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DO BANGLADESHI FOOD AND BEVERAGE ENTREPRENEUR INTEND TO ADOPT THE ADVANCED LEVEL OF IR 4.0 TECHNOLOGY IN MANUFACTURING OPERATIONS?

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Abstract
The performance of SME enterprises will drive the country's economy forward. Upgrading the technologies currently used in SMEs will enhance the manufacturing process of the food and beverage (F&B) industries. Those firms are still using traditional equipment and machinery in their F&B manufacturing process; however, they are required to adopt the next level of technologies for maximum productivity, which they cannot afford. Thus, the study focuses on the intention to adopt upgraded technologies in F&B SMEs in developing countries. A total of 230 F&B SME owners and top management were surveyed in Bangladesh. The collected data were analysed using PLS-SEM with SmartPLS software. The results showed that disaster preparedness and business continuity were significant in influencing the intention to adopt; similarly, performance expectancy, effort expectancy, and social influence were also significant in influencing the intention to adopt the next level of IR technologies. The moderating role of government support and policy has mixed effects on intention. The study is significant because disaster preparedness and business continuity plans are utilised in technology adoption and intention scenarios. For the investigation of this intention, the study adopted two perspectives: the invasion and role of disasters and hazards on SMEs through disaster preparedness and business continuity plans, and secondly, the unified theory of acceptance and usage of technology (UTAUT) for measuring the intention. The study contributed to these two theories in a new context, utilising specific constructs. The study will also contribute to policymakers in the government in developing constructive policies and effective financial and non-financial support for F&B manufacturing SMEs.

Keywords
Adoption Intention, Bangladesh, Business Continuity, Disaster Preparedness, F&B Manufacturing SMEs, Government Support and Policy, IT technology, UTAUT Model;

INTRODUCTION

Small and Medium Enterprises (SMEs) of any country are the key driving force (Erdin & Ozkaya, 2020; Xin et al., 2023). Among SME Manufacturing firms, food and beverage (F&B) manufacturing firms make a significant contribution to the economy (X. Chen & Voigt, 2020). According to the World Bank (2023) report, around 40% of the contribution comes from a formal SME in an emerging economy. As the highest contributor, new and updated technologies are being widely used in the F&B sector. This adoption sometimes ensures better SME performance, maximising profit and profitability. Different names have been used in various ages to describe this advanced technology. Industry revolution (IR) refers to the application of cutting-edge technology in business models (Butt et al., 2020; Wei & Pardo, 2022). Rakshit et al. (2022) and Smith et al. (2022) stated that SMEs are a driving force for the flourishing of the national economy, similar to large industries. It is noticeable that the cutting-edge technologies used in the F&B manufacturing industry are costly, which can sometimes be a burden for small firms. Bilan et al. (2020), Bruce et al. (2023), and Indrawati (2020) noted that small and medium-sized firms often struggle to afford advanced technologies due to a lack of capital, manpower, and operational efficiencies. An enterprise adopts and uses the state-of-the-art technology or modern equipment according to its capabilities and affordability (financial and non-financial capacities and affordability) (Zhang et al., 2022). However, many small and medium F&B firms make an effort to use advanced technologies, whereas other significant portions are still using older versions and indigenous technology. This scenario is primarily found in the least developed countries (LDCs) and developing countries (Sundaram & Zeid, 2023).

Bangladesh is a developing country. In the event of overpopulation and a high demand for food, as well as food shortages, SMEs can play a significant role. Besides the Bangladeshi government, SME firms have taken efforts to maximise production and meet local demand. A large number of SMEs play a crucial role in driving Bangladesh's economic growth. Therefore, developing this sector through increased production is essential. To achieve higher production efficiency, the adoption of technology is indispensable. However, many food and beverage SMEs may find it challenging to implement the latest technologies immediately. In such cases, a gradual approach to technological adoption could be more practical. This means that these SMEs can progressively upgrade their current systems by incorporating more advanced technologies in their production, packaging, and transportation processes.

