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DIGITAL TECHNOLOGY ADOPTION AND SUSTAINABLE PERFORMANCE IN AGRI-FOOD SUPPLY CHAINS: EVIDENCE FROM DELTA STATE, NIGERIA

Williams Okpebenyo [1]
Owabor Rosemary Njideka

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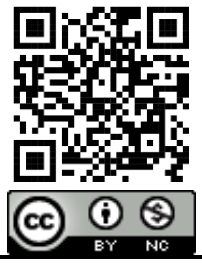

A B S T R A C T

This study aimed at technology adoption and agri-food supply chain in Delta State, Nigeria. The study assessed the effect of optimism toward technology, perceived usefulness, perceived ease of use, attitude toward use and behavioral intention to use on sustainable agri-food supply chain performance. The survey research design was employed. The population of the study comprised the actors involved in the supply chain of the agri-food industry in Delta State, Nigeria. The actors include the farmers, processors, distributors, and retailers who are directly involved in the handling and supply of agricultural products. The study employed a purposive sampling technique and snowballing technique. A total of 248 participants took part in the research. Data analysis was done using descriptive and inferential statistics. Regression weight was employed for hypothesis testing. Finding showed that technology has a significant positive effect on the performance of the agri-food supply chain. Findings also showed that optimism, perceived usefulness, attitude, and behavioral intention have a significant positive effect on sustainable agri-food supply chain performance. The study concluded that the adoption of technology can improve the performance of agri-food supply chains. The study recommended that investment in technology should be encouraged, and that training and awareness should be encouraged to ensure optimism towards the adoption and use of technology since optimism towards the adoption and use of technology enhances sustainable supply chain performance.

1. INTRODUCTION

Technology is currently an essential factor in enhancing food availability, food quality, and sustainability in different areas of the world. The agri-food supply chain entails different processes, such as food production, processing, storage, transportation, and delivery of food to consumers. The processes in the supply chain have been greatly enhanced through the use of technology, which ensures better coordination, traceability, and information sharing in the food supply chain. Therefore, the adoption of technology in the food supply chain affects the way different actors in the chain manage resources, food availability, and sustainability (Kumar et al., 2020; Yadav et al., 2020; Yadav et al., 2022). For example, the use of digital tracking systems, data systems, and monitoring systems enhances the level of transparency in the food supply chain, thus improving efficiency in the chain. The use of blockchain technology and Internet of Things enhances the tracking and monitoring of food movement in the supply chain, from production to distribution (Chen et al., 2021; Hassini et al., 2025). This enhances sustainability in the food supply chain, thus improving food availability and food quality in the chain (Park & Li, 2021; Ciccullo et al., 2021).

Research on the adoption of technology in the agri-food supply chain has also grown along with the volume of research on the digital transformation and innovation of

[1] Corresponding author: Williams Okpebenyo
Email: williamokpebenyo01@gmail.com

the supply chain. Previous research on the adoption of technology was primarily concerned with the sharing of information and the improvement of the supply chain. However, recent studies on the adoption of technology include the adoption of advanced technologies such as blockchain technology, smart monitoring tools, and the adoption of integrated digital tools (Duan et al., 2020; Vu et al., 2023). This is associated with the improvement of the transparency of the supply chain, the level of trust among consumers, and the financial sustainability of the supply chain (Fan et al., 2022; Guo et al., 2024). However, the adoption of technology is not an easy task; the main issues associated with the adoption of technology include the cost factor (Nafiu et al., 2024), the level of infrastructure, and the level of knowledge among the actors in the supply chain (Nayal et al., 2023; Kumar et al., 2024). This indicates that the adoption of technology is not only associated with the availability of technology but also the level of acceptance among the actors.

Research also indicates that the adoption of technology is dependent on individual and organizational perceptions of technology. For example, optimism about technology, usefulness of the technology, ease of use, attitude towards technology, and behavioral intention are all determinants of the adoption of new technologies. These are the determinants that affect the way people perceive the advantages of using technology, how they handle uncertainty, and whether they are willing to invest in new technologies (Smidt & Jokonya, 2022; Adebayo et al., 2022). In addition, the conditions of the organizations and the technological readiness of the organizations are also determinants of the adoption of new technologies, especially if there is a difference in the resources, skills, and infrastructures of the different players in the supply chain (Bhardwaj et al., 2021; Ugwu & Balogun, 2024). This is important because, despite the advantages of using technology, not all people adopt the use of technology.

