexplored. Social influence, peer

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dynamics, and environmental consciousness further shape their attitudes and behaviors towards technology adoption. As such, the role of youth in leading innovative agriculture initiatives is increasingly recognized as essential for ensuring long-term sustainability and food security.

Although IoT has been identified as a key enabler of agricultural innovation, its integration faces multiple barriers in Malaysia. These include high implementation costs, lack of regulatory clarity, limited technical know-how, and concerns over data security. Youth involvement in the agro-sector remains insufficient, with only a small percentage expressing interest in pursuing agricultural careers despite growing exposure to ICT. Additionally, the readiness of youth to adopt IoT technology is influenced not only by access and awareness, but also by psychological factors, such as their perceptions of the benefits and risks. A deeper understanding of these influencing factors is crucial to closing the gap between technology availability and actual adoption. This study aims to assess youth readiness for adopting IoT in agriculture by investigating the mediating role of perceived benefits and perceived risks within the framework of the Technological Readiness Index (TRI). Specifically, it aims to investigate how TRI dimensions optimism, innovativeness, discomfort, and insecurity impact youth perceptions and intentions. The findings are expected to inform strategic planning in policy, education, and industry, fostering a digitally driven and sustainable agricultural sector led by future-ready youth.

LITERATURE REVIEW

Internet of Things (IoT) and Agriculture

The Internet of Things (IoT) refers to a network of interconnected devices that communicate with each other and the cloud to facilitate real-time data exchange without human intervention (Yasar & Gillis, 2024). In agriculture, IoT underpins smart farming practices by enabling data-driven decisions through sensors that monitor soil conditions, weather, crop health, and irrigation needs (Jayashree et al., 2020; Wolfert et al., 2017). These technologies increase productivity, optimize resource use, and reduce environmental impact (Kamilaris et al., 2017; Balafoutis et al., 2017). Despite the benefits, challenges such as infrastructure limitations, technical complexity, and cost hinder widespread adoption, particularly in rural regions (Ayaz et al., 2019). In the Malaysian context, successful applications in oil palm plantations demonstrate IoT's transformative potential (Azman et al., 2019), though policy support and education remain critical to expand usage (Gebbers & Adamchuk, 2010; Shamshiri et al., 2018).

Technological Readiness Index (TRI)

The Technological Readiness Index (TRI) is a framework that assesses an individual's propensity to adopt and use new technologies (Parasuraman, 2000). It comprises four dimensions: optimism, innovativeness, discomfort, and insecurity (Parasuraman & Colby, 2001). Optimism and innovativeness are drivers of technology use, while discomfort and insecurity serve as inhibitors. These dimensions are essential for understanding youth readiness to adopt IoT in agriculture, especially as digital natives who are more likely to engage with technology-driven solutions (Prensky, 2001).

Perceived Benefits and Perceived Risk as Mediators

Perceived benefits, such as improved efficiency and productivity, positively influence youth intentions to adopt IoT applications in agriculture (Misra et al., 2018). Conversely, perceived risks, including data privacy concerns, system reliability, and high upfront costs, can discourage adoption (Hair et al., 2019). According to Karimi et al. (2019), farmers are more likely to use IoT when they perceive strong benefits and minimal risks. For youth, these perceptions mediate the relationship between TRI dimensions and their readiness to adopt technology in agriculture.

Optimism and Innovativeness

Optimism is associated with a positive outlook on technology and enhances perceived benefits of IoT applications (Karjaluoto et al., 2015; Jayaraman et al., 2020). Innovative youth are more likely to embrace IoT tools such as smart irrigation and crop monitoring systems (Agarwal & Prasad, 1998). Together, these traits lead to stronger adoption intentions and support the transformation of agriculture through technological integration.

Insecurity and Discomfort

Insecurity refers to mistrust or fear of technology malfunction, while discomfort relates to uneasiness with using new tools (Parasuraman, 2000). These inhibitors increase perceived risk and lower the likelihood of IoT adoption among youth (Featherman & Pavlou, 2003; Yildirim & Cangur, 2018). Educational interventions and training are crucial for mitigating these feelings and building confidence in technology usage.