Entrepreneurs' age and their business experience are also essential factors that can influence an entrepreneur's perception and decision-making processes (Hossain et al., 2024). The intention to adopt new technologies in food and beverage manufacturing SMEs may depend on several factors, including perceived performance, ease of use, and reliability. Various theoretical frameworks have identified and validated these constructs. In particular, the Unified Theory of Acceptance and Use of Technology (UTAUT) highlights three key influencing factors: performance expectancy, effort expectancy, and social influence. Previous studies have emphasised the significant roles of these factors in determining the adoption of new or upgraded technologies (Alwadain et al., 2024; Ayaz & Yanartaş, 2020a; Blut et al., 2021). In the context of this study, the business continuity plan also considers aspects of disaster preparedness and overall business resilience.

This study aims to address the following research questions: whether small and insolvent food and beverage (F&B) manufacturing SMEs are interested in adopting advanced technologies that are more sophisticated than those they currently use, and whether their age, experience, and gender should be considered in this context. Answering these questions, this research focuses on the intention of small and medium-sized firms to adopt advanced technologies that are more competitive than those they currently use. Manufacturing operations. This indicates whether these firms are inclined to adopt their next level of technology over the presently used ones, such as manual or traditional mechanisms in their production, light machinery, IR technology 2.0, or using IR3.0 over IR2.0 or IR4.0 in their manufacturing operations. Existing literature indicates a scarcity of research examining firms' intentions to progress toward the next level of technological adoption (Meng et al., 2021). To the best of the researcher's knowledge, no research has been conducted on the intention of food and beverage SMEs to adopt next-level technologies in manufacturing food and beverages in the Bangladeshi context.

The current study is grounded in a literature review, theoretical foundation, hypothesis development, method and materials, data analysis, and findings, as well as a relevant discussion of the findings. The study concludes with recommendations, implications, and future direction.

LITERATURE REVIEW

Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) is widely used to explain the adoption of new or upgraded technologies in business. Venkatesh et al. (2003), the pioneers, recommended that UTAUT improve the technological adoption framework (Venkatesh et al., 2003). This model comprises four constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions (Popova & Zagulova, 2022; Tewari et al., 2023). This model examines the identification of skills and competencies, as well as customised training, to determine whether these predictors of actual technology use are visible or logical (Batucan et al., 2022). These theories-Innovation Diffusion Theory, Model of PC Utilisation (MPCU), Motivational Model (MM), Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB), and Theory of Reasoned Action (TRA) are combinedly used in the UTAUT model. There are generally three types of extensions or integrations used to examine the UTAUT model in new contexts. These include studies focusing on new technologies, such as collaborative platforms and health information systems (Akinnuwesi et al., 2022); new user populations, such as healthcare professionals and consumers (Tamilmani et al., 2021); and new cultural contexts, including countries like China, India, and those in the Middle East (M. Chen et al., 2021).

Hypothesis Development

This section discusses empirical studies that demonstrate the relationship between variables, providing theoretical support for the research framework.

Performance expectancy and intention to adopt next-level technologies.

Performance expectancy refers to the performance of technology or devices, specifically how efficiently they work. Upadhyay et al. (2021) stated that firms expect new technology to deliver time savings, ease, and efficiency. The understanding is that new technology will increase the outcome and effect (Chen et al., 2021). In their studies, Chen et al. (2021) and Jadil et al. (2021) found that the performance of a technology, device, or app is an active component that influences how a firm perceives and intends to use it. Many researchers have looked into the impact of performance expectancy on behavioural intention to adopt new technological arrangements, including Habib and Hamadneh (2021), Khan et al. (2021), Budi et al. (2021), Tewari et al. (2023), Tamilmani et al. (2021), and Jadil et al. (2021). (Akinnuwesi et al., 2022) suggested the behaviour and purpose of adopting new technologies. Specifically, in the F&B sector, IR technologies can enhance performance through quality control, waste reduction, inventory optimisation, and production efficiency. Performance expectancy in this setting is not just about subjective perception; measurable improvements in business processes reinforce it.