For Nigeria, the issue of enhancing agri-food supply chains has become more critical due to the issue of food security, productivity, and market coordination. There have been attempts to use digital technology and agricultural extension for the betterment of supply chains in different regions of the country. Evidence of the positive impact of technology support and innovation has proven that it can improve agricultural outcomes and strengthen the value chains (Ehiwario et al., 2024; Arowosegbe et al., 2024). Technology has also proven its ability to enhance collaboration and coordination among the food industry through digital communication and information sharing (Akinbamini et al., 2025).

Despite the growing body of knowledge on the role of technology in supply chain management, little attention has been paid to the role of behavioral adoption factors in sustainable agri-food supply chains in particular states in Nigeria. Most studies focus on the general pattern of adoption or national level, while little attention is paid to the role of optimism towards technology, perceived usefulness, perceived ease of use, attitude towards use, and behavioral intention in sustainable agri-food supply chains in particular states in Nigeria, such as Delta State. This study addresses this gap by examining how technology adoption affects the agri-food supply chain.

1.1 Objectives of the Study

The main objective was to examine the effect of technology adoption on agri-food supply chain. The specific objectives were to assess the effect of optimism toward technology, perceived usefulness, perceived ease of use, attitude toward use and behavioral intention to use on sustainable agri-food supply chain performance.

1.2 Hypotheses of the Study

H1: Technology adoption has a significant effect on agri-food supply chain performance.

H2: Optimism toward technology has a significant effect on sustainable agri-food supply chain performance.

H3: Perceived technology usefulness has a significant effect on sustainable agri-food supply chain performance.

H4: Perceived technology ease of use has a significant effect on sustainable agri-food supply chain performance.

H5: Attitude toward technology use has a significant effect on sustainable agri-food supply chain performance.

H6: Behavioral intention to use technology has a significant effect on sustainable agri-food supply chain performance.

2. LITERATURE REVIEW

2.1 Technology adoption

Technology adoption has been conceptualized differently in various previous studies, but all researchers seem to agree that technology adoption entails the acceptance and use of new technology in real work activities. For example, Chen et al. (2021) describe technology adoption as "a mechanism through which organizations adopt and use new technology to enhance their operations and information exchange in the supply chain." Similarly, Smidt and Jokonya (2022) describe technology adoption as "a choice and use of new technology, which is subject to the readiness of the user, their skills, and the benefits of the new technology." From a more operational perspective, Kumar et al. (2020) describe technology adoption as "the integration of information and communication technologies into SC practices to facilitate improvements in SC performance." In terms of SC innovation, Bhardwaj et al. (2021) emphasize that technology adoption is subject to organizational capacity, resources, and technology. Other researchers have a more behavioral and goal-oriented focus. For example, Nayal et al. (2023) describe technology adoption as "a willingness to use new technology to support sustainability," while Ehiwario et al. (2024) describe technology adoption as "accepting

and using new agricultural technologies to support improvements in food." Common variables in these constructs include the decision to use technology, implementation of the technology in activities, users' readiness and skill levels, benefits derived, and supportive conditions. These similarities in variables illustrate that technology adoption involves more than just access to technology; it involves acceptance, implementation, and utilization of the technology in activities. Based on these constructs and similarities, this study defines technology adoption as the process by which individuals and/or organizations accept, implement, and utilize technological tools in activities for improved benefits and conditions to enhance performance and sustainability in the agri-food supply chain.

2.2 Agri-food supply chain

The agri-food supply chain is a chain that shows the movement of food products from the farm to the end user. It is a chain that covers all the processes that are included in the production, handling, movement, processing, and marketing of food products. Yadav et al. (2022) describe the agri-food supply chain as a chain that consists of various actors and activities that are connected to the production of food and the consumption of food products. This shows that the chain is not just one activity but several activities that are connected. According to Kumar et al. (2020), the agri-food supply chain is a chain that is formed through the coordination of the production, processing, storage, movement, and marketing of food products. This shows that the main variables of this chain are coordination, stages, and management. Chen et al. (2021) defined the food supply chain as a system through which food products, information, and money flow. Duan et al. (2020) defined the agri-food supply chain as a chain of connected processes that seek to provide food products that are safe and of quality to the consumer. From the sustainability perspective, Ciccullo et al. (2021) defined the agri-food supply chain as a system that should promote the minimization of waste and the efficient use of resources. This definition can be applied to this research.

