



# Reconceptualizing E-Commerce Adoption in Agriculture: A TOE-Based Structural Model with Social Identity as a Mediator

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**Abstract:** This study develops an integrated model to explain e-commerce adoption among agricultural producers by combining the Technology–Organisation–Environment (TOE) framework with social identity theory (SIT). Drawing on cross-sectional data from 585 farmers in Shanxi Province, China, and analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM), the research assesses both the direct and mediating effects of technological readiness, organisational barriers, and environmental enablers. Results reveal that social identity acts as a critical mediator, transforming indirect contextual drivers into adoption behaviour. Notably, factors such as complexity and digital environmental change influence adoption exclusively through social identity rather than direct paths. These findings advance existing literature by embedding sociopsychological mechanisms into digital adoption models, and offer practical guidance for promoting inclusive e-commerce development in rural and agricultural contexts, particularly in developing regions like rural China.

**Keywords:** Technology; Organisation; Environment; E-commerce adoption; Agricultural products; Social identity; Complexity; Skill

**JEL Classification:** Q1, O33, R58

## 1. Introduction

E-commerce adoption has emerged as a transformative force in modern agriculture. Over the years, this adoption rate depends on multiple socio-cultural factors, where social identity helps in shaping farmers' perceptions and willingness to embrace e-commerce platforms. Social identity plays a mediating role between different factors, which impacts the role of edging factors (Curll & Brown, 2020; Ruangkanjanases et al., 2020). The context of e-commerce also shows a growth that brings change in traditional practices. According to Su et al. (2021), a casual relationship exists between the adoption process of e-commerce among farmers. Digital transformation performs trades in different marketing practices. Shahbandeh (2023) has stated that the process of smart farming will show growth in 2021, and it is forecasted that it will show growth in the next 5 years. Additionally, it is expected that by the end of 2024, the sales volume of e-commerce will reach 4.1 trillion U.S. dollars in the global market (Gelder, 2024). More specifically, China become the largest market of e-commerce in 2021, with a revenue of \$1.5 trillion (Trade, 2023). China's Ministry of Agricultural and Rural Affairs (MARA) is developing a plan for the next 10 years (2023–2032) to narrow the gap in the agricultural market through the use of new technology (Mfat, 2023). Moreover, at present, farmer populace in Shanxi Province approximately at 4.3 million in 2023 (Chinayearbooks, 2023). Thus, introduction of e-commerce in farming can help to increase the value of this region in the Chinese market. Additionally, the government of Shanxi Province target 2025 to improve its digital economic condition to reach 5.4 percent of regional GDP (Chinaservicesinfo, 2023). Focusing on this specific region highlight the developing importance of digital platforms such as e-commerce development to improve the regional value of a nation.

However, traditional agricultural markets in China often restrict farmers to local buyers, limiting their ability to reach broader consumer bases. This constraint hampers their income potential and market expansion opportunities

(Lin et al., 2024). Further, reliance on intermediaries can lead to inconsistent pricing and reduced profitability for farmers (Song et al., 2024). Based on this, this study examines the benefits of e-commerce platforms, as it is found to offer a way to mitigate these issues by enabling direct sales to consumers. The integration of e-commerce platforms with agriculture may influence the social identity of farmers. However, the rural environment of Shanxi does not show the adoption of the required technology which can be a major barrier to the adoption of e-commerce for farmers. According to Thomas et al. (2023), the implication of self-identity theory improves the strategy of business development. Thus, focusing on this theoretical concept helps in the promotion of business intention in a market. Moreover, past studies do not show the direct use of social identity as a mediator between TOE and e-commerce adoption, which is going to be recognised through this study. Therefore, this study highlights the development of e-commerce platforms and their impact on agricultural products in Shanxi province of China. The aim of the study is to determine the mediating effect of social media during the adoption of the e-commerce process for farmers of agricultural products in Shanxi Province of China.

### **Research questions**

**RQ1:** How have the factors of technology, organisation and environment impacted the e-commerce adoption intensity process for farmers of agricultural products in Shanxi Province of China?

**RQ2:** What is the impact of technology, organisation and environment on the social identity of farmers?

**RQ3:** What is the impact of social identity as a mediating factor between technology, organisation, environment and e-commerce adoption intensity?

## **2. Literature Review**

### **Technology**

The adoption of technology helps in the promotion of sustainable and stable development which helps in the promotion of a specific aspect. According to Wang & Huang (2018), mixing up technology with agriculture promote economic growth in that field. The concept of technology includes two factors, e-commerce awareness and complexity which are connected with e-commerce adoption intensity.

### **E-commerce Awareness**

The concept of e-commerce includes the concept of technology adoption, which provides new scope to a firm. According to Fedushko & Ustyianovych (2022), e-commerce awareness is related to the aspects of the customers view point. Additionally, Najafi (2012) stated that the level of consciousness is related to the concept of awareness which become conscious of the events, objects and sensory patterns. Therefore, the development of awareness promote identity through e-commerce platforms in a broader marketplace. Conversely, Emmanuel (2012) has critiqued that the development of e-commerce awareness requires a strong networking system, thus the lack of a networking system hampers the effectiveness of e-commerce awareness. Therefore, the proper development of a networking system promotes e-commerce awareness among a set of people. However, the design of an e-commerce website is related to the identity of the users (Chen et al., 2019). Thus, the presence of awareness regarding the use of e-commerce platforms impacted the social identity of the users. Therefore, hypotheses have been developed as follows:

**H1.1:** *E-commerce awareness positively influences e-commerce adoption intensity*

**H1.2:** *E-commerce awareness positively influences social identity*

### **Complexity**

The process of promoting social identity includes the use of technology-based systems such as e-commerce platforms. Morepje et al. (2024) have stated that e-commerce platforms include complex processes to promote sustainability in farming. Similarly, the presence of complexity due to the presence of limited technological knowledge limits the technological expertise activity of farmers (Chen et al., 2019). Therefore, technology-based systems may promote sustainability in a practice, though the presence of complexity hinders the improvement process of the social identity. Moreover, Reddy & Nalla (2024) stated that digital platforms include real-time data processing, which is a complex and evolving field. Therefore, the use of e-commerce platforms for the promotion of agricultural products is also a complex process that represent the identity of an individual in a large market. Conversely, Weerapperuma et al. (2025) critiqued that the presence of prior knowledge helps in the adoption of new technologies. The inconsistency in the evidence is represented based on contextual factors such as digital literacy rate and cultural attitudes. Though, farmers may lack knowledge about technology-based systems which increases the complexity of the adoption of e-commerce platforms for the farmers of agricultural products in China which making this study niche-specific. Thus, the complexity of the e-commerce platform shows its impact on social identity. Additionally, Sanasi et al. (2022) stated the complex first changing environment are main dimension of a change, which improves the traditional practice. The problem-solving and learning become complex, which improves the adoption of new technology.

