

The Role of Public Policy in Strengthening Training and Development Practices for Smart Agribusiness Transformation

Zainab Noor¹, Nazeer Hussain Boumal², Shahan Aziz³,
Muhammad Hassan Kamal⁴ and Tooba Mujtaba⁵

<https://doi.org/10.62345/jads.2025.14.3.164>

Abstract

In today's fast-paced digital era, the need for smart agribusiness transformation in emerging markets has been accelerated by growing environmental uncertainty. The study uses a quantitative cross-sectional research design, and data are collected via a structured questionnaire administered to employees, managers, and professionals in the agribusiness sector. The collected data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) in SmartPLS to examine the direct, mediating, and moderating relationships among the proposed variables. The results indicate that agricultural training policy and public policy support significantly and positively affect training and development practices. The training and development practices are positively influencing smart agribusiness transformation ($\beta = 0.195$, $p = 0.007$), and the environmental dynamism is not statistically significantly moderating the relationship with smart agribusiness transformation ($\beta = -0.024$, $p = 0.316$). The model also explained well the training practices ($R^2 = 0.727$) and the agribusiness transformation ($R^2 = 0.700$). The study belongs both theoretically, as it extends the Human Capital Theory in the context of agribusiness, and practically, given the strong emphasis on the need for a workforce development approach through policy to support sustainable digital agricultural transformation in emerging economies.

Keywords: Agricultural Training Policy, Public Policy Support, Training and Development Practices, Smart Agribusiness Transformation, Environmental Dynamism, Human Capital Theory.

Introduction

Technological advances, climate change, and the demand for sustainable food production systems have driven the need to transform agribusinesses, making it a pivotal strategic priority for agricultural economics (Kamal et al., 2024; Prodi et al., 2022). The use of smart technologies such

¹Research Scholar, Department of Agriculture & Agribusiness Management, University of Karachi, Pakistan, ORCID: <https://orcid.org/0009-0006-0586-7027>, Email: zainab.noor.agr.uok@gmail.com

²Research Scholar, Department of Management Sciences, Ilma University, Karachi, Pakistan, ORCID: <https://orcid.org/0009-0002-8137-943X>, Email: nazeerhussain.boumal@gmail.com

³Assistant Professor, Department of Agriculture and Agribusiness Management, University of Karachi, ORCID: <https://orcid.org/0000-0002-3776-6451>, Email: shah.aziz@uok.edu.pk

⁴Research Scholar, Karachi University Business School, University of Karachi, ORCID: <https://orcid.org/0009-0002-8685-0120>, Email: hkkamal33@gmail.com

⁵Research Scholar, Department of Management Sciences, Ilma University, Karachi, Pakistan, ORCID: <https://orcid.org/0009-0004-0275-8971>, Email: Toobamujtaba559@gmail.com



as AI, precision farming, the Internet of Things (IoT), automation, and digital farming systems has substantially changed the way agribusinesses operate, enhancing productivity, efficiency, and sustainability (Ahmed et al., 2025; Khoso et al., 2025). The implementation of smart agribusiness practices, however, relies on effective public policy support and the labour force's readiness to be trained and developed for them (Roh et al., 2020). To enhance agribusiness competitiveness and technological adaptation, governments around the world have made agribusiness training policies, the development of digital infrastructure, and innovation-oriented public policies a key priority (Prodi et al., 2022; Van, 2022a). The lack of training systems, policy implementation, and technological readiness remains a challenge to smart agricultural transformation in emerging economies, including agribusiness (Azhar et al., 2022). Thus, it is essential to reinforce training and development practices to improve workforce skills and support smart agribusiness transformation in a dynamic agricultural sector, within supportive public policy frameworks (Communist Party of Vietnam, 2021a; Toth, 2021).

The agribusiness industry is an important contributor to sustainable development in the world economy, including food security, employment creation, rural development and international trade (Ahmed et al., 2025; Kamal et al., 2024). Over the last few years, the industry has undergone significant changes with the implementation of smart agriculture technologies, precision farming, drones, artificial intelligence, blockchain, cloud computing, and IoT-based agriculture systems (Khoso et al., 2025; Prodi et al., 2022). These technologies are enabling agribusiness organisations to boost productivity, reduce operational costs, optimise resource use, and enhance environmental sustainability (Azhar et al., 2022). The increasing pressure to meet growing population demands, climate-related challenges, and supply chain disruptions has accelerated the need for digital transformation within the agricultural sector (García-Herrero & Weil, 2022). To this end, the governments and agricultural institutions are focusing on equipping their workforces with the skills they need, enacting policy changes, and preparing for the technological future of agribusiness modernisation (Roh et al., 2020; Van, 2022a). Despite the advancement of the agribusiness industry, there are still many technological, human resource, and policy challenges that need to be addressed in developing countries like Pakistan, which is why training and development practices are becoming more and more critical to ensure the transformation of agribusiness to smart agribusiness (Toth, 2021; Kamal et al., 2024).

Although the world is increasingly focused on smart agriculture and digital transformation, many agribusiness organisations face significant challenges in effectively implementing smart agribusiness practices, especially in developing countries (Prodi et al., 2022; Ahmed et al., 2025). The lack of effective public policy support and poorly equipped agricultural training systems to train the workforce for digital and technology-enabled agricultural operations is one of the major problems (Roh et al., 2020). Despite various agricultural modernisation programmes being implemented, there is a lack of well-defined training and development practices, low digital skills, inadequate technological infrastructure, and insufficient policy implementation mechanisms, which continue to affect the transformation of smart agribusinesses (Azhar et al., 2022; Van, 2022a). Also, agribusiness companies in such dynamic areas have limited human resource preparedness and organisational capability development, which makes it difficult for them to cope with rapid technological and environmental changes (Toth, 2021). While significant research exists on the adoption of technologies in agriculture, few studies have investigated the policy of agricultural training and public policy as a way to improve training and development practices in the context of transforming agriculture into smart agribusiness, especially in the light of the

moderating effect of environmental dynamism in an emerging economy (Khosro et al., 2025; Kamal et al., 2024).