2.3 Technology adoption and agri-food supply chain

The proxies of adoption include optimism towards technology adoption, perceived usefulness, perceived ease of use, attitude towards use, and behavioral intention to use. Many studies have shown that adoption is dependent on the way people think and feel about the technology before actually using the technology. For example, Smidt and Jokonya (2022) have demonstrated that farmers are willing to adopt technology if they perceive the usefulness and ease of use of the technology. This is an indication of perceived usefulness and perceived ease of use. Furthermore, Adebayo et al. (2022) have demonstrated that the expected benefits of technology adoption enhance the willingness to adopt. This is an indication of optimism towards technology adoption. In supply chain management, Kumar et al. (2020) have demonstrated that adoption can enhance supply chain coordination and performance if the people involved accept and adopt the technology. For example, studies on blockchain and digital tracking have demonstrated that a favourable attitude towards use and a strong intention to use can enhance the implementation of the technology (Chen et al., 2021; Vu et al., 2023).

Research on agri-food supply chains has found that the use of digital technologies and blockchain can enhance their performance, collaboration, and sustainability, particularly when the benefits of their use are perceived and the intention to use them is present (Kumar et al., 2020; Nayal et al., 2023; Hassini et al., 2025). However, the adoption of technologies can also be constrained by challenges such as low technical capabilities, lack of confidence in the technologies themselves, and low organizational support, despite their availability (Kumar Bhardwaj et al., 2021; Ehiwario et al., 2024). In Nigeria, especially in Delta State, the effectiveness of technologies in achieving better food production and delivery and sustainability is dependent on perception and behavioral outcomes (Akinbamini et al., 2025; Arowosegbe et al., 2024).

2.4 Theoretical Consideration

Technology Acceptance Model (TAM) was proposed by Davis (1989). This model offers a strong theoretical foundation for understanding the acceptance of technology in agri-food supply chains. The model posits that the acceptance of technology in supply chains depends on the perceived usefulness and ease of use of the technology. In this study, the concept of optimism towards the use of technology, attitude towards using the technology, and behavioral intention towards using the technology have been adopted in line with the Technology Acceptance Model. Previous studies have been conducted using the Technology Acceptance Model in the agri-food supply chain. For example, Kumar et al. (2020) used the Technology Acceptance Model to examine the role of ICT in improving supply chain coordination and performance in the food supply chain. The results of the study showed that the usefulness and ease of using the technology have a significant influence on the acceptance of the technology. Similarly, Smidt & Jokonya's (2022) research, which focused on small-scale farmers in South Africa, revealed that behavioral intention and attitude towards technology were strong predictors of the adoption of technology. This supports the assumptions of the TAM model, which suggests that user perceptions play a major role in the adoption of technology, making the model relevant to analyzing the adoption of Delta State's agri-food chain (Chen et al., 2021; Nayal et al., 2023).

The Diffusion of Innovation Theory (DOI), which was introduced by Rogers (2003), is another theory that is applicable to the adoption of technology in the agri-food supply chain. According to this theory, the adoption of innovation is affected by the perceived attributes of innovation, which are relative advantage, compatibility, complexity, trialability, and observability. Optimism

about the use of the innovation and usefulness are related to the relative advantage of innovation, ease of use is related to complexity, and behavioral intention is related to the decision to adopt. This theory is applicable to this research because it explains the relationship between individual and organizational perceptions and actual adoption and implementation of innovation. This theory is applicable to the adoption of innovation in the agri-food supply chain because several researchers have applied this theory to understand the adoption of innovation. For example, Hassini et al. (2025) used this theory to understand the adoption of IoT innovation in the food supply chain, and Vu et al. (2023) used this theory to understand the adoption of blockchain innovation, which is affected by the user's perception of the innovation's benefits and ease of use. This study can then examine the effects of optimism, usefulness, ease of use, attitude, and behavioral intention on sustainable agri-food supply chain performance in Delta State through the combined use of the TAM and DOI.