Therefore, hypotheses have been developed as follows:

**H2.1:** *Complexity negatively impacted e-commerce adoption intensity*

**H2.2:** *Complexity negatively impacted social identity*

## **Organisation**

The context of the organisation in the TOE framework helps in the adoption intensity of technology-related innovation (Abed, 2020). Therefore, improving the capability of an organisation helps in the adoption of e-commerce platforms and the presence of a firm in the market.

### **Lack of skills**

Skill is an essential concept for the adoption of any technology; thus, a lack of skills hampers the adaptability process of a technology-based system. Lack of proper knowledge or lack of skill among a set of people, such as farmers, hampers the adoption intensity of new skills (Gerli et al., 2022; Wagner et al., 2008). People show that they rely on smart technology in their daily lives which enhances the skill set of people for the adoption of a technology-based system. According to Morandini et al. (2023), up-skilling and re-skilling help an organisation to work in a new organisation model. Henceforth, the presence of skill sets among the farmers helps them to promote their identity through e-commerce platforms. Therefore, the adoption of these practices may help to avoid existing barriers in the infrastructural development process. However, Ariansyah et al. (2021) have stated that a lack of ability to use internet platforms hampers the identity of people on social platforms. Henceforth, the mixed findings represented the relationship between skill and the adoption of new skills in regards to the technology adoption. Thus, the concept of social identity is connected with the skills of people, as it improves the disabilities of farmers. Additionally, Awan et al. (2021) stated that lack of skill restricts the adoption intensity of a new practice. The presence of this issue increases the time for the adoption of technological aspects to improve social identity.

Therefore, hypotheses have been developed as follows:

*H3.1: Lack of skills negatively impacted e-commerce adoption intensity*

*H3.2: Lack of skills negatively impacted on social identity*

### **E-commerce training**

The arrangement of the training facility plays an essential role in the development of the skill set of individuals. According to Irasuti & Bachtiar (2024), the arrangement of training programs improves the literacy skills of a learner. Additionally, the development of the training facility increases the capability of farmers to bring change in their practice of adopting e-commerce platforms. Improving the knowledge of farmers about the benefits of adopting e-commerce platforms provokes their social identity. Brahma & Dutta (2020) have stated that the arrangement of training improves the skill of an individual. Thus, getting proper training regarding the use of online platforms impacted their presence on social sites.

Therefore, hypotheses have been developed as follows:

*H4.1: E-commerce training positively influences e-commerce adoption intensity*

*H4.2: E-commerce training positively impacted the social identity*

### **Environment**

Another component of the TOE framework is the environment which includes the surroundings of a business environment (Pateli et al., 2020). External environmental conditions such as government support and digital environmental support play an important role in the adoption of e-commerce technology.

### **Government support**

The concept of government support is an external factor that allows people to learn a new concept and implement it effectively; moreover, government support is essential for the promotion of research and development activities (Kim et al., 2016; Nugroho, 2015). Therefore, this concept helps in the development of innovation management practices which allows for the adoption of technology-based systems among the farmers. Getting support from governing organisations increase the willingness of farmers for continuous learning and support which provokes them to make continuous learning and support. Moreover, Azhima & Manopo (2024) stated a multicultural society can be developed easily through the presence of government support and individual awareness. Thus, the government system plays a significant role in the development of the social identity of an individual.

Therefore, hypotheses have been developed as follows:

*H5.1: Government support positively influences e-commerce adoption intensity*

*H5.2: Government support positively impacted the social identity*

### **Digital environmental change**

Improving external factors such as digital environmental change improve the attitude and behaviour of people. According to Kim & Kim (2022), digital environmental changes perform quick responses and easy acceptance of new technology. Additionally, Yoon (2023) has stated that the presence of external pressure and the rapidly changing digital environment impacted the adoption intensity process of a technology-based system. However, Galhotra & Dewan (2020) have stated that the use of e-commerce platforms has become a trend in the market which has helped to enhance the business value in the market. The increasing use of internet platforms among people also shows the acceptance of this change, which enhances the business value in a market. Additionally, Chuang (2020) stated that the online environment has an impact on social presence. Henceforth, the presence of a digitally advanced environment improves the identity of an individual on social platforms.

Therefore, hypotheses have been developed as follows:

*H6.1: Digital environmental change positively influences e-commerce adoption intensity*

### ***H6.2: Digital environmental change is positively related to social identity***

#### **Social Identity**

The presence of a strong social identity differentiates a brand image in a community and it helps in the development of self-brand communication based on its identification through its customers (Kuo & Hou, 2017). Additionally, Charness & Chen (2020), have stated that social identity provokes individual behaviour in experimental tasks. Therefore, making changes in the behaviour of people based on the adoption of new practices helps in the promotion of the e-commerce presence of farmers. Grimalda et al. (2018) have stated that social identity can play a mediating role between two variable factors. Therefore, social identity connects two different variables such as the factors of the TOE framework and the e-commerce adoption intensity process. Therefore, hypotheses have been developed as follows:

***H7: Social identity positively influences e-commerce adoption intensity***

***H8: E-commerce awareness influences e-commerce adoption intensity through social identity***

***H9: Complexity influences e-commerce adoption intensity through social identity***

***H10: Lack of skills influences e-commerce adoption intensity through social identity***

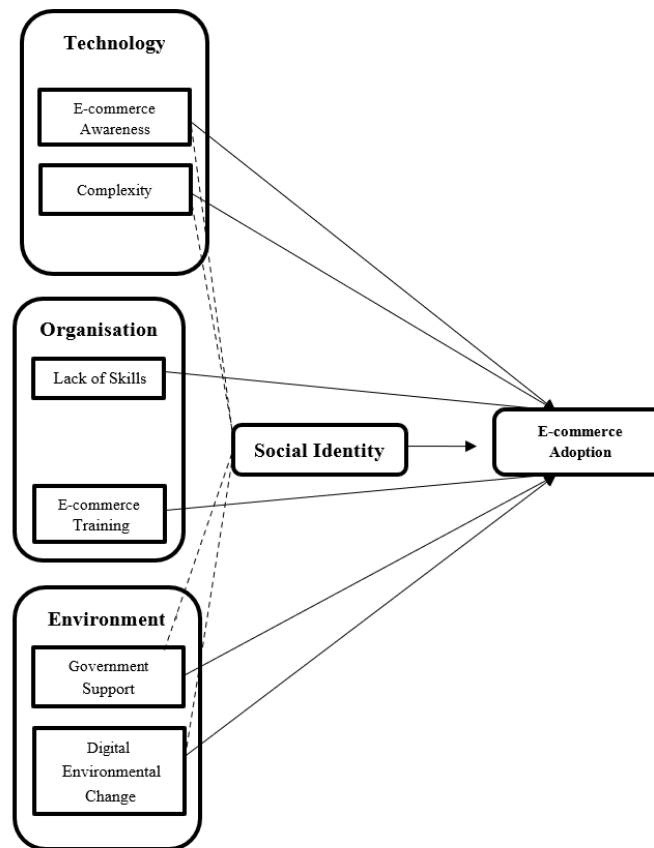
***H11: E-commerce training influences e-commerce adoption intensity through social identity***

***H12: Government support influences e-commerce adoption intensity through social identity***

***H13: Digital environmental change influences e-commerce adoption intensity through social identity***

### **3. Theoretical Framework**

SIT itself expresses the importance of the identity of an individual in a social aspect (Steffens et al., 2021). Thus, the improvement of social identity expresses the presence of a farmer on an e-commerce site, which process agricultural products in China. Moreover, the framework of TOE determines the impact of a pre-adaptive technology on a firm (Cruz-Jesus et al., 2019). Thus, focusing on the subfactors of technology, organisation and environment impact on social identity, which also impacts e-commerce adoption. Social identity is fostered among farmers in e-commerce adoption and is built through trust, collaboration, and shared community values facilitated by TOE factors such as technological accessibility, organizational readiness, and external environmental support (Song et al., 2024). Based on this concept, a conceptual framework has been developed, which been presented in Figure 1:



**Figure 1.** Conceptual framework

## 4. Literature Gap

Past studies also make effective research on the field of e-commerce adoption intensity in the farming and agricultural industry. However, some of the studies have been completed by focusing on different geographical regions than China (Nugroho, 2015; Nurunnisha & Dalimunthe, 2018), which shows a difference in the perception of people during their responses. Moreover, the mediating effect of social identity has not been analysed in past studies by connecting it between the factors of the TOE framework and e-commerce adoption. Past studies also focus on the concept of e-commerce adoption in China (Lin et al., 2024; Song et al., 2024), though they do not highlight the adoption of e-commerce in the farming industry. Henceforth, the current study was developed by focusing on the existing gaps of past studies.

## 5. Method

The quantitative method has been adopted to collect numerical insights to meet the aim of the study. According to Saunders et al. (2019), the quantitative method covers the assumption that develops based on the objectives. Moreover, the use of different measurement instruments helps in the development of objective-based results. According to Mohajan (2020), following the quantitative method deal with a large amount of data. The current study was developed by the use of 8 variable factors, and the measurement scales have been identified for each independent and mediating variable factor which helps in the collection of numerical insights.

Additionally, the generalisability of the study has been maintained by the collection of a large sample size. The current study has selected a total of 585 respondents based on a 95% confidence level based on their connection with the farming and agricultural industry in Shanxi Province of China. According to Wagner & Grimm (2023), the sample size has to be 10 times larger than the arrowheads, which is expressed in the 10-times rule. The current study has a total of 8 arrowheads thus, the sample size must be greater than 80. The selection of a sample size greater than 80 was appropriate for the study which was followed. The sample was collected by following the convenience sampling method which helps in the collection of samples based on the accessibility of respondents (Mujere, 2016). This study mainly selected respondents from social media platforms who lived in Shanxi Province of China and related to farming and agriculture.

The current study has undertaken cross-sectional research that helped to complete the study within a specific time limit (Atalla et al., 2022). Henceforth, following the empirical process and cross-sectional method helps in the collection of numeric-based required insights. The study also used a 5-point Likert scale in a specific direction (1- Strongly Disagree to 5- Strongly Agree) to collect responses from the respondents. This study has followed the quantitative method which has been analysed by following statistical insights such as SPSS (Abbasnasab Sardareh et al., 2021). Henceforth, the use of SPSS allowed for the use of regression analysis models through quantitative insights. The ethics were maintained throughout the study as it did not collect any personal insights from the respondents. Overall, the collected insights were kept in a password-protected system to enhance the ethical value of the study. Besides some initial descriptive and the reliability analysis, which was done in SPSS, the major statistical approach chosen in the given study was Partial Least Squares Structural Equation Modelling (PLS-SEM). PLS-SEM was chosen due to its ability to be applied to prediction-based research, to work with complex models that include mediating variables, and weaknesses in the cases with distributions that are not normally distributed. SmartPLS 4.0 was used to conduct the analysis. First, the measurement model was tested on the reliability and validity, such as Cronbachs alpha, composite reliability, average variance extracted (AVE), and discriminant validity based on the Fornell-Larcker criterion and HTMT ratio. Such tests were taken to make sure that the constructs were adequately measured prior to the test of hypotheses. Structural model was also tested in order to test direct and indirect relationships. A bootstrapping, with 5,000 resamples, was used to produce standard errors and determine whether path coefficients and mediating effects were significant. Two-tailed tests at the 95% confidence level were used to test significance. The quality of structural models was also determined using the R<sup>2</sup> values, effect sizes (f<sup>2</sup>).

## 6. Measurement Scale

In valid measurement scale, a 4 item-scale of e-commerce awareness developed from Chen et al. (2020); Nurunnisha & Dalimunthe (2018); Zhao & Tian (2014). The 4-item scale of complexity is developed based on Yoon et al. (2020); the 2-item scale of Lack of skill is also adopted from Yoon et al. (2020). The 2-item scale of e-commerce training is adopted from variable sources such as Dey & Shekhawat (2021); Hu (2016); Zhao & Tian (2014). Moreover, the 3-item scale of government support and the 3-item scale of digital environmental changes were adopted from the study by Yoon et al. (2020). The 4-item scale for the variable factor of social identity was adopted from the study of Bruner & Benson (2018).