Literature Review

The use of smart technologies in agriculture has shifted the agribusiness equation toward a more technology-oriented, innovation-driven sector (Azhar et al., 2022; Lee et al., 2023). Smart agribusiness transformation refers to the use of digital technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), automation, precision agriculture, blockchain, and cloud-based systems to boost agricultural productivity, operational efficiency, and environmental sustainability (Kamal et al., 2024). In this transformation process, it has been identified that agricultural training policy and public policy support are key institutional mechanisms that can enable the workforce to be ready and adapt to technologies (Garavan et al., 2023; Communist Party of Vietnam, 2021a). Agricultural training policy is a government initiative aimed at enhancing farmers' and employees' technical skills, digital literacy, and understanding of advanced agricultural technologies (Shrivastava, 2022).

Policy initiatives are mediated by training and development to become practical organisational capacities that enable smart agribusiness transformation (Azhar et al., 2022; Garavan et al., 2023). They encompass technical training, digital skills development, ongoing learning initiatives, employee growth initiatives, and knowledge transfer channels that enhance competencies and readiness to embrace technological advancements (Lee et al., 2023). Based on the current literature, agribusiness companies operating in highly uncertain, technologically dynamic environments need robust training systems to build organisational resilience, innovation capacity, and digital preparedness (Kamal et al., 2024; Rashid et al., 2025). The need for workforce development is reinforced by environmental dynamism, including rapid technological changes, market uncertainty, climate variability, and competition (Communist Party of Vietnam, 2021a). Previous research indicates that organisations with robust training systems are better equipped to address uncertainty and technological shifts in their environment (Shrivastava, 2022; Lee et al., 2023).

Theoretical Foundation

Human Capital Theory

This study is based on Human Capital Theory, which states that investing in employee knowledge, skills, education and training will lead to increased individual productivity and organisational performance (Garavan et al., 2023). Based on the Human Capital theory, it is argued that organisations can attain sustainable competitive advantage by continually enhancing their workforce's skills through effective training and development (Shrivastava, 2022). The theory is also pertinent in the context of smart agribusiness transformation, as the integration of new technologies like artificial intelligence, the internet of things, automation, and precision farming demands advanced skills and expertise among the agricultural workforce (Lee et al., 2023). Agricultural training policy and public policy support are thus institutional mechanisms that enhance workforce capacity and equip employees and farmers to navigate the digital agricultural transformation (Communist Party of Vietnam, 2021a). Organisations with a focus on workforce training and technological skill development have been found to be better equipped to adapt to digital transformation and environmental uncertainty in today's agricultural systems, as revealed in recent literature (Azhar et al., 2022; Kamal et al., 2024).

This study aims to investigate the roles of agricultural training policy and public policy support in the process of smart agribusiness transformation, with training and development practices mediating this process amid environmental dynamism (Lee et al., 2023). The study is grounded in Human Capital Theory, suggesting that the development of skills through agribusiness policies contributes to employee competencies, digital literacy, innovation capacity, and technological adaptability, which, in turn, lead to better outcomes in smart agribusiness transformation (Garavan et al., 2023; Shrivastava, 2022). The primary purpose of this study is to gain a thorough understanding of the process by which policy support is translated into actual organisational capacity for sustainable agribusiness modernisation (Kamal et al., 2024).

Supporting and Negating Views

There are multiple supporting arguments in recent literature that agricultural training policy, public policy support, and agricultural training and development practices play a significant role in the smart agribusiness transformation by enhancing workers' competencies, technological readiness, and organisational adaptability. The studies highlight the role of supportive government policies and workforce development initiatives in enabling the adoption of digital agriculture technologies such as precision farming, artificial intelligence, automation, and IoT systems within agribusiness organisations (Baierle et al., 2022; Cazeri et al., 2022). According to the Human Capital Theory, organisations that invest in employee training and development are more likely to achieve sustainable competitive advantage and technological transformation by developing skilled employees who can utilise advanced agricultural technologies (Lee et al., 2023). Moreover, earlier research indicates that organisations in highly dynamic settings need continuous learning systems and workforce adaptability to successfully manage technological uncertainty and environmental change (Egan et al., 2022; Gu et al., 2021).

However, other (negating) perspectives suggest that training and development as a strategy might not be enough to achieve the outcomes of smart agribusiness when there are serious infrastructural, financial, and institutional constraints. A few studies suggest that workforce training initiatives in developing countries can also be less effective due to weak policy implementation, limited technological infrastructure, limited financial resources, and resistance to technological change (Cordeiro et al., 2023). Some other researchers contend that, in certain cases, environmental dynamism might create uncertainty that exceeds organisational capabilities; therefore, although agribusiness firms invest in training, they find it challenging to fully adopt digital transformation strategies (Baierle et al., 2022). Furthermore, public policies can become ineffective if coordination among governmental institutions, training service providers, and agribusiness organisations is lacking, thereby reducing the impact of policy-based workforce development programmes (Luongngoc & Vuhong, 2022; Hoduc et al., 2022). In the literature, both positive and negative views are available regarding the effectiveness of policy support and training practices for smart agribusiness transformation.