3. METHODOLOGY

This research employed a survey research design for the examination of the effect of technology adoption on the performance of the sustainable agri-food supply chain. Quantitative research is appropriate for the examination of the effect of technology adoption on the performance of the sustainable agri-food supply chain because it enables the measurement of the relationship between variables and the testing of hypotheses. The population of the study comprised the actors involved in the supply chain of the agri-food industry in Delta State, Nigeria. The actors include the farmers, processors, distributors, and retailers who are directly involved in the handling and supply of agricultural products. For the purpose of the research, the researcher employed a purposive sampling technique for the selection of the participants who were actors involved in the supply chain with experience in the adoption of technology. The researcher also employed a snowballing technique for the triangulation of the research. A total of 248 participants took part in the research. The researcher employed a structured questionnaire as the data collection tool. The questionnaire was designed to include questions related to the proxies of technology adoption (optimism towards technology adoption, perceived usefulness, perceived ease of use, attitude towards use, and behavioral intention to use) and sustainable agri-food supply chain performance. These research questions were adapted from the literature on TAM, DOI, and agri-food supply chain (Kumar et al., 2020; Hassini et al., 2025; Smidt & Jokonya, 2022). The research questions were intended to collect the responses on a 5-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree." In order to ensure the reliability and validity of the research questions, the researcher consulted experts in supply chain management and technology adoption. A pilot study was conducted among a small group of supply chain actors to test the questionnaire. Cronbach's alpha was calculated to test the reliability of the questionnaire. Cronbach's alpha is accepted if the alpha is greater than 0.7 (Table 1).

Table 1. Reliability of Instrument

S/N	Variables	Items	Results
1	Technology Adoption	20	0.757
2	Optimism Toward Technology	4	0.812
3	Perceived Usefulness	4	0.727
4	Perceived Ease Of Use	4	0.721
5	Attitude Toward Use	4	0.780
6	Behavioral Intention To Use	4	0.745
7	Sustainable Agri-Food Supply Chain Performance	4	0.812

Source: *Survey, 2025*

Data analysis was done using descriptive and inferential statistics. Descriptive statistics, such as percentage, were employed to describe the demographic characteristics of the respondents. For the inferential analysis, regression weight was employed for hypothesis testing. In specific form, the models are as follows:

$$SSP = a + \beta_1 TAN + \varepsilon \ldots\ldots\ldots\ldots \quad 1$$

$$SSP = a + \beta_1 OTT + \beta_1 PUS + \beta_1 PEU + \beta_1 ATU + \beta_1 BIU + \varepsilon \ldots\ldots\ldots\ldots \quad 2$$

Where,
a = Constant
TAN= Technology adoption
OTT= Optimism toward technology
PUS= Perceived usefulness
PEU= Perceived ease of use
ATU= Attitude toward use
BIU= Behavioral intention to use.
SSP= Sustainable agri-food supply chain performance
β_1 = regression coefficients
ε = residual or stochastic term

4. DATA ANALYSIS AND RESULTS

This section shows data analyses and results on demographic characteristics of respondents, as well as the test of hypotheses.

Table 2. Demographic characteristics of respondents

Variable	Category	Frequency	Percent
Gender	Male	126	50.81
	Female	122	49.19
	Total	248	100
Age Bracket (Years)	>18	30	12.10
	23-28	55	22.18
	30–35	112	45.16
	>36	51	20.56
	Total	248	100
Marital Status	Single	42	16.94
	Married	146	58.87
	Widow(er)	6	2.42
	Separated	53	21.37
	Divorced	1	0.40

	Total	248	100
Education Qual.	Primary School Leaving Certificate	12	4.84
	SSCE/WAEC	86	34.68
	OND/NCE	100	40.32
	HND/Bachelor Degree	32	12.90
	Master's Degree and others	18	7.26
	Total	248	100
Years of Exp.	< 1 year	52	20.97
	5–10 years	98	39.52
	>10 years	98	39.52
	Total	248	100

Source: Field Survey, 2026

Table 2 shows males (50.81%) and females (49.19%). This means both genders are well represented. Most respondents are between 30–35 years (45.16%), followed by 23–28 years (22.18%). Most of the respondents are married (58.87%), while singles (16.94%) and separated respondents (21.37%) are not many. Most respondents held OND/NCE (40.32%) and SSCE/WAEC (34.68%), while fewer held higher degrees. This shows that many respondents held at least secondary or diploma level education. Most respondents have 5–10 years (39.52%) or more than 10 years (39.52%), while fewer have less than one year experience (20.97%). This means many respondents have enough experience to give reliable information for the study.