## 7. Result

### Descriptive analysis

Table 1 presents demographic and socio-economic data for a survey population focused on e-commerce use. It shows that 58.8% of respondents are male and 41.2% are female. Age distribution indicates that the majority (34.5%) are aged 18–30, followed by 26.3% in the 31–45 range, 24.1% aged 46–60, and 15.0% over 60. Educational background varies, with 60.3% having completed high school or technical secondary school, 25.3% attending junior college, 10.6% are undergraduates, and 3.8% hold a master's degree or higher. Income levels are segmented, with 34.5% earning between 3,000–5,000 Yuan and similar proportions in the subsequent income brackets up to over 10,000 yuan. Work experience shows 16.2% with less than a year, increasing to a peak of 33.2% with 2–3 years, then tapering off. All respondents use e-commerce, emphasising its pervasive adoption intensity across varied demographic segments.

**Table 1.** Demographic characteristics of respondents

Variable	Categories	Frequency	Percentage
Gender	Male	344	58.8%
	Female	241	41.2%
Age	18–30	202	34.5%
	31–45	154	26.3%
	40–60	141	24.1%
	>60	88	15.0%
	High school and technical secondary school	353	60.3%
Education	Junior college	148	25.3%
	Undergraduate	62	10.6%
	Master's degree or above	22	3.8%
Income	3,000–5,000 yuan	202	34.5%
	5,001–8,000 yuan	188	32.1%
	8,001–10,000 yuan	95	16.2%
	>10,000 yuan	100	17.1%
	Less than 1 year	95	16.2%
Experience	1–2 years	104	17.8%
	2–3 years	194	33.2%
	3–4 years	101	17.3%
	4–5 years	50	8.5%
	More than 5 years	41	7.0%
E-commerce Use	Yes	585	100.0%

### Reliability

**Table 2.** Reliability table

	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
Complexity	0.731	0.811	0.849	0.660
Digital environmental change	0.736	0.760	0.848	0.652
E-commerce awareness	0.815	0.948	0.911	0.837
E-commerce training	0.821	0.864	0.895	0.743
E-commerce adoption	0.738	0.855	0.879	0.784
Government support	0.629	0.629	0.843	0.729
Lack of skills	0.742	0.744	0.854	0.661
Social identity	0.908	0.910	0.935	0.783

Table 2 outlines the reliability of various constructs associated with e-commerce and related factors using Cronbach's Alpha as a measure of internal consistency. The construct for social identity shows the highest reliability with an alpha value of 0.908, suggesting a very consistent internal structure. This is closely followed by e-commerce awareness and e-commerce training with alpha values of 0.815 and 0.821, respectively, indicating robust consistency within these constructs as well. The Digital Environmental Change and complexity constructs also show adequate reliability with alpha values of 0.736 and 0.731. The Government Support construct, however, has the lowest Cronbach's Alpha at 0.629, pointing to a weaker internal consistency relative to the other constructs. Still, it is acceptable as previous studies have stated that the generally accepted rule is that an alpha of 0.6–0.7

(Ursachi et al., 2015). Furthermore, the relatively high composite reliability ( $\rho_c = 0.843$ ) and average variance extracted ( $AVE = 0.729$ ) provide additional evidence that the construct remains valid and captures sufficient variance, supporting its inclusion despite the lower Cronbach's alpha. Similarly, lack of skills has a moderate alpha value of 0.742. These values indicate that most constructs in the study are measured with a high degree of reliability, although improvements might be needed for those with lower alpha values to ensure the consistency of the measurement scales.

#### The Heterotrait-Monotrait ratio

**Table 3.** The Heterotrait-Monotrait ratio of correlations (HTMT)

	Complexity	Digital Environmental Change	E-Commerce Awareness	E-Commerce Training	E-commerce Adoption	Government Support	Lack of Skills	Social Identity
<b>Complexity</b>	1							
<b>digital environmental change</b>	0.614	1						
<b>E-commerce awareness</b>	0.113	0.114	1					
<b>E-commerce training</b>	0.703	0.468	0.267	1				
<b>E-commerce adoption</b>	0.411	0.161	0.349	0.390	1			
<b>Government support</b>	1.107	0.400	0.099	0.638	0.543	1		
<b>Lack of skills</b>	0.617	0.539	0.111	0.557	0.107	0.467	1	
<b>Social identity</b>	0.816	0.625	0.215	0.686	0.406	0.736	0.616	1

**Table 4.** Cross loadings

	Complexity	Digital Environmental Change	E-commerce Awareness	E-commerce Training	E-commerce Adoption	Government Support	Lack of Skills	Social Identity
<b>COM1</b>	0.735	0.300	0.006	0.228	0.176	0.342	0.314	0.367
<b>COM2</b>	0.900	0.335	0.059	0.496	0.261	0.728	0.362	0.578
<b>DCNG1</b>	0.431	0.939	0.082	0.305	0.076	0.287	0.374	0.502
<b>DCNG2</b>	0.210	0.838	0.094	0.248	0.066	0.124	0.281	0.313
<b>EA1</b>	0.006	0.084	0.875	0.178	0.195	0.008	0.071	0.157
<b>EA2</b>	0.064	0.092	0.953	0.222	0.354	0.113	0.088	0.182
<b>ECMADP1</b>	0.166	0.042	0.140	0.223	0.830	0.281	-0.014	0.212
<b>ECMADP2</b>	0.293	0.091	0.374	0.339	0.938	0.377	0.106	0.383
<b>ECT1</b>	0.456	0.378	0.161	0.699	0.043	0.339	0.407	0.485
<b>ECT2</b>	0.388	0.232	0.197	0.936	0.352	0.413	0.341	0.504
<b>ECT3</b>	0.395	0.244	0.214	0.930	0.390	0.428	0.372	0.536
<b>GS1</b>	0.674	0.208	0.064	0.385	0.318	0.852	0.244	0.476
<b>GS2</b>	0.506	0.216	0.070	0.398	0.331	0.856	0.301	0.476
<b>LOS1</b>	0.306	0.294	0.090	0.362	0.082	0.255	0.836	0.415
<b>LOS2</b>	0.321	0.285	0.048	0.350	0.076	0.271	0.846	0.408
<b>LOS3</b>	0.376	0.338	0.077	0.322	0.003	0.252	0.755	0.406
<b>SI1</b>	0.587	0.330	0.131	0.501	0.349	0.552	0.399	0.868
<b>SI2</b>	0.573	0.313	0.166	0.551	0.393	0.544	0.422	0.909
<b>SI3</b>	0.510	0.504	0.167	0.507	0.276	0.457	0.461	0.897
<b>SI4</b>	0.424	0.553	0.198	0.514	0.229	0.414	0.507	0.864