Intention to Use IoT Applications

The intention to use technology is a predictor of actual adoption behavior (Ajzen, 1991). TRI dimensions, along with perceived benefits and risks, shape youth intentions to adopt IoT in agriculture (Venkatesh et al., 2003). Optimism and innovativeness enhance this intention, while insecurity and discomfort reduce it. Addressing these factors can support policy design aimed at increasing youth participation in smart agriculture.

Figure 1: Conceptual Framework

The conceptual framework illustrates the relationship between the TRI dimensions and youth readiness to use IoT in smart agriculture, with perceived benefits and perceived risk acting as mediators.

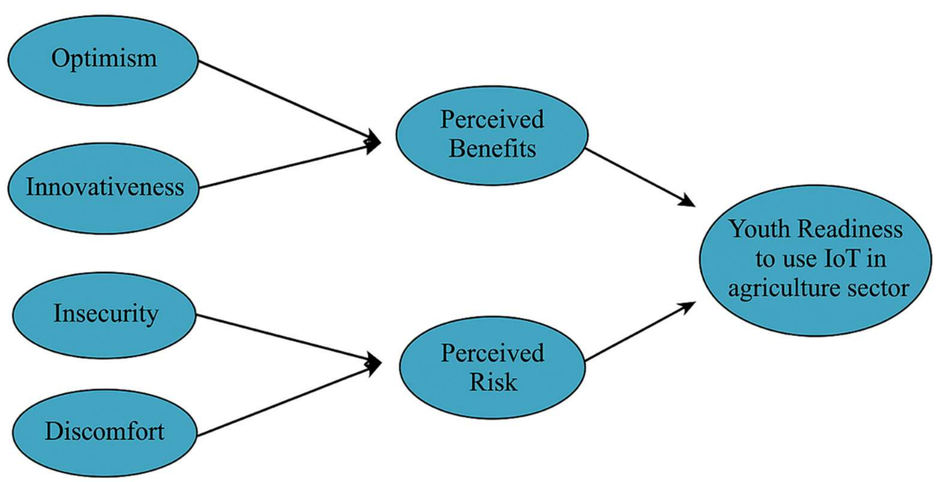

Figure 1. Conceptual Framework of the TRI and Youth Readiness to Use IoT-Based Smart Agriculture in Melaka

RESEARCH METHOD

This study employed a quantitative approach using a structured questionnaire to assess youth readiness to adopt IoT in agriculture, focusing on Universiti Teknologi MARA (UiTM) Kampus Jasin. A total of 130 students with agricultural backgrounds were surveyed, using G*Power for sample determination. The constructs measured included optimism, innovativeness, insecurity, discomfort, perceived benefits, and perceived risks based on the Technological Readiness Index (TRI). Data were analyzed using SPSS for descriptive statistics and SEM-PLS for structural modeling, allowing for an in-depth exploration of mediation effects.

FINDINGS AND DISCUSSION

In the analysis of the interaction effects of mediator using PLS-SEM, this study applied the product indicator approach, as suggested by Hair et al., (2014). The objective is to detect the mediator role of perceived benefits and perceived risk between youth readiness to use IoT in agriculture sector. The significant impact of perceived benefits and perceived risk between youth readiness to use IoT in agriculture sector was assessed using a bootstrapping re-sampling with 5000 re- samples. The finding in Table 1 shows that the perceived benefits significantly mediate the youth readiness to use IoT in agriculture sector (t-value: 1.806) and perceived risk also significantly mediate the youth readiness to use IoT in agriculture sector (t-value: 3.135). H3, Perceived benefits mediation the relationship between optimisim and innovativeness towards the youth readiness to use internet of things (IoT) in agriculture sector. Optimism and perceived benefits play a mediation role in influencing the relationship between youth optimism, innovativeness, and their readiness to adopt IoT in agriculture sector (Jayaraman et al., 2020).