H1: Performance expectancy has a significant effect on the intention to adopt next-level technologies.

Effort Expectancy and Intention to Adopt Next-Level Technologies.

According to Abushakra and Nikbin (2019), business owners are unlikely to adopt IoT technology.

Effort expectancy is a key construct of the Unified Theory of Acceptance and Use of Technology (UTAUT), reflecting the perceived ease of using a technology or system (Venkatesh et al., 2003). Within the context of Industry Revolution (IR) technologies, this refers to how SME owners and employees perceive the complexity or user-friendliness of tools like automated production systems, real-time monitoring platforms, and AI-powered decision support systems. The logic is that when users expect minimal effort to learn and use these technologies, their intention to adopt them increases. Numerous studies have investigated this relationship, yielding varying results. Blut et al. (2021) and Sánchez et al. (2021) observed that technologies perceived as easy to use increase the likelihood of adoption in contexts such as education and digital services. Similarly, Yein and Pal (2021) confirmed a positive relationship between effort expectancy and the adoption of mobile learning. However, this relationship appears to be highly contextual and dependent on the users' familiarity with technology.

H2: Effort expectancy has a significant effect on the intention to adopt next level technologies.

Social Influences and Intention to Adopt Next-Generation Technologies.
Social influence (SI) is a critical construct within the UTAUT model and is frequently cited as a significant factor in shaping the behavioural intention to adopt new technologies (Venkatesh et al., 2003). It reflects the extent to which individuals or organisations perceive that essential others, such as colleagues, competitors, regulators, or even family members, believe they should adopt a particular technology. In the context of IR technologies for F&B SMEs in Bangladesh, this includes peer entrepreneurs, industry associations, and governmental bodies encouraging the use of automation, IoT, or AI-driven tools to modernise production and ensure food safety. Chang et al. (2019) emphasised that social influence arises not just from direct stakeholders but also from broader social constructs, including social media, community norms, and public policy campaigns. Given that Bangladeshi F&B SMEs operate within a business environment that values social validation and peer engagement and considering that government and non-governmental actors actively promote Industry 4.0 technologies, this research posits social influence as a key driver in the decision-making process. Therefore, the following hypothesis is proposed:
H3: Social influence has a significant effect on the intention to adopt next-level technologies.

Facilitating Conditions and Intention to Adopt Next-Level Technology
Facilitating conditions refer to the degree to which individuals or organisations believe that sufficient infrastructure, resources, and external support are available to aid in the adoption of new technologies (Popova & Zagulova, 2022). Within the Unified Theory of Acceptance and Use of Technology (UTAUT), facilitating conditions are considered crucial elements that enable actual technology usage, particularly in terms of resource accessibility, institutional support, and training systems (Tewari et al., 2023). In the context of Industry Revolution (IR) technology adoption in SMEs, especially those operating within resource-constrained environments, such as the Bangladeshi food and beverage (F&B) sector, facilitating conditions become even more vital. Entrepreneurs and SME owners often rely heavily on institutional infrastructure, technological readiness, and policy support to effectively implement IR technologies. This includes access to high-speed internet, affordable automation tools, industry-specific training programs, and advisory services that reduce technological ambiguity (Ivanova & Kim, 2022). The presence of these conditions positively influences an entrepreneur's behavioural intention to adopt IR technologies, as the perception of available support reduces the perceived complexity and risk of implementation (Pasaribu, 2022; Osei et al., 2022).
H4: Facilitating conditions have a significant effect on the intention to adopt next-level technologies.