Mediation and Moderation Perspective

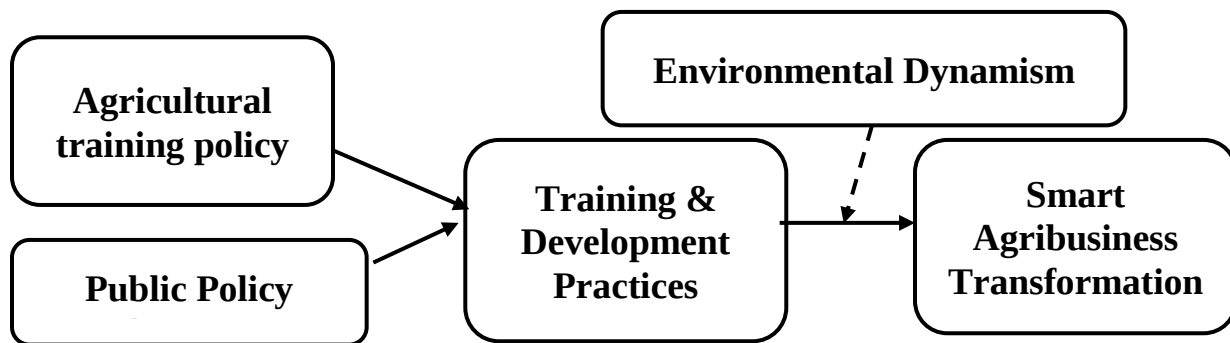
The current literature supports these ideas through mediation, indicating that training and development practices are a crucial mechanism through which agricultural training policy and public policy contribute to the smart agribusiness transformation. While government policies are essential, their limited impact without a structured training system, a digital training program, and ongoing learning is argued (Egan et al., 2022; Shrivastava, 2022). In the light of Human Capital Theory, training and development practices enhance the knowledge, innovation capability, and

technological adaptability of agribusiness organisations, helping them implement digital farming technologies and smart agricultural systems (Lee et al., 2023). Moreover, existing research suggests that companies with robust workforce development are better able to effectively leverage technological resources and adapt to smart transformation projects (Baierle et al., 2022; Gu et al., 2021). The results confirm the mediation between smart agribusiness transformation and policy support by training and development practices.

However, other perspectives on mediation see training and development as not always effective mediators between policy initiatives and smart agribusiness transformation due to infrastructural, financial, and organisational constraints. Some researchers conclude that technological facilities are inadequate, managers' commitment is insufficient, or there is no coordination among institutions that provide policy-oriented training programs in the development of agricultural economies (Cordeiro et al., 2023). Some employees may be given training courses that do not relate to the organisation's technological needs, and the application of workforce development in this sense may limit its impact on smart transformation outcomes (Luongngoc & Vuhong, 2022). In the same vein, financial constraints and environmental uncertainties can hinder agribusiness companies from fully adopting digital agricultural systems, even when they are provided with policy guidance and workforce training (Cazeri et al., 2022; Baierle et al., 2022). Hence, while training and development practices are seen as significant mediating factors, the literature also identifies contextual issues that can hinder their effectiveness in supporting smart agribusiness transformation.

The supportive moderation views imply that environmental dynamism will enhance the connection between training and development practices and smart agribusiness transformation, as organisations' environments are uncertain and dynamic, requiring a highly adaptive, technologically skilled workforce. Environmental dynamism refers to the constantly evolving nature of the environment, including climate variability, technological disruption, market volatility and competitive pressures, which require continual learning and organisational adaptability (Gu et al., 2021). Previous work suggests that in a dynamic environment, the successful training and development of agribusiness organisations will be more beneficial, as skilled workers can adapt quickly to technological advancements and operational challenges (Egan et al., 2022). Furthermore, well-established learning cultures and workforce capabilities enable organisations to ensure sustainable digital transformation and innovation in an uncertain environmental context (Lee et al., 2023; Agarwala & Chaudhary, 2021). The results of this study confirm that environmental dynamism moderates the impact of training and development practices on smart agribusiness transformation.

Other negative moderation perspectives, however, suggest that high environmental dynamism could also hinder organisational transformation, as it can be so overwhelming that it strains organisational capabilities and resources. The evolving technological landscape, volatile agricultural markets, and climate-related shocks and stresses could introduce operational challenges that hinder the impact of workforce development efforts (Cordeiro et al., 2023). Organisations could find it difficult to continue training systems, invest in technology, and adapt digital agricultural strategies effectively, even if their workforce is ready, in a highly uncertain context (Cazeri et al., 2022). Additionally, others have suggested that a dynamic environment may amplify organisational stress and resistance to change, thereby dampening the impact of training and development efforts on transformation outcomes (Baierle et al., 2022; Gu et al., 2021). Literature therefore offers conflicting evidence both for and against the moderating perspectives on the role of environmental dynamism in the transformation of smart agribusiness.

Figure 1: Conceptual Framework

Hypothesis Development

Agricultural Training Policy and Training & Development Practices

The capability development of agricultural labour force has become an important determinant of the capability development in modern agribusiness organizations through training policy. The governments and agricultural institutions are increasingly highlighting the importance of specialized training programs, digital farming education, technical workshops and awareness campaigns on smart agriculture to train employees and farmers for technologically advanced agricultural systems. Recent research suggests that the policy-driven training programs in agriculture enhance the skills of the workforce, digital literacy, and employee adaptability with precision agriculture, internet of things (IoT) agriculture and agricultural operations based on automation (Garavan et al., 2023; PRODI et al., 2022). Such policies also push agribusiness organizations to create structured learning systems to boost their employee performance and their readiness to digital transformation (HU, 2021). Based on the Human Capital Theory, agricultural workforce training policies can enhance employee productivity and firm competitiveness by strengthening employee skill sets and their competitiveness in agribusiness environments (Shrivastava, 2022).

H1: The impact of agricultural training policy on the practice of training and development in agribusiness industry is positive.

Public Policy Support and Training & Development Practices

Support for public policy is essential to build the capacity of training and development practices through institutional guidance and support, financial support, infrastructure development and innovation-focused frameworks for agribusiness organizations. Governments around the world are adopting more and more agricultural modernization policies, digital transformation programs and workforce development programs to increase technological adoption in the agricultural sector. Recent research indicates that supportive public policies foster the adoption of employee training, digital skill development, and implementation of continuous learning systems to support the smart agricultural transformation (Martínez, 2024; Roh et al., 2020). Access to technology resources, funds, and educational facilities to develop the skills of the workforce is also enhanced through public policy support in the agribusiness environment (Communist Party of Vietnam, 2021a). In the lens of Human Capital Theory, policy-oriented organizational support increases the abilities of the workforce and boosts organizational learning and capabilities that lead to sustainable business transformation (Van, 2022a).

H2: There is a positive relationship between public policy support and training and development practices in the agribusiness industry.