Table 3. Model Fit

Fit Indices	Model	Default Model	Saturated Model	Independence Model
CMIN	NPAR	63	300	24
	CMIN	373.486	0	7603.609
	DF	237	0	276
	P	.000		.000
	CMIN/DF	1.576		27.549
RMR, GFI	RMR	.045	.000	.481
	GFI	.895	1.000	.312
	AGFI	.867		.252
	PGFI	.707		.287
Baseline Comparisons	NFI (Delta1)	.951	1.000	.000
	RFI (rho1)	.943		.000
	IFI (Delta2)	.981	1.000	.000
	TLI (rho2)	.978		.000
	CFI	.981	1.000	.000
Parsimony-Adjusted Measures	PRATIO	.859	.000	1.000
	PNFI	.817	.000	.000
	PCFI	.843	.000	.000
RMSEA	RMSEA	.048		.328
	LO 90	.039		.322
	HI 90	.057		.334
	PCLOSE	.610		.000

Source: *AMOS-IBM 25.0*

Table 3 indicates that the CMIN/DF is 1.576, which is below 3. This indicates a good fit. The low RMR of .045, GFI (0.895), and AGFI (0.867) are close to the acceptable level. This indicates a good fit. The incremental fit measures: NFI (0.951), IFI (0.981), TLI (0.978), and CFI (0.981) are all above 0.90..

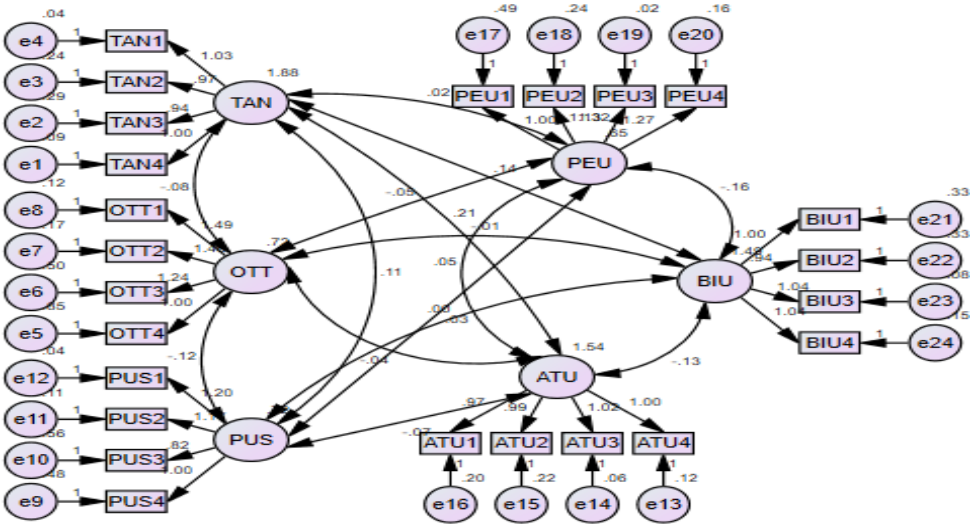

Figure 1. SEM on covariances

This indicates a strong model fit. The low RMSEA of .048 and the high PCLOSE of .610 are also indicative of a good fit. However, the default model is acceptable and suitable for the study Figure 1 shows that the relationship among the latent variables (technology adoption, optimism toward technology, perceived usefulness, perceived ease of use, attitude toward use and behavioral intention to use) are less that 0.5. Hair et al. (2017) noted that 0.5 is an acceptable threshold. The covariance estimates are small and do not point out that there is a serious overlap. Thus, there is no covariance problem among the variables. The variables are sufficiently independent for analysis.