Table 3 displays correlation coefficients between constructs related to e-commerce, focusing on the relationships between e-commerce adoption intensity, social identity, and other variables such as complexity, digital environmental change, and government support. E-commerce adoption intensity correlates moderately with complexity (0.411) and strongly with government support (0.638), suggesting that more complex e-commerce environments and supportive government policies can boost e-commerce adoption intensity. It also shows a significant correlation between e-commerce training (0.390) and lack of skills (0.557), indicating that training and addressing skill gaps are crucial for adoption intensity. Social identity is strongly linked to e-commerce training (0.686) and Government Support (0.736), reflecting how cultural and social norms influence the effectiveness of training programs and government initiatives in e-commerce contexts. However, as part of evaluating the discriminant validity, the value of HTMT between Government Support (GS) and complexity (COM) was found

to be 1.107, which is higher than the suggested coefficient of 0.90. To check this issue, a cross-loadings test was also done as shown in Table 4. The result showed that some items (especially GS1/GS2 (0.506 and 0.674 on COM), or GS2) (0.649 on GS) and some overlap, namely, that the constructs share a conceptual variance. This overlap is conceptually possible because government support measures, including subsidies, training, and advice, can directly contribute to the apparent complexity of the adoption of e-commerce practices. Considering the conceptual justification, the two constructs were included in the model. Nevertheless, the overlap is recognized.

#### Loadings

**Table 5.** Loading table for variable

	Original Sample (O)
COM1 ← Complexity	0.584
COM2 ← Complexity	0.905
COM3 ← Complexity	0.906
DCNG1 ← Digital environmental change	0.866
DCNG2 ← Digital environmental change	0.776
DCNG3 ← Digital environmental change	0.775
EA1 ← E-commerce awareness	0.875
EA2 ← E-commerce awareness	0.953
ECMADP1 ← E-commerce adoption	0.830
ECMADP2 ← E-commerce adoption	0.938
ECT1 ← E-commerce training	0.699
ECT2 ← E-commerce training	0.936
ECT3 ← E-commerce training	0.930
GS1 ← Government support	0.852
GS2 ← Government support	0.856
LOS1 ← Lack of skills	0.836
LOS2 ← Lack of skills	0.846
LOS3 ← Lack of skills	0.755
SI1 ← Social identity	0.871
SI2 ← Social identity	0.911
SI3 ← Social identity	0.896
SI4 ← Social identity	0.862

Table 5 presents loadings for various constructs in a study on e-commerce and related factors, highlighting the strength of relationships between specific items and their associated latent variables. Items under the Complexity construct—COM1, COM2, and COM3—demonstrate significant contributions, particularly COM2 and COM3 with loadings above 0.9. For Digital Environmental Change, DCNG1 shows the highest loading at 0.866. E-commerce awareness is strongly represented by EA1 and EA2, with EA2 having an exceptionally strong loading of 0.953. E-commerce adoption is robustly measured by ECMADP1 and ECMADP2, with ECMADP2 reflecting a very strong relationship at 0.938. Items ECT1, ECT2, and ECT3 under e-commerce training also show substantial contributions. Similarly, government support items GS1 and GS2, and lack of skills items LOS1, LOS2, and LOS3 indicate effective measurement. Social identity is distinctly captured by SI1 through SI4, notably SI2 at 0.911, underscoring strong associations and validity within the constructs.

#### Variance inflation factor (VIF)

**Table 6.** VIF

	VIF
Complexity → E-commerce adoption	3.601
Complexity → Social identity	3.354
Digital environmental change → E-commerce adoption	1.483
Digital environmental change → Social identity	1.375
E-commerce awareness → E-commerce adoption	1.068
E-commerce awareness → Social identity	1.056
E-commerce training → E-commerce adoption	1.723
E-commerce training → Social identity	1.613
Government support → E-commerce adoption	2.607
Government support → Social identity	2.581
Lack of skills → E-commerce adoption	1.457
Lack of skills → Social identity	1.403
Social identity → E-commerce adoption	2.464

Table 6 displays VIF values for various predictor variables within a regression model analysing e-commerce



adoption intensity and related factors. VIF is used to assess multicollinearity among predictors in a regression model, with values above 5 generally indicating high multicollinearity. In this table, the highest VIF is 3.601 for complexity's impact on e-commerce adoption intensity, suggesting moderate multicollinearity. Other notable VIF values include complexity affecting social identity at 3.354 and Government Support on e-commerce adoption at 2.607, indicating some degree of correlation but below problematic levels. Relationships such as digital environmental change and e-commerce awareness towards e-commerce adoption and social identity show VIF values well below 2, pointing to minimal multicollinearity. This suggests that the predictors provide relatively independent information, supporting the robustness of the regression analysis in this study context.

#### Direct effects

Table 7 outlines the direct effects of various predictors on e-commerce adoption and social identity, highlighting significant relationships using t-statistics and *p* values. Complexity significantly influences social identity (0.317;  $p < 0.001$ ) but not e-commerce adoption. Digital environmental change positively affects social identity (0.209;  $p < 0.001$ ), without significantly impacting adoption. E-commerce awareness notably boosts both adoption (0.249;  $p < 0.001$ ) and social identity (0.072;  $p = 0.003$ ). E-commerce training also positively impacts adoption (0.128;  $p = 0.007$ ) and social identity (0.211;  $p < 0.001$ ). Government Support is significant for adoption (0.269;  $p < 0.001$ ) and moderate for Social identity (0.102;  $p = 0.030$ ). Lack of Skills has a negative effect on adoption ( $-0.172$ ;  $p < 0.001$ ) and a positive one on social identity (0.147;  $p < 0.001$ ). Social identity itself positively influences adoption (0.209;  $p < 0.001$ ), indicating that social factors drive adoption behaviours as well. These findings demonstrate the complex interactions between individual, social, and environmental factors in the context of e-commerce.