Training & Development Practices and Smart Agribusiness Transformation

Training and development practices are vital organizational practices that help enable the smart agribusiness transformation by enhancing the competencies and technical knowledge of employees, and their innovation capability. There is a need for technical skills and digital literacy in the adoption of smart agricultural technologies like artificial intelligence, precision farming, Internet of Things (IoT) and automation etc. in the work of employees and farmers. Research from the last few years shows that businesses with workforce training programs, digital learning systems, and ongoing employee development initiatives exhibit higher technological readiness and innovation performance in agribusiness operations (Lee et al., 2023; DA SILVA et al., 2021). Training and development practices also foster employees' adaptability to technological change to promote the effective implementation of digital agricultural systems and sustainable farming practices (CAZERI et al., 2022). In addition to this, Human Capital Theory is another piece of evidence that equips and knowledgeable workers are a key to organizational transformation and long-term competitive advantage in technology-driven sectors (Toth, 2021).

H3: H3 Training and development practices positively affect smart agribusiness transformation in the agribusiness industry.

Agricultural Training Policy, Training & Development Practices and Smart Agribusiness Transformation

The agricultural training policy has an important role in assisting smart agribusiness transformation with the intermediary role of training and development practices. Government-backed agricultural training programs boost the skills of agricultural workers, equip them with digital literacy and technological awareness, and enhance their ability to effectively utilize smart agricultural technologies, including precision agriculture, automation, and IoT systems. The literature suggests that organizations with institutional training support can effectively implement continuous learning systems and employee development programs that enhance the technological adaptability and innovation performance within agribusiness operations, as demonstrated by Egan et al., (2022) and Hang and Van., (2020). In addition, according to the Human Capital Theory, investments in employees' skills, driven by policy, can boost the productivity of the workforce and readiness to digital transformation of the organization, thus supporting the sustainable modernization of smart agribusiness (Garavan et al., 2018). Thus, it is hypothesized that training and development practices will act as a mediator between the agricultural training policy and the smart agribusiness transformation.

H4: Agricultural training and development practices as the intervening variables between agricultural training policy and smart agribusiness transformation.

Public Policy Support, Training & Development Practices and Smart Agribusiness Transformation

Support for Public policy has a significant role in smart agribusiness transformation by enhancing the organizational training and the development process. Government policies that foster digital agriculture, skill development and training of workers, financial incentives and technological infrastructure all assist agribusiness organizations to invest in employee learning and digital skills development, and innovation-enhanced workforce development systems. Previous research

suggests that the technological readiness and organizational capability of organisations towards smart agricultural transformation is higher when they operate under strong policy support and when the capacity of their workforce is enhanced through training, which leads to an improvement of the adaptability of their employees and their digital competence (Van, 2022b; Luongngoc & Vuhong, 2022). Besides, the practices of training and development also contribute to the implementation of technology opportunities from policies into operational abilities which enable sustainable agribusiness modernization and innovation performance (Azhar et al., 2022; SILTORI et al., 2021). Hence, the mediation role of training and development practices will be expected between public policy support and smart agribusiness transformation.

H5: There is a mediating effect between public policy support and smart agribusiness transformation, through training and development practices.

Training & Development Practices, Environmental Dynamism and Smart Agribusiness Transformation

The association of training and development practices and smart agribusiness transformation will be influenced by environmental dynamism as it is expected to moderate the relationship between training and development practices and smart agribusiness transformation; organizations with dynamic and changing environments demand greater adaptability and technological capability of their workforce. In the context of the dynamic agricultural environment, which is facing risks and uncertainties due to the impact of climate change, technological disruptions, changing market demands and the pressure of competition, the significance of having a workforce learning and innovation capability for successful digital transformation is growing. Past research indicates that companies with strong training and development programs can adapt better to environmental changes and adopt agricultural technologies by leveraging smart agriculture to cope with uncertainty (Cordeiro et al., 2023; Gu et al., 2021).

H6: Environmental dynamism positively moderates the relation between training and development practices and smart agribusiness transformation, making the relation stronger when the environmental dynamism is high.

Methodology

Research Design

This study employs quantitative research with cross sectional research design which focuses on the relationship between agricultural training policy, public policy support, training and development practices, environmental dynamism, and smart agribusiness transformation. It is thought that it should be quantitative research in order to allow the researcher to measure the relationships between the variables objectively and to test the proposed hypotheses statistically in the conceptual framework. The cross sectional design is appropriate to gather data from respondents at one moment in time and useful for understanding organizations' perceptions, workers' capabilities, and policy-related factors in the agribusiness industry. In recent studies on smart agriculture and organizational change, cross-sectional quantitative designs have been employed to explore the relationships between the adoption of technology, workforce development, and organizational performance in dynamic business contexts (BAIERLE et al., 2022; DE FIGUEIREDO & GRAGLIA, 2021). Moreover, PLS-SEM is very suitable for conducting direct, mediating, and moderating relationships analysis in complex conceptual models, which is very suitable for cross-sectional quantitative designs (Iqbal et al., 2025; Fukuda-Parr et al., 2014).

Sampling

Data for this study will be gathered by a structured questionnaire survey to be sent out to employees, managers, supervisors and professionals involved in the agribusiness industry. Primary data collection is appropriate, as it allows getting primary responses on agricultural training policy, public policy support, training and development practices, environmental dynamism and smart agribusiness transformation. The questionnaire will be based on a 5-point Likert scale from strongly disagree to strongly agree, to assess the perceptions of the respondents and the practices in the organizations. In recent studies, data collection using survey tools has proven to be effective in gathering quantitative data from organizations to analyze the digital transformation (Zaman et al., 2025) and the development of skills (Hoduc et al., 2022) and smart agriculture. Moreover, data collection through questionnaires helps meet the needs of PLS-SEM analysis in examining both direct and indirect and/or mediating relationships in complex conceptual frameworks (Fukuda-Parr et al., 2014).