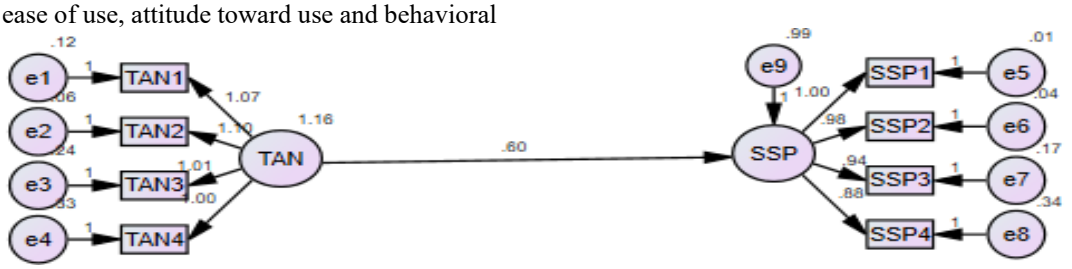

Figure 2. SEM on technology adoption and sustainable agri-food supply chain performance

Fig. 2 shows that TAN node directly affects the SSP node. The estimated value (0.60) indicates that the effect is possible. Table 4 provides a detailed results that supports the Fig. 2.

Table 4. Regression weights on technology adoption and sustainable agri-food supply chain performance

			Estimate	S.E.	C.R.	P-value
SSP	<---	TAN	.604	.063	9.546	***

Source: *AMOS-IBM 25.0*

Table 4 shows that TAN has a significant positive effect on SSP. The estimate value (0.604) shows that when TAN increases, SSP also increases. The C.R. value of 9.546 is high, and the p-value (***) shows that the result is significant (<0.001). This means TAN has a strong prediction on SSP in the model.

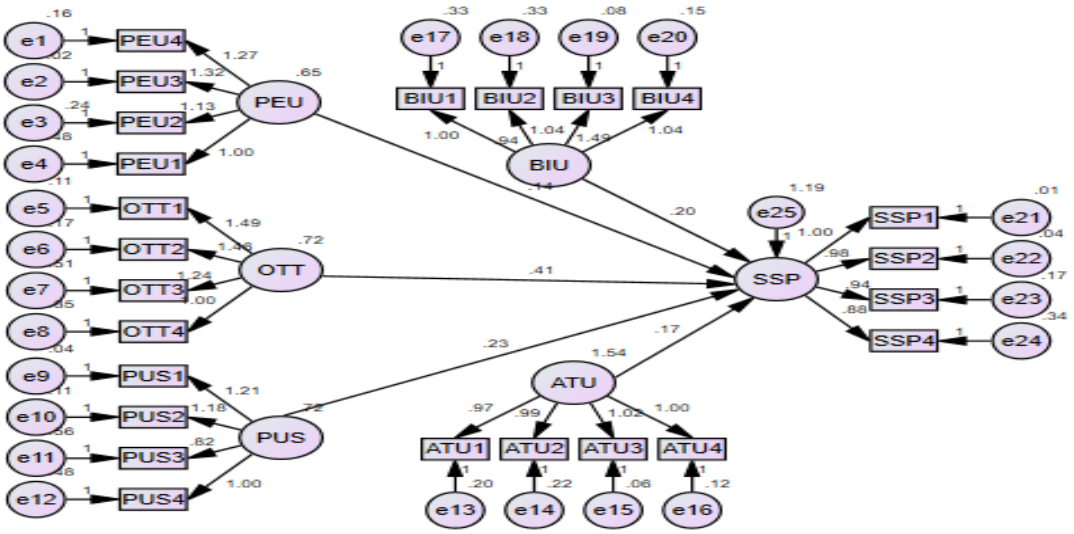

Figure 3. SEM on optimism toward technology, perceived usefulness, perceived ease of use, attitude toward use, behavioral intention to use and sustainable agri-food supply chain performance

The path analysis (Fig. 3) shows SSP is positively affected by PEU (Est.= 0.14), BIU (Est.= 0.20), OTT (Est.= 0.41), PUS (Est.= 0.23) and ATU (Est.= 0.17). The Fig. 3 agrees with Table 5 for details.