Moderating Role of the Entrepreneur's Gender, Age, and Experience.
The moderating role of gender in the adoption of technology has been well investigated from various perspectives, including new mobile adoption, online class adoption, new EV car adoption, new medical instrument adoption, e-commerce and m-commerce adoption, and others. However, a minimal number of studies have been conducted on the moderating effect of gender in the event of next-level technologies in SMEs. Previous investigations have shown that males are more likely to accept new technology than females (Venkatesh et al. 2003). Research indicates that male users tend to demonstrate greater confidence in adopting and engaging with emerging technologies, likely due to their broader exposure to technology in the workplace. In contrast, female users generally exhibit slower adoption and lower usage levels of new technologies, which has been associated with comparatively lower self-confidence in their technological capabilities (Kimbrough et al. 2013). Interestingly, Yang's (2005) exploratory study found that gender differences influence perceptions of usefulness and perceived ease of use, contrary to what was previously assumed (Megdadi & Nusair, 2011). "Ease of use" refers to the extent to which an individual believes that utilising a specific system will enhance their job performance.
Accordingly, Venkatesh et al. (2003) posited that gender plays a vital role in moderating the relationships between the constructive psychological elements of UTAUT and the intention to use technology. Hence, individuals develop different values based on gender differences, leading to variations in their ethical and value preferences (Yang 2005; Barba & Iraizoz 2020). The existing research

has demonstrated that gender has a moderating effect on the relationships among the constructs, including Performance Expectancy, Effort Expectancy, and social influence (Okazaki and Mendez 2013; Cheng et al. 2011). Among these relationships, males have shown the most potent effects associated with performance expectancy, whereas women have shown the most substantial impact regarding effort expectancy and social influence (Chong et al., 2012; Al-Dalahmeh et al., 2021; Prasanna et al., 2021). Prior research suggests that gender can moderate the key relationships within the UTAUT model (Venkatesh et al., 2003), as individuals tend to form different value orientations based on their gender (Yang, 2005; Barba & Iraizoz, 2020). Studies have reported that men are more strongly influenced by performance expectancy, whereas women are more affected by effort expectancy and social influence (Chong et al., 2012; Al-Dalahmeh et al., 2021; Prasanna et al., 2021), supporting earlier findings (Okazaki & Mendez, 2013; Cheng et al., 2011). However, evidence also shows that gender differences in technology acceptance have been declining as technology becomes more widely diffused (Khechine et al. 2014). For example, no significant gender differences were observed in mobile shopping behaviour (Bigné et al. 2007) or m-commerce usage in SMEs (Lip-Sam and Hock-Eam 2011), suggesting that men and women may now demonstrate similar perceptions and satisfaction levels (Yol et al. 2006). In addition, awareness has been highlighted as a critical factor for improving ethical standards and driving technology adoption (Lip-Sam and Hock-Eam 2011). Yet, low levels of public awareness continue to constrain the uptake of new mobile technologies in developing economies (Wan et al. 2012). For instance, the limited adoption of 4.5G has been attributed to insufficient user knowledge of its benefits (Yaqub et al., 2013), although this effect has not been empirically examined within the context of the UTAUT framework. Thus, the present study investigates awareness as a moderating variable linking performance expectancy, effort expectancy, social influence, and behavioural intention to adopt upgraded technology in SMEs.

Age influenced the impact of performance expectancy on behavioural intention. This argument is supported by Ahamed et al. (2024) and Hu et al. (2024) in their research. According to earlier UTAUT investigations, age has a moderating effect on the association between performance expectancy and adoption intention (Mariani et al., 2021). Men are more task-focused, productive, and effective than women, especially younger men (Lai & Stacchezzini, 2021). Therefore, younger men are more inclined to accept technology when they feel that next-level technologies will enhance their ability to accomplish their jobs. Using new word processing software, Maritz et al. (2021) evaluated 107 MBA students and found that experience mitigated the impact of effort expectation on behavioural intention. There is a claim that becoming older has a detrimental moderating impact on effort expectancy. It is more difficult for older individuals to comprehend complex inputs and concentrate attention while working, which makes it more difficult for them to master new technologies (Guerola-Navarro et al., 2022). Therefore, the following hypothesis was proposed:

Experience is expected to moderate the relationship between social influence and the inclination to adopt new technologies. According to Ho et al. (2022), a person's frame of reference may be shaped by their experience with technology. Individuals with minimal technological experience tend to conform more readily to social pressure, whereas users with high levels of expertise are less sensitive to others' judgments. In a separate investigation, Karadžić & Ristić (2022) examined people's experiences with personal computers and found that these experiences had a moderating effect on the association between social influence and behavioural intention. The moderating effects of experience on the relationship between social influence and behavioural intention were also significantly observed by Guerola-Navarro et al. (2022). Thus, the following hypothesis was created:

The significance of UTAUT was emphasised by Akinnuwesi et al. (2022). It is simple to comprehend that customers have developed a consumption pattern before their real consumption behaviour. However, the design of a new technology that boosts consumer interest may now be what draws users to adopt and utilise it. Numerous studies have demonstrated that a consumer's age and experience influence their hedonic motivation and behavioural intention, thereby affecting their usage behaviour (Arfi et al., 2021; Ayaz & Yanartaş, 2020b; Budi et al., 2021; Merhi et al., 2019). They predicted that experience and age would moderate the effects of UTAUT. Thus, the study formulated the following hypothesis:

H5a1-3: Gender, age, and experience have a moderating effect on the relationship between performance expectancy and intention to adopt next-level technologies.

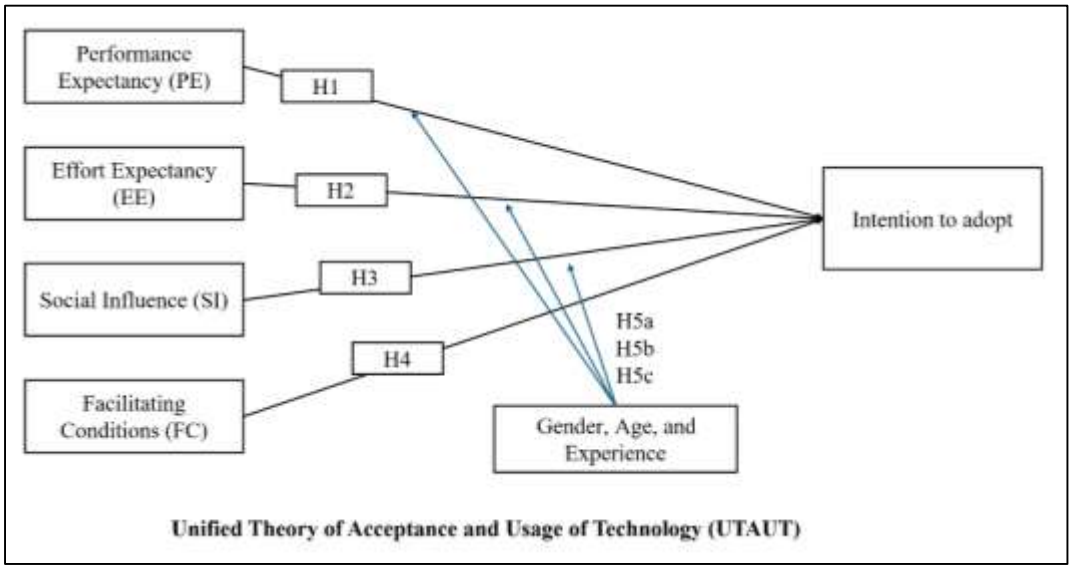
H5b1-3: Gender, age, and experience have a moderating effect on the relationship between effort expectancy and intention to adopt next-level technologies.

H5c1-3: Gender, age, and experience have a moderating effect on the relationship between effort expectancy and intention to adopt next-level technologies.