The sampling technique in this study will be purposive sampling as it is a primary sampling technique in the research because the respondents in this study are those with knowledge and practice in smart agribusiness operations, workforce training and organizational transformation. In the case of purposive sampling, the researcher can choose the respondents who are directly involved in agricultural technology adoption, employee development and policy implementation in the agribusiness organizations. Because of the subject matter of the study, which deals with specialized organizational and technological phenomena, it is more advantageous to use knowledgeable respondents to increase the quality and relevance of the data collected. Based on the literature, purposive sampling method is very appropriate for conducting research with an object that has an organization and is a technology object which needs respondents who have industry expertise and practical experience (Egan et al., 2006; Government, 2020). In addition, the purposive sampling technique is commonly employed in smart agriculture and vocational training studies, which ensures the sampling subjects have enough knowledge of the constructs and practices of the study (BAIERLE et al., 2022).

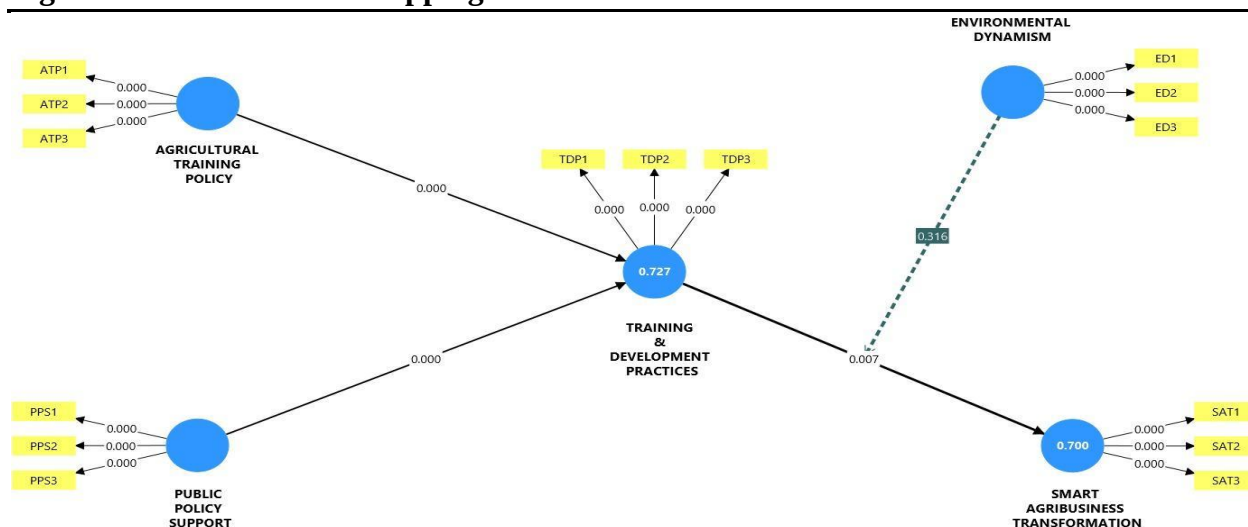
Results and Discussion

The findings of this study confirm that agricultural training policy and public policy support plays a significant role in enhancing training and development in the agribusiness industry. It was found that the most prominent positive influence on training and development practices is public policy support, followed by agricultural training policy, suggesting that government support, institutional infrastructure and policy-based efforts to foster employee competencies and organizational learning systems are crucial in improving these systems (Garavan et al., 2023; PRODI et al., 2022). The high R-square value obtained for training and development practices also supports the conclusion that the factors related with the policy play a significant role in the development of the capacity of the workforce in agribusiness. These results confirm the human capital theory which suggests that investing in workforce education, training and capability development contributes to better organizational performance and technological readiness in dynamic industries (Collins et al., 2017). The results also align with previous studies that highlight the positive effects of policy-driven training programs on digital competencies, flexibility, and technology integration in smart agriculture contexts (Lee et al., 2023; Roh et al., 2020).

Table 1: Reliability and Validity Analysis

Construct reliability and validity				
Overview				
	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
AGRICULTURAL _TRAINING _POLICY	0.887	0.888	0.930	0.815
ENVIRONMENTAL _DYNAMISM	0.862	0.863	0.916	0.784
PUBLIC _POLICY _SUPPORT	0.832	0.832	0.899	0.748
SMART _AGRIBUSINESS _TRANSFORMATION	0.856	0.859	0.912	0.776
TRAINING _& _DEVELOPMENT _PRACTICES	0.908	0.909	0.942	0.844

The results of construct reliability and construct validity showed that the measurement model has a strong internal consistency reliability and has a satisfactory convergent validity. The Cronbach's Alpha values for all constructs were above the recommended value of 0.70, ranging from 0.832 to 0.908, which suggests high reliability and consistency among the measurement items (Hair et al., 2021). Likewise, the Composite Reliability values (rho_c) for all constructs ranged from 0.899 to 0.942 which is above the acceptable level of 0.70, indicating high construct reliability in the model. In addition, the Average Variance Extracted (AVE) values ranged from 0.748 – 0.844, much higher than the minimum threshold of 0.50, reflecting that the indicators have good convergent validity and therefore explained the variance of the constructs well. The most reliable and valid results were obtained for the Training & Development Practices variable, and the least reliable, but still acceptable, were the results for Public Policy Support, out of all the variables.

Figure 2: PLS SEM Bootstrapping

Based on the results of the structural model, it was found that Agricultural Training Policy (ATP) and Public Policy Support (PPS) variables both have positive significant effects on Training &

Development Practices (TDPs), which is shown by the p value of both variables, respectively, at 0,000. The results reveal that the implementation of policy driven workforce development programs, government supports and institutional agricultural policies have a strong influence on the development of employee training systems, digital learning capacity and workforce readiness of agribusiness organizations. The two predictors, specifically Public Policy Support and Innovation Knowledge, both show a relatively high impact on Training & Development Practices, suggesting that the development of the organizational workforce is strongly influenced by supportive government policies, infrastructures and innovation policies. In addition, the R-square value of 0.727 for the Training & Development Practices shows that there is a high level of explanatory power in the model, with Agricultural Training Policy and Public Policy Support together having an explanatory power of 72.7%. This finding indicates the need for policy interventions to enhance the organizational capability development and technological preparedness in smart agribusiness environments.