**Table 7.** Direct effects

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ( O/STDEV )	<i>p</i> values
Complexity → E-commerce adoption	-0.020	-0.023	0.063	0.312	0.755
Complexity → Social identity	0.317	0.317	0.060	5.306	0.000
Digital environmental change → E-commerce adoption	-0.048	-0.049	0.039	1.227	0.220
Digital environmental change → Social identity	0.209	0.210	0.046	4.530	0.000
E-commerce awareness → E-commerce adoption	0.249	0.248	0.034	7.374	0.000
E-commerce awareness → Social identity	0.072	0.071	0.024	3.011	0.003
E-commerce training → E-commerce adoption	0.128	0.130	0.048	2.678	0.007
E-commerce training → Social identity	0.211	0.210	0.044	4.828	0.000
Government support → E-commerce adoption	0.269	0.270	0.051	5.217	0.000
Government support → Social identity	0.102	0.103	0.047	2.165	0.030
Lack of skills → E-commerce adoption	-0.172	-0.173	0.042	4.060	0.000
Lack of skills → Social identity	0.147	0.148	0.042	3.545	0.000
Social identity → E-commerce adoption	0.209	0.211	0.052	4.002	0.000

#### Indirect effects

**Table 8.** Indirect effect

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ( O/STDEV )	<i>p</i> values
Government support → Social identity → E-com Adoption	0.021	0.022	0.011	1.886	0.059
Lack of skills → Social identity → E-com Adoption	0.031	0.031	0.012	2.529	0.011
Complexity → Social identity → E-com Adoption	0.066	0.067	0.021	3.099	0.002
Digital environmental change → Social identity → E-com Adoption	0.044	0.044	0.015	2.895	0.004
E-commerce Awareness → Social identity → E-com Adoption	0.015	0.015	0.007	2.233	0.026
E-commerce training → Social identity → E-com Adoption	0.044	0.044	0.014	3.126	0.002

Table 8 provides a summary of the indirect effects of various predictors on e-commerce adoption mediated through social identity, using original sample values, sample means, standard deviations, t-statistics, and  $p$  values. Notably, complexity through social identity to e-commerce adoption shows a significant effect (0.066;  $p = 0.002$ ). Digital environmental change also demonstrates a significant indirect impact on adoption via social identity (0.044;  $p = 0.004$ ). Both e-commerce awareness and e-commerce training influence e-commerce adoption through social identity, with respective  $p$  values of 0.026 and 0.002, indicating their significant roles as mediators. Lack of Skills in social identity and then e-commerce adoption yields a significant indirect effect (0.031;  $p = 0.011$ ). However, Government Support's indirect effect via social identity on adoption approaches significance (0.021;  $p = 0.059$ ), suggesting a potential but less pronounced impact.

## Model

In Figure 2, some relationships between several constructs concerning e-commerce adoption using path coefficients and significance levels. They evaluated the impact of constructs: Complexity, e-commerce awareness, e-commerce training, government support, digital environmental changes, and lack of skills in social identity and e-commerce adoption. Specifically, social identity highly mediates the effects of other constructs on e-commerce adoption. For example, e-commerce training and awareness promote its adoption via social identity. Indirect effects include the marginal importance of government support on adoption, while direct effects include government support's small effect on adoption. This structural model also explained the interplay between the individual skills, awareness, environmental changes and support structures involved in e-commerce.