Proposed Theoretical Model

The study proposed the following research model, which explains the factors affecting the intention to adopt the next level of technologies for SMEs in Bangladesh compared to the current level of usage. This study's framework is conceptualised based on the UTUAT Model (**Error! Reference source not found.**).

Figure 1. Research framework



MATERIALS AND METHODS

Population and Sample

This study focused on small and medium-sized food and beverage manufacturing companies in Bangladesh. For this cross-sectional study, Dhaka city and its surrounding suburban areas were selected because approximately 32% of all SMEs in the country are located in these areas. The researcher obtained lists of F&B SMEs from various organisations, including the SME Foundation (SMEF), Bangladesh Agro-Processing Association (BAPA), and Bangladesh Standard and Testing Institute (BSTI). These lists were all separate and did not overlap with each other.

Sample Size and Its Determination Techniques

There are several methods for determining the sample size. When using structural equation modelling (SEM), variable-based or indicator-based approaches are widely employed. Among them, the number of samples is determined by multiplying the variable number by 20 times. Many scholars use a simple approach, such as the "rule of 5" or "rule of 10," where normal data distribution exists, as this study used SEM with the help of partial least squares SEM (PLS-SEM) SmartPLS-4, where data normality is handled efficiently. Thus, the rules of '5' and '10' are a good choice (Hunziker & Blankenagel, 2021). Considering the above criteria of constructs and their items, as well as the cases ratio (Bell et al., 2019; Rosenstein, 2019), this research attempts to investigate five (5) primary constructs and three moderating constructs. The total number of indicators in the model is 28. Therefore, the minimum required sample

size is 140 (i.e., 28 x 5 = 140), and the maximum number of samples is 280 (i.e., 28 x 10 = 280). Based on this criterion, 230 respondents are considered to be the representative sample.

Research Instrument

The five-point Likert scale was employed in the current study, as it is the most widely used scale in many fields, although it originated in the fields of psychology and social sciences (Martino et al., 2018). Five scores were given for 'strongly agree', four for 'agree', three for 'neutral', two for 'disagree', and one for 'strongly disagree' answers.

Data Collection and Field Work

The study utilised five data enumerators with expertise in data collection and survey administration. These enumerators are under the direct supervision of the researcher. In the paper list of respondents, they are contacted at their formal business address or registered business address with contact numbers. After confirming the appointment, the enumerators first visited the respective managers, owners, or CEOs at a specific time and date. They explained the purpose of the study, the process, and the final use of the data. When they agreed to participate in the survey, a hard copy of the questionnaire was provided for them to fill out.

FINDINGS

Demographic Profile

As mentioned earlier, data was gathered using a structured questionnaire. In terms of demographics, most respondents were male (96%, n = 221), and only a small number were female (3%, n = 7). This suggests that in Bangladesh, manufacturing industries are predominantly led by men. For age groups, approximately 43% of respondents were between 31 and 40 years old, and 30% were between 41 and 50 years old. Around 20% were young entrepreneurs in the 21–30 age group.

Regarding education level, most respondents held a bachelor's degree (42%), while 30% had completed higher secondary school. A large portion (72%) of respondents were business owners, proprietors, or directors. In terms of business category, 85% of the firms were in the food manufacturing sector, and 9% were in the beverage manufacturing sector.

For annual revenue, 38% of enterprises earned between BDT 10–50 lakh per year, 25% earned between BDT 50 lakh–1 crore, and 23% earned between BDT 5–10 lakh per year.

Looking at employment, 82% of the enterprises had 5–74 permanent employees, and 61% had 5–74 temporary employees. For business age, enterprises were diverse: some were new (less than 2 years), about 19% were under 5 years old, 32% had operated for less than 10 years (the highest), and 20% had been operating for over 25 years.