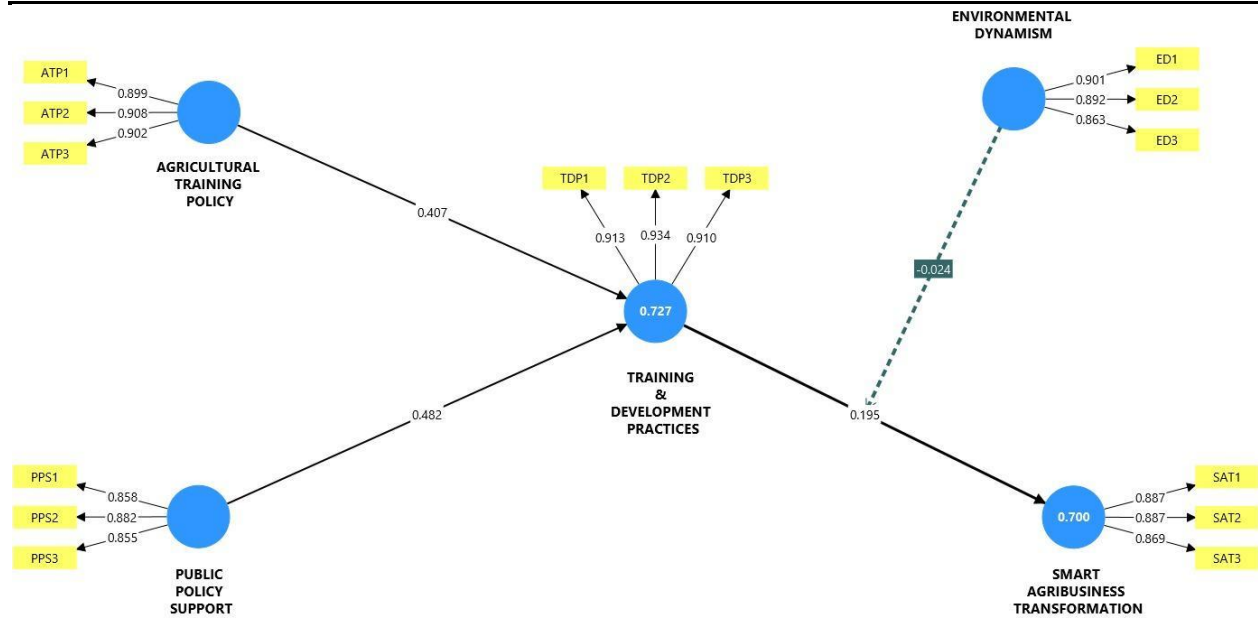
Table 2: Hypothesis Testing

Path coefficients					
Mean, STDEV, T values, p values					
	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics ((O-ST DEV))	P values
AGRICULTURAL_TRAINING_POLICY -> TRAINING_&_DEVELOPMENT_PRACTICES	0.407	0.410	0.078	5.201	0.000
ENVIRONMENTAL_DYNAMISM -> SMART_AGRIBUSINESS_TRANSFORMATION	0.656	0.645	0.074	8.914	0.000
ENVIRONMENTAL_DYNAMISM x TRAINING_&_DEVELOPMENT_PRACTICES -> SMART_AGRIBUSINESS_TRANSFORMATION	-0.024	-0.022	0.024	1.003	0.316
PUBLIC_POLICY_SUPPORT -> TRAINING_&_DEVELOPMENT_PRACTICES	0.482	0.480	0.075	6.445	0.000
TRAINING_&_DEVELOPMENT_PRACTICES -> SMART_AGRIBUSINESS_TRANSFORMATION	0.195	0.207	0.072	2.700	0.007

The Agricultural Training Policy had a significant positive influence on Training & Development Practices ($\beta = 0.407$, $t = 5.201$, $p = 0.000$), showing that training policy initiatives in agriculture are important for augmenting the skills of agricultural workers in agribusiness organizations. In the same way, Public Policy Support shows a high and significant positive correlation with Training & Development Practices ($\beta = 0.482$, $t = 6.445$, $p = 0.000$), which suggests that governmental support, institutional policies and innovation oriented frameworks are important elements in enhancing organizational learning and employee development systems. Moreover, Training & Development Practices has a positive relationship with Smart Agribusiness Transformation with the following results: $\beta = 0.195$, $t = 2.700$, $p = 0.007$, which shows that workforce training, digital skill enhancement, and continuous learning are significant to smart agricultural modernization and technological adoption. The Smart Agribusiness Transformation (SAT) also has a strong positive direct effect on environmental dynamism ($\beta = 0.656$, $t = 8.914$, $p = 0.000$), which means that a dynamic and technologically changing environment is seen as a tool

that pushes organizations to do smart agribusiness transformation more quickly. The negative moderating effect of Environmental Dynamism on the relationship between Training & Development Practices and Smart Agribusiness Transformation was statistically insignificant ($\beta = -0.024$, $t = 1.003$, $p = 0.316$) and therefore did not strengthen the relationship between the variables in the current study. In general, the results offer some level of support to most of the hypothesized. This included the significance of policy support and human capital development in attaining sustainable smart agribusiness transformation.

Figure 3: PLS SEM



All the study variables showed good indicator reliability and satisfactory construct representation in the measurement model. All outer loadings were beyond the recommended value of 0.70, indicating that the indicators are properly reflecting the latent constructs in the conceptual framework. It is observed that the loadings of the measurement items in the domain of Agricultural Training Policy are high (ranging from 0.899 to 0.908), and also in the case of Public Policy Support (ranging from 0.855 to 0.882). Likewise, Training & Development Practices had high loadings from 0.910 to 0.934, indicating the construct is very reliable for measuring agribusiness enterprise capability building for workforce. The over 80 percent factor loading on all indicators demonstrated the satisfactory measurement quality and convergent validity of all indicators, with scores of 0.863 to 0.901 for the indicators in the Environmental Dynamism construct and 0.869 to 0.887 for the indicators in the Smart Agribusiness Transformation construct. These findings indicate that the measurement model proposed has a high level of reliability and validity for analyzing smart agribusiness transformation in the agribusiness sector.