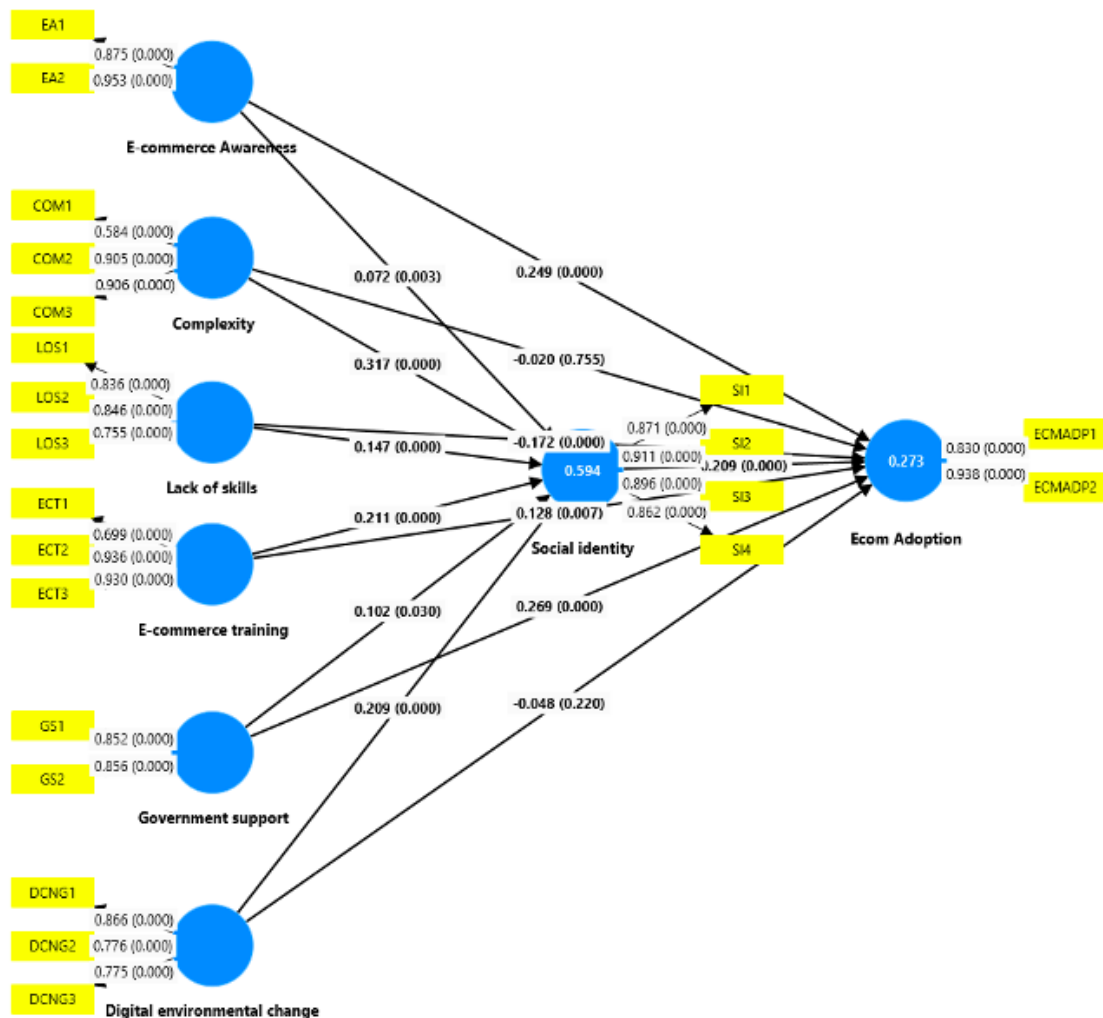
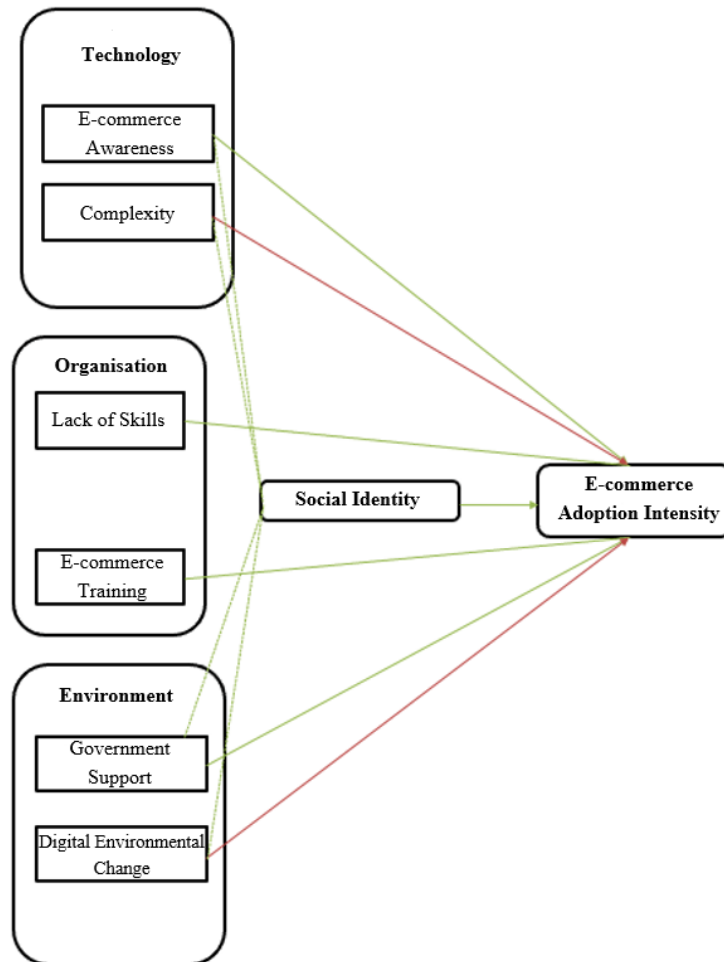


Figure 2. Pathway model



**Figure 3.** Conceptual framework

Figure 3 represented the conceptual framework, which represented the accepted and rejected hypotheses through coloured lines, as the green shows the accepted ones and the red one shows the rejected hypotheses.

### Hypothesis table

**Table 9.** Hypotheses table

Hypothesis	Status
H1.1: E-commerce awareness positively influences e-commerce adoption intensity	Accepted
H2.1: Complexity negatively impacted e-commerce adoption intensity	Rejected
H3.1: Lack of skills negatively impacted e-commerce adoption intensity	Accepted
H4.1: E-commerce training positively influences e-commerce adoption intensity	Accepted
H5.1: Government support positively influences e-commerce adoption intensity	Accepted
H6.1: Digital environmental change positively influences e-commerce adoption intensity	Rejected
H1.2: E-commerce awareness positively influences social identity.	Accepted
H2.2: Complexity negatively impacted social identity	Accepted
H3.2: Lack of skills negatively impacted on social identity	Accepted
H4.2: E-commerce training positively impacted the social identity	Accepted
H5.2: Government support positively impacted the social identity	Accepted
H6.2: Digital environmental change is positively related to social identity	Accepted
H7: Social identity positively influences e-commerce adoption intensity	Accepted
H8: E-commerce awareness influences e-commerce adoption intensity through social identity	Accepted
H9: Complexity influences e-commerce adoption intensity through social identity	Accepted
H10: Lack of skills influences e-commerce adoption intensity through social identity	Accepted
H11: E-commerce training influences e-commerce adoption intensity through social identity	Accepted
H12: Government support influences e-commerce adoption intensity through social identity	Accepted
H13: Digital environmental change influences e-commerce adoption intensity through social identity	Accepted

Table 9 shows the status (accepted or rejected) of a series of hypotheses concerning the influencing factors of e-commerce adoption intensity and social identity.

## 8. Discussion

The TOE model includes some key factors of Technology, Organisation and Environment, which impact the e-commerce adoption intensity process. The factors of the TOE model are developed with the combination of sub-factors. Firstly, the findings of this study identified that e-commerce awareness, lack of skill, e-commerce training and government support skills have a positive impact on the e-commerce adoption intensity process. However, the factor of lack of skill negatively impacted the e-commerce adoption intensity process and there is no impact of digital environmental change on it. Past studies also highlighted that consciousness about a concept increases along with the level of awareness (Najafi, 2012). Moreover, the complex structure of the e-commerce platforms impacted users (Morepje et al., 2024). Making regular practice of e-commerce platforms may help to adopt it, which reduce the complexity of this process. Conversely, the lack of ability to use internet platforms also hampers the adaptability process (Ariansyah et al., 2021); thus, the primary result of the study and the findings of past studies show similarities between them. Moreover, the presence of proper training facilities (Irasuti & Bachtiar, 2024) and support from governing organisations helps in the innovation management practice through the promotion of research and development activities (Kim et al., 2016). The primary result of the study also highlighted that both factors are equally important for the adoption of e-commerce platforms. However, Galhotra and Dewan (2020) have stated that the digital environment shows a change and helps in the promotion of business value; which is also identified in the primary result of the study. Therefore, the result of the study shows similarity with the findings of past studies, which express the effectiveness of the result which can help to improve the e-commerce adoption process in the Shanxi Province of China.