In terms of the respondents' own experience, 44% had 6–10 years of experience, 21% had 11–15 years, and 20% had less than 5 years of experience. This mix of experience suggests that many of these individuals may be capable of understanding and adopting advanced technologies in the future.

Inferential Statistics

Structural Equation Model and PLS-SEM Usage.

Hair et al. (2021) noted that PLS-SEM can handle both formative and reflective indicators. Additionally, this study employs the SEM technique because it helps produce results that can be generalised.

Hypothesis testing with Structural Equation Modeling (SEM).

SEM is based on two core models: the Measurement Model and the Structural Model.

Measurement Model Assessment

Reliability in measurement is usually examined in terms of stability and internal consistency. In this study, reliability was assessed using factor loadings, Cronbach's alpha, composite reliability, and the average variance extracted (AVE). Ensuring strong reliability helps produce findings that are valid and trustworthy, which in turn strengthens the study's credibility and overall generalizability (Kieser, 2020). For factor loadings, Cronbach's alpha, and composite reliability, values above 0.708 are considered acceptable.

Table 1. Summary Measurement Model Analysis

Variable	Items	Loading	CA	rho_A	CR	AVE
Intention to adopt	IA1	0.754	0.820	0.825	0.881	0.650
Next Level Technologies	IA2	0.820				
	IA3	0.830				
	IA4	0.817				
Performance Expectancy	PE1	0.750	0.811	0.819	0.876	0.639
	PE2	0.863				
	PE3	0.779				
	PE4	0.801				
Effort Expectancy	EE1	0.756	0.812	0.819	0.876	0.639
	EE2	0.847				
	EE3	0.808				
	EE4	0.785				
Social Influence	SI1	0.857	0.830	0.848	0.886	0.662
	SI3	0.738				
	SI4	0.858				
	SI5	0.796				
Facilitating Condition	FC1	0.844	0.888	0.900	0.914	0.640
	FC2	0.725				
	FC3	0.759				
	FC4	0.862				
	FC5	0.799				
	FC6	0.802				