The proposed structural model yielded a good fit to the data, suggesting it could be used to explain the relationships among the studied constructs. Both the saturated (SRMR = 0.054) and the estimated (SRMR = 0.055) models show good fit and are below the recommended threshold of 0.08, with little difference between the observed and model-predicted correlations. The discrepancy levels of d_{ULS} and d_G is also relatively low, indicating that the model quality in PLS-SEM is satisfactory and the discrepancy levels are acceptable. The Chi-square values (727.472 for the saturated model and 704.554 for the estimated model) also suggest good agreement between the theoretical model and the observed data.

Table 3: Model fitness

Model fit		
Fit summary		
	Saturated model	Estimated model
SRMR	0.054	0.055
d_{ULS}	0.349	0.358
d_G	0.331	0.324
Chi-square	727.472	704.554
NFI	0.857	0.862

Discussion

The results of the present study have significant theoretical implications, as they extend Human Capital Theories in the context of smart agribusiness transformation. The study validates that agricultural training policy and public policy support significantly improve training and development practices, which, in turn, enhance smart agribusiness transformation in agriculture. The results support the basic tenets of Human Capital Theory, which posits that investments in employee knowledge, training, and workforce capability to adapt to new technologies and enhance organisational productivity are beneficial. The significant role of public policy support in training and development practices suggests that institutional and governmental intervention is a key factor in supporting the organisational learning system and increasing the workforce's readiness to adapt to digital transformation in agribusiness environments (Garavan et al., 2023; PRODI et al., 2022). The study also makes theoretical contributions by incorporating the concept of environmental dynamism into the framework, but the low level of moderating effect suggests that the influence of environmental uncertainty is not always a reinforcing factor for the outcomes of workforce-driven transformation in emerging agricultural economies. This result partially contrasts with the Dynamic Capability Theory perspective, which argues that a dynamic environment leads to organisational adaptability and innovation capability (Gu et al., 2021). The study thus makes a contribution to theory by emphasising the need for workforce capability development in order to achieve transformation, but in the context of uncertain agricultural conditions, environmental instability may diminish organisational effectiveness.

Conclusion

The present study has concluded that agricultural training policy and public policy support are important factors in enhancing training and development practices in agribusiness. The findings indicated that policy-based workforce development activities positively impacted the learning systems, digital literacy and organisational capability development of employees, which are vital to attaining smart agribusiness transformation. The most significant predictor of training and development practices was public policy support, suggesting that governmental infrastructure support, innovation-oriented policies, and institutional frameworks play a significant role in enhancing workforce readiness for digital agricultural transformation (Garavan et al., 2023; PRODI et al., 2022). The results are consistent with Human Capital Theory, which suggests that the more employees know and are capable of learning during training, the more productive the organisation and flexible with technology in changing business contexts. The study thus establishes that policy-driven workforce capability building is of importance for agribusiness modernisation and digital agricultural transformation in a sustainable manner.

Future Research Direction

The scope of research should be further extended with the inclusion of other organisational, technological and behavioural factors that could impact the transformation of the agribusiness as a smart agribusiness in future research. Technological readiness, organisational innovation capability, digital leadership, resistance to changes by employees and organisational culture can offer more detailed answers to the process of transformations in agribusiness related to employees. Researchers can also investigate other mediating and moderating variables to shed more light on the underlying mechanisms of the role of policy support in smart agricultural modernisation (Egan et al., 2022). Moreover, future research could create a multi-theoretical framework that combines Dynamic Capability Theory, Technology-Organisation-Environment (TOE) Framework, and Resource-Based View Theory to enhance the theoretical analysis of digital agricultural transformation processes (Gu et al., 2021).

References

- Agarwala, N., & Chaudhary, R. D. (2021). “Made in China 2025”: Poised for success? *India Quarterly*, 77(3), 424–461.
- Ahmed, B., Zaman, S. U., & Alam, S. H. (2025). Role of AI-based marketing activities in shaping brand experience, brand preference, and brand loyalty. *Qlantic Journal of Social Sciences and Humanities*, 6(1), 237–253. <https://doi.org/10.55737/qjssh.vi-i.25320>
- Azhar, Z., Mohamad, M. N., & Pitchay, A. A. (2022). Accounting information and supply chain management practices in the era of IR 4.0: The case of a Japanese subsidiary in Malaysia. *Asian Journal of Business and Accounting*, 15(1).
- Baierle, I. C., Pacheco, D. A. de J., Benitez, G. B., Seles, B. M. R. P., da Silva, W. V., & Tortorella, G. L. (2022). Competitiveness of the food industry in the era of digital transformation towards agriculture 4.0. *Sustainability*, 14(18), 11779.
- Cazeri, G. T., Anholon, R., Rampasso, I. S., Ordonez, R. E. C., Leal Filho, W., & Quelhas, O. L. G. (2022). Potential COVID-19 impacts on the transition to Industry 4.0 in the Brazilian manufacturing sector. *Kybernetes*, 51(7), 2233–2239.