Optimistic youth who perceive greater benefits from IoT technologies are more likely to exhibit innovativeness in exploring and adopting these innovations in agriculture (Pradhan, Oh, & Lee, 2018). This interaction enhances their readiness to adopt IoT applications, as evidenced by the strong mediation effect found in the study (t-test result = 29.327). H4, Perceived risk mediation the relationship between insecurity and discomfort towards the youth readiness to use internet of things (IoT) in agriculture sector. Perceived risks moderate the relationship between insecurity, discomfort, and youth readiness to adopt IoT in agriculture sector (Yildirim & Cangur, 2018). Higher perceived risks amplify feelings of insecurity and discomfort among youth, inhibiting their readiness to adopt IoT technologies in agriculture (Featherman & Pavlou, 2003). The study's finding (t-test result = 2.597) supports the hypothesis that addressing perceived risks is crucial to minimizing feelings of insecurity and discomfort, thereby promoting greater adoption of IoT solutions in Malaysian agriculture. These findings underscore the complex interplay between optimism, innovativeness, perceived benefits, perceived risks, insecurity, and discomfort in shaping youth readiness to adopt IoT in agriculture sector. Understanding these dynamics is essential for developing effective strategies to promote technology adoption and overcome barriers to innovation in agricultural practices.

Table 1. Hypothesis and Result for Mediation

Relationship	Path Coefficient	Standard Deviation (STDVE)	T Value	LLCI (2.5%)	ULCI (97.5%)	Supported
H1: IPB x OPB -> IOTA	0.180	0.100	1.806	0.014	0.378	Yes
H2: DPR x IPR -> IOTA	0.453	0.144	3.135	0.063	0.651	Yes
H3: OPB x IPB	0.923	0.031	29.327	0.843	0.966	Yes
H4: IPR x DPR	0.288	0.111	2.597	-0.035	0.428	Yes

Note: *p value < 0.10, **p value < 0.01, ***p value < 0.001

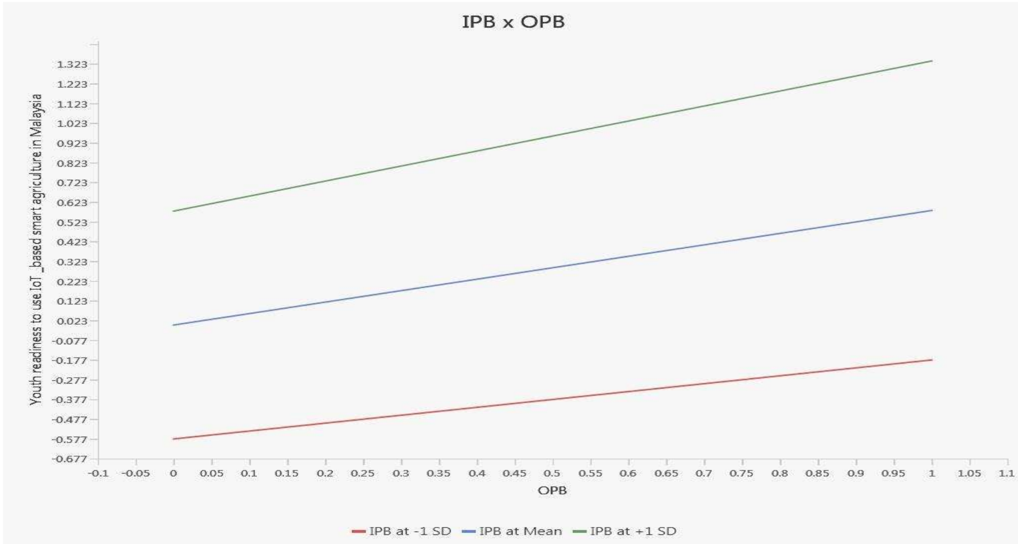

Figure 2. Perceived Benefits Mediator Youth Readiness to Use IoT in Agriculture Sector

Figure 2 shows how the youth's readiness to use IoT in the agriculture sector is mediated by perceived benefits. This statistic highlights how youth readiness to adopt IoT innovation is significantly shaped by their perceptions of the technology's benefits. More specially, it demonstrates that the youth readiness to use IoT in the agriculture sector is positively correlated with some predictor variables such as optimism, and innovativeness when perceived benefits increase. This implies that even in cases when other factors are neutral or marginally negative, youth are more likely to adopt IoT if they see clear benefits, such as increased production, efficiency, or profitability.