Table 5. Regression weights on optimism toward technology, perceived usefulness, perceived ease of use, attitude toward use, behavioral intention to use and sustainable agri-food supply chain performance

			Estimate	S.E.	C.R.	P-value
SSP	<---	PEU	.140	.087	1.603	.109
SSP	<---	BIU	.199	.058	3.417	***
SSP	<---	OTT	.408	.088	4.610	***
SSP	<---	PUS	.229	.084	2.728	.006
SSP	<---	ATU	.167	.057	2.940	.003

Source: *AMOS-IBM 25.0*

As shown in Table 5, OTT, BIU, PUS, and ATU have significant positive effects on SSP (p-values < 0.05). The results show that increases in these variables will lead to a proportional increase in SSP. Based on the results, OTT (β = 0.408) is the strongest predictor, followed by PUS (β = 0.229), BIU (β = 0.199), and ATU (β = 0.167). However, PEU does not have a significant effect on SSP. This is because of the p-value (0.109 > 0.05). This means PEU does not have strong predictions on SSP in this model.

5. DISCUSSION

Finding shows that technology has a significant positive effect on the performance of the agri-food supply chain. This finding supports the technology acceptance model, which assumes that if the benefits of the technology are clear, the users of the technology will be more willing to use it, resulting in better performance (Smidt & Jokonya, 2022; Adebayo et al., 2022). This finding also supports the diffusion of innovation theory, which argues that the diffusion of innovation occurs when the benefits of the innovation are clear (Yadav et al., 2022). Previous studies also support the findings of the research. For example, the adoption of ICT has a positive effect on the performance of the agri-food supply chain (Kumar et al., 2020), the adoption of blockchain technology has a positive effect on the sustainability of the agri-food supply chain (Chen et al., 2021; Park & Li, 2021), and the adoption of IoT has a positive effect on the operations of the food supply chain (Hassini et al., 2025). In Nigeria, the adoption of technology has a positive effect on collaboration and supply chain activities (Akinbamini et al., 2025; Ugwu & Balogun, 2024).

Findings show that optimism, perceived usefulness, attitude, and behavioral intention have a significant positive effect on sustainable agri-food supply chain performance. This means that when supply chain actors feel positive about technology, see it as useful, and have a good attitude and strong intention to use it, performance improves. However, perceived ease of use has no significant effect. This means that ease of use alone may not improve performance if users do not see strong value in the technology. This finding implies that benefits and positive mindset are more important than simplicity. The technology acceptance model supports this finding because it states that usefulness, attitude, and intention are key drivers of performance outcomes (Smidt & Jokonya, 2022). Past studies agree with these findings. Digital tools improve sustainability in food supply chains (Duan et al., 2020; Nayal et al., 2023).

6. CONCLUSION

In conclusion, it can be said that the adoption of technology can improve the performance of agri-food supply chains. Further, this study has also proven that optimism towards the use of technology, usefulness of the technology, attitude towards the use of technology, and behavioral intention towards the use of technology can improve the performance of sustainable agri-food supply chains. This is because if the supply chain actors in the agri-food supply chain have optimism towards the use of technology, find it useful to use, and have a strong intention to use the technology, then the performance of the supply chain improves. However, it has been found that ease of use of the technology alone may not improve supply chain performance.

7. RECOMMENDATIONS

The study recommends that:

- Since the adoption of technology enhances the performance of the agri-food supply chain, investment in technology should be encouraged.
- Training and awareness should be encouraged to ensure optimism towards the adoption and use of technology since optimism towards the adoption and use of technology enhances sustainable supply chain performance.
- The benefits and value of the adoption and use of technology should be demonstrated since perceived usefulness enhances sustainable supply chain performance.
- Since perceived ease of use has no effect on sustainable supply chain performance, emphasis should not only be on ensuring that the adoption and use of technology are easy but also on demonstrating the benefits and value of the adoption and use of technology.
- Efforts should be made to ensure that attitudes towards the adoption and use of technology are positive since attitude towards the adoption and use of technology enhances sustainable supply chain performance.
- Since behavioral intention enhances sustainable supply chain performance, emphasis should be made on ensuring a strong intention to adopt and use technology in the agri-food supply chain.

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Williams Okpebenyo
Department of Business Administration/Management, Delta State Polytechnic, Otefe-Oghara, Nigeria.
williamokpebenyo01@gmail.com
ORCID: 0009-0005-3360-9319

Owabor Rosemary Njideka
Department of Banking and Finance, School of Business and Management Technology,
Delta State Polytechnic Ogwashi-uku, Nigeria.
rosemaryowabor6@gmail.com
ORCID: 0009-0000-5789-2167