- Collins, J. C., Zarestky, J., & Tkachenko, O. (2017). An integrated model of national HRD and critical HRD: Considering new possibilities for human resource development. *Human Resource Development International*, 20(3), 236–252.
- Communist Party of Vietnam. (2021a). *Document of the XIIIth National Congress of the Communist Party of Vietnam* (Vol. 1). National Politics Truth.
- Communist Party of Vietnam. (2021b). *Document of the XIIIth National Congress of the Communist Party of Vietnam* (Vol. 2). National Politics Truth.
- Cordeiro, R. F., Reis, L. P., & Fernandes, J. M. (2023). A study on the barriers that impact the adoption of Industry 4.0 in the context of Brazilian companies. *The TQM Journal*.
- Da Silva, S. B., Puffal, D. P., & Flores, T. M. (2021). Promoção de resiliência por meio da tecnologia a partir das instituições científicas, tecnológicas e de inovação no Brasil. *Revista Ciências Administrativas*, 27(2), 9872.
- De Figueiredo, A. R., & Graglia, M. A. V. (2021). Industry 4.0 in Brazil and the challenges of the productivity of the economy. *Journal on Innovation and Sustainability RISUS*, 12(4), 13–28.
- Egan, T. M., Upton, M. G., & Lynham, S. A. (2006). Career development: Load-bearing wall or window dressing? Exploring definitions, theories, and prospects for HRD-related theory building. *Human Resource Development Review*, 5(4), 442–477.
- Egan, T., Akdere, M., & Kim, S. (2022). Extending research and practice in our dynamic world of work. *Human Resource Development Quarterly*, 33(2), 109–113.
- Fukuda-Parr, S., Yamin, A. E., & Greenstein, J. (2014). The power of numbers: A critical national human resource development research: A systematic review and research agenda. *Journal of Human Development and Capabilities*, 15(2–3), 105–117.
- Garavan, T., Wang, J., Matthews-Smith, G., Nagarathnam, B., & Lai, Y. (2018). Advancing national human resource development research: Suggestions for multilevel investigations. *Human Resource Development International*, 21(4), 288–318.
- Garavan, T., Wang, J., Nolan, C., McCarthy, A., Murphy, K., O'Brien, F., & Carbery, R. (2023). Putting the individual and context back into national human resource development research: A systematic review and research agenda. *International Journal of Management Reviews*, 25(1), 152–175.
- García-Herrero, A., & Weil, P. (2022). *Lessons for Europe from China's quest for semiconductor self-reliance*. Bruegel.
- Government of Vietnam. (2020). *Decree No. 112/2020/ND-CP on disciplining cadres, civil servants, and public employees*. Hanoi, Vietnam.
- Gu, J., Dong, K., & Jiang, Q. (2021). Is the fourth industrial revolution transforming the relationship between financial development and its determinants in emerging economies? *Technological Forecasting and Social Change*, 165, 120563.
- Hang, L. T., & Van, V. H. (2020). Building strong teaching and learning strategies through teaching innovations and learners' creativity: A study of Vietnam universities. *International Journal of Education and Practice*, 8(3), 498–510.
- Hoduc, H., VoThanh, H., & Vuhong, V. (2022). The changes in education policy in the context of educational innovation in Vietnam. *Revista on Line De Política E Gestão Educacional*, 26(esp.1), e022043.

- Hu, G.-G. (2021). Is knowledge spillover from human capital investment a catalyst for technological innovation? The curious case of fourth industrial revolution in BRICS economies. *Technological Forecasting and Social Change*, 162, 120327.
- Iqbal, L., Zaman, S. U., & Alam, S. H. (2025). Social media influencers and cosmetics: The role of trust and materialism in consumer purchase decisions. *Journal of Regional Studies Review*, 3(1), 297–313.
- Kamal, M. H., Zaman, S. U., Alam, S. H., Iqbal, M., & Dashnyam, A. (2024). Sustaining Pakistan's economy through strategic gas planning and predictive analytics. *ILMA Journal of Social Sciences & Economics*, 5(2).
- Khoso, R. H., Alejandra, C., Faheem, M., & Alam, S. H. (2025). Ethical intelligence in digital marketing: The interplay of algorithmic bias, transparency, and data privacy on consumer trust. *Journal for Social Science Archives*, 3(2), 444–458.
- Kthiar, F. G., & Al-Hindawy, Z. A. R. (2022). The role of organizational creativity in achieving strategic superiority through knowledge sharing. *International Journal of Professional Business Review*, 7(5), e0869.
- Lee, S., Lee, Y., & Park, E. (2023). Sustainable vocational preparation for adults with disabilities: A metaverse-based approach. *Sustainability*, 15(15), 12000.
- Luongngoc, V., & Vuhong, V. (2022). O papel educacional das redes sociais na comunicação de políticas no Vietnã. *Revista on Line De Política E Gestão Educacional*, 26(esp.1), e022037.
- Martínez, J. (2024). What is public policy? *Civiced.org*. <https://www.civiced.org/project-citizen/what-is-public-policy>
- Prodi, E., Fontana, R., Marzucchi, A., & Vezzani, A. (2022). Industry 4.0 policy from a sociotechnical perspective: The case of German competence centres. *Technological Forecasting and Social Change*, 175, 121341.
- Rashid, S. A., Zaman, S. U., & Alam, S. H. (2025). Impact of retailer identity and website design on purchase intent in cross border e-commerce. *Research Journal for Social Affairs*, 3(3), 23–32. <https://doi.org/10.71317/RJSA.003.02.0186>
- Roh, K., Ryu, H., & McLean, G. N. (2020). Analysis of national human resource development (NHRD) policies of 2016 in South Korea with implications. *European Journal of Training and Development*, 44(4/5), 355–368.
- Shrivastava, R. (2022). Talent management and effectiveness of recruitment process: A study of higher education institutions in Central India. *International Journal of Professional Business Review*, 7(6).
- Siltori, P. F. S., de Vargas Mores, G., da Silva Cezarino, L. O., Liboni, L. B., & de Oliveira, B. G. (2021). Industry 4.0 and corporate sustainability: An exploratory analysis of possible impacts in the Brazilian context. *Technological Forecasting and Social Change*, 167, 120741.
- Toth, I. (2021). *Thriving in modern knowledge work: Personal resources and challenging job demands as drivers for engagement at work*. LUT University Press.
- Van, V. H. (2022a). The state's legal policy and management on civil servants: The current situation and issues raised. *International Journal of Early Childhood Special Education*, 14(3). <https://doi.org/10.9756/INT-JECSE/V14I3.688>
- Zaman, S. U., Khalid, M. U. I., Alam, S. H., & Hunain, M. (2025). Investigating the factors influencing the acceptance of Islamic mobile banking services. *The Asian Bulletin of Green Management and Circular Economy*, 5(1), 99–126.