The figure illustrates how decision-making processes can be greatly influenced by advantages perception, which encourages adoption by increasing the perceived benefits of IoT applications in the agriculture sector. Understanding this information is essential for individuals engaged in the promotion of Internet of Things technology, as confirmation suggests that increasing awareness and demonstrating the practical benefits of IoT can significantly speed up the rate at which it is adopted.

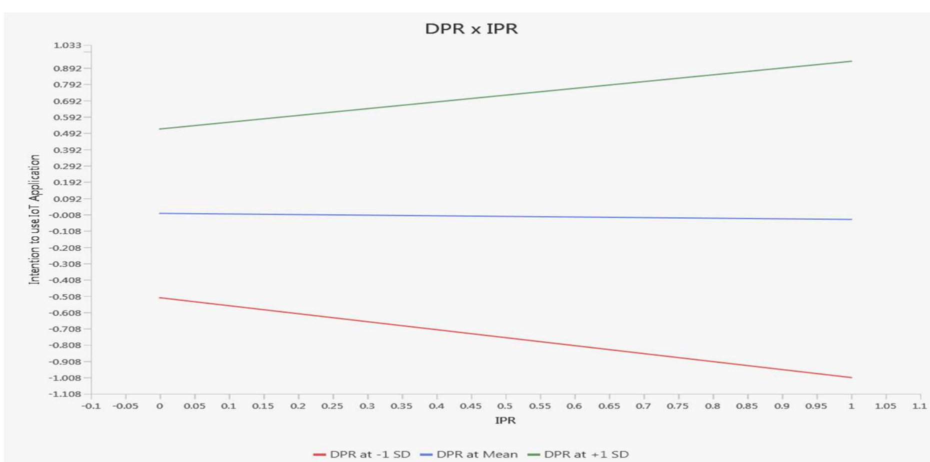

Figure 3. Perceived Risk Mediation Youth Readiness to Use IoT in Agriculture Sector

The mediator impact of perceived risk on the youth readiness to use IoT in agriculture sector is show in Figure 3. Figure 3 shows that the level of perceived risk has an effect on how ready young people are in Malaysia to use IoT in agriculture sector. Figure 3 displays how people think risks affect their choices to use IoT apps in farming, focusing on how these risks keep things in line. The graph shows that people are more likely to be interested in employing IoT apps if they believe that IoT can help them. However, the effect can be reduced if people believe that the apps are dangerous. People may be less likely to use IoT technologies if they think they bring risks, such as worries about data protection, costs, and how reliable the technology is. In other words, people may not use IoT apps as much even though they know they should.

CONCLUSIONS

This study highlights the pivotal role of Malaysian youth in advancing agricultural modernization through the adoption of IoT, particularly among those in tertiary agricultural institutions. As digital natives, they bring creativity, adaptability, and openness to technology, positioning them as key drivers of smart farming. Nonetheless, barriers such as high implementation costs, limited technical exposure, and generational technology gaps remain significant. Within the TRI framework, findings reveal that perceived benefits and risks act as critical mediators between youth technology readiness shaped by optimism, innovativeness, discomfort, and insecurity and their actual readiness to adopt IoT. While positive perceptions foster greater adoption intentions, risk perceptions hinder progress.

To bridge these gaps, strategic measures are necessary. Educational programs that integrate practical IoT applications can build confidence and reduce discomfort, while transparent communication on costs and data security can address risk concerns. Collaboration among policymakers, academia, and industry is vital to provide financial incentives and accessible, youth-friendly IoT solutions. A forward-looking policy environment that nurtures innovation and cultivates a positive mindset toward technology will ultimately ensure that Malaysia's young generation is well-prepared to champion sustainable, IoT-driven agricultural transformation.

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