Additionally, H2.1 represented the relationship between complexity and adoption intensity, which was rejected and H6.1 was also rejected, which represented positive relationship between digital environmental change and adoption intensity. The presence of social support avoids the negative role of complexity during the learning activity (Weerapperuma et al., 2025). Moreover, the external pressure may raise along with the adoption intensity of digital environment, which may impact the personal decision-making process. Yoon (2023) represented that individual readiness and organisational support is also connected with a new technology adoption intensity process. Therefore, the e-commerce adoption intensity process is related to the complexity and external digital pressure. H2.1 and H6.1 are rejected, meaning that complexity and change to digital environment are not directly influencing e-commerce adoption but influence indirectly, through social identity. This implies complete mediation in which farmers feeling of belonging and identification with peer groups is the main channel through which contextual factors are converted into adoption behaviour. Zhao et al. (2022) stated that identity mediates the emotional condition, while the direct effects become non-significant during direct effect. Therefore, the results show a significant effect.

Secondly, the factors of the TOE model also impact the social identity of farmers. The relation between the sub-factors of the TOE model and social identity is accepted. Conversely, the factors of complexity and lack of skills show a lower level of impact. Past studies also expressed that e-commerce websites highlighted the identity of a user, though the presence of complexity impacts the social presence of the user (Chen et al., 2019). The primary result of the study shows some variation, as it indicates a poor impact of complexity; thus, the result of the study represents some uniqueness regarding the concept of e-commerce adoption. Therefore, farmers facing technological issues try to get help from a peer group, which reduces their anxiety level. Shared norms enhance the confidence level as collective identity promotes behavioural changes despite the presence of complexity. Similarly, Ariansyah et al. (2021) stated that the lack of skill regarding the use of use of internet platforms hampers the social identity of an individual on media platforms. The current study shows that lack of skills also has a lower level of impact as getting proper training will help an individual to express their presence on social sites.

Thirdly, the mediating effect of social identity is identified in this study, which represents that technology, organisation, and environment - all impact e-commerce adoption through the mediating effect of social identity. Past studies also highlighted the mediating impact of social identity along with its individual impact on e-commerce adoption. According to Kuo and Hou (2017), social identity helps in the development of brand communication practices through online platforms, which helps in the adoption of e-commerce platforms. Moreover, Grimalda et al. (2018) identified the mediating effect of social identity, which connect different variable factors. Therefore, the result of the current study shows similarity with the findings of past evidence, which represents the effectiveness of current findings.

## 9. Conclusion

This research will contribute to the knowledge of adopting e-commerce in agriculture by combining the TOE framework with SIT. In contrast to the previous studies, which tested these factors individually, the results indicate

that social identity is one of the mediators, and the reason why some barriers like complexity, continue to influence adoption intensity indirectly. Such a theoretical input enhances adoption intensity literature, through demonstrating how collective belonging and peer pressure turn challenges into a chance of engaging with digital participation. Practically, the findings indicate that not only technical literacy but also group-based learning should be developed in skill development, and training of the farmers since peer networks of support improve confidence and anxiety. The policy makers in Shanxi and other rural areas need to intensify the digital cooperatives, offer specific training programs, and develop non-discriminatory platforms that can use the sense of community identity. The government support should not be restricted to infrastructure but activities that will develop trust and common norms among farmers.

However, the current study has undertaken a quantitative method which collects numerical insights. Therefore, this study lacks qualitative insights, which limits the detailed insights of the participants. Moreover, this study is only limited to the Shanxi Province of China, thus, the findings cannot be generalised to other geographical locations. Henceforth, future studies can be done by undertaking the qualitative method through interviews to collect participant's detailed views. Moreover, studying other geographical regions, such as Asian countries (India and Japan) or African countries can help to analyse the e-commerce adoption intensity process through the impact of social identity.

### Author Contributions

Conceptualization: W.L.; Methodology: W.L, O.I.; Data Collection: W.L.; Data Analysis: W.L, O.I.; Writing - Original Draft Preparation: W.L.; Writing - Review and Editing: W.L, O.I.; Visualization: W.L, O.I.; Supervision: O.I. All authors have read and agreed to the published version of the manuscript.

### Data Availability

The data used to support the research findings are available from the corresponding author upon request.

### Conflicts of Interest

The authors declare no conflict of interest.

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## Appendix

**Appendix 1.** Measurement table

Variable	Measurement	Source
E-commerce Awareness	Awareness of e-commerce platforms for agriculture	Chen et al. (2020); Nurunnisha & Dalimunthe (2018); Zhao & Tian (2014)
	Farmer's understanding of the benefits of e-commerce in agriculture	
	Perceived ease of use of agricultural e-commerce systems	
	Willingness to adopt based on perceived market reach	
Complexity	The use of e-commerce technology require lot of mental effort	Yoon et al. (2020)
	The adoption of e-commerce is frustrating	
	The use of e-commerce is complex for farmers	
	The skill needed to adopt e-commerce is complex	
Lack of skills	Farmers does not have technical capability to adopt e-commerce	Yoon et al. (2020)
	Farmers have a little information about the adoption of e-commerce	
E-commerce training	Training on e-commerce systems for agriculture	Dey & Shekhawat (2021); Hu (2016); Zhao & Tian (2014)
	Perception of training quality for adopting digital sales systems	
Government support	Government provides various support to farmers	Yoon et al. (2020)
	Government encourages farmers to adopt e-commerce platforms	
Digital environmental change	Government support various project in the adoption of e-commerce in farming	Yoon et al. (2020)
	E-commerce platforms are become trends of the time	
	Internet platforms are actively discussed in farming	
	In today's farming and agricultural sector e-commerce platform is an essential survival technique	
Social Identity	I find easy to bond with others in the adoption of e-commerce	Bruner & Benson (2018)
	I feel good in a team while adopting e-commerce	
	I feel strong ties with others in a team during the adopting e-commerce	
	I feel a sense of connection through the use of e-commerce platforms	