Figure 2. Measurement model

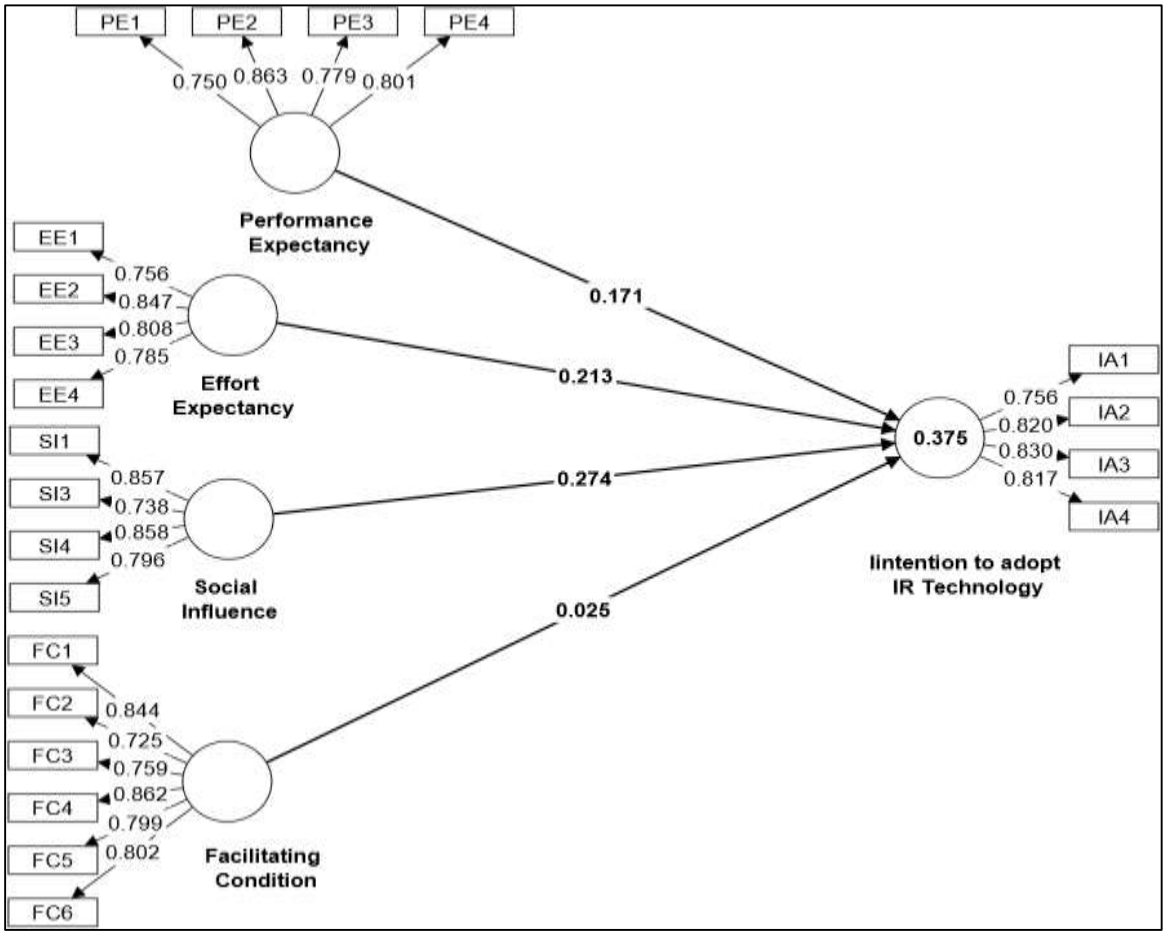


Table **1** and
Figure **2** offer an in-depth evaluation of the measurement model, spotlighting the intricate relationships between observed variables and their corresponding latent constructs. Factor Loadings, Cronbach's Alpha values, and Composite Reliability are more than 0.708. Additionally, the Average Variance Extracted (AVE) indicates another layer of validation, with a value above 0.5 (the threshold). Besides, the reliability and stability of a measurement model are very important because they strengthen the fact that data collected from samples can truly capture population characteristics (Hair et al., 2021). Construct validity can be examined by establishing convergent validity through AVE and discriminant validity through Fornell and Larcker criterion.
One of the widely accepted methods for assessing discriminant validity is by examining the square root of the Average Variance Extracted (AVE) of the constructs (Hair et al., 2021), which refers to the Fornell and Larcker criterion. Table 2 showed that the analysis adhered to this criterion. For each construct, the square root of its AVE consistently surpassed its correlation coefficients with other constructs. Similarly, the Heterotrait-Monotrait Ratio (HTMT) Matrix is another way to test discriminant validity. Generally, values less than 0.85 and extreme cases, values less than 0.90, indicate the uniqueness of the constructs. Table 2 shows that the highest value is 0.889.

Table 2.: Discriminant validity via Fornell and Larcker (F&L) Criteria and HTMT Ratio Matrix

	F&L Criteria					*HTMT Ratio Matrix*				
Constructs	**01**	**02**	**03**	**04**	**05**	**01**	**02**	**03**	**04**	**05**
01. Effort Expectancy	**0.800**									
02. Facilitating Conditions	0.732	**0.800**				0.859				
03. Intention to Adopt next-level technologies	0.554	0.489	**0.806**			0.669	0.551			
04. Performance Expectancy	0.726	0.619	0.527	**0.799**		0.889	0.719	0.641		
05. Social Influence	0.722	0.737	0.563	0.679	**0.814**	0.882	0.868	0.669	0.826	

Structural Model For Testing Hypothesis
The structural model aims to examine the hypothesised relationships outlined in the theoretical framework after the measurement model has satisfactorily met all required criteria. In this case, the multicollinearity test and determination of R-squared are checked in the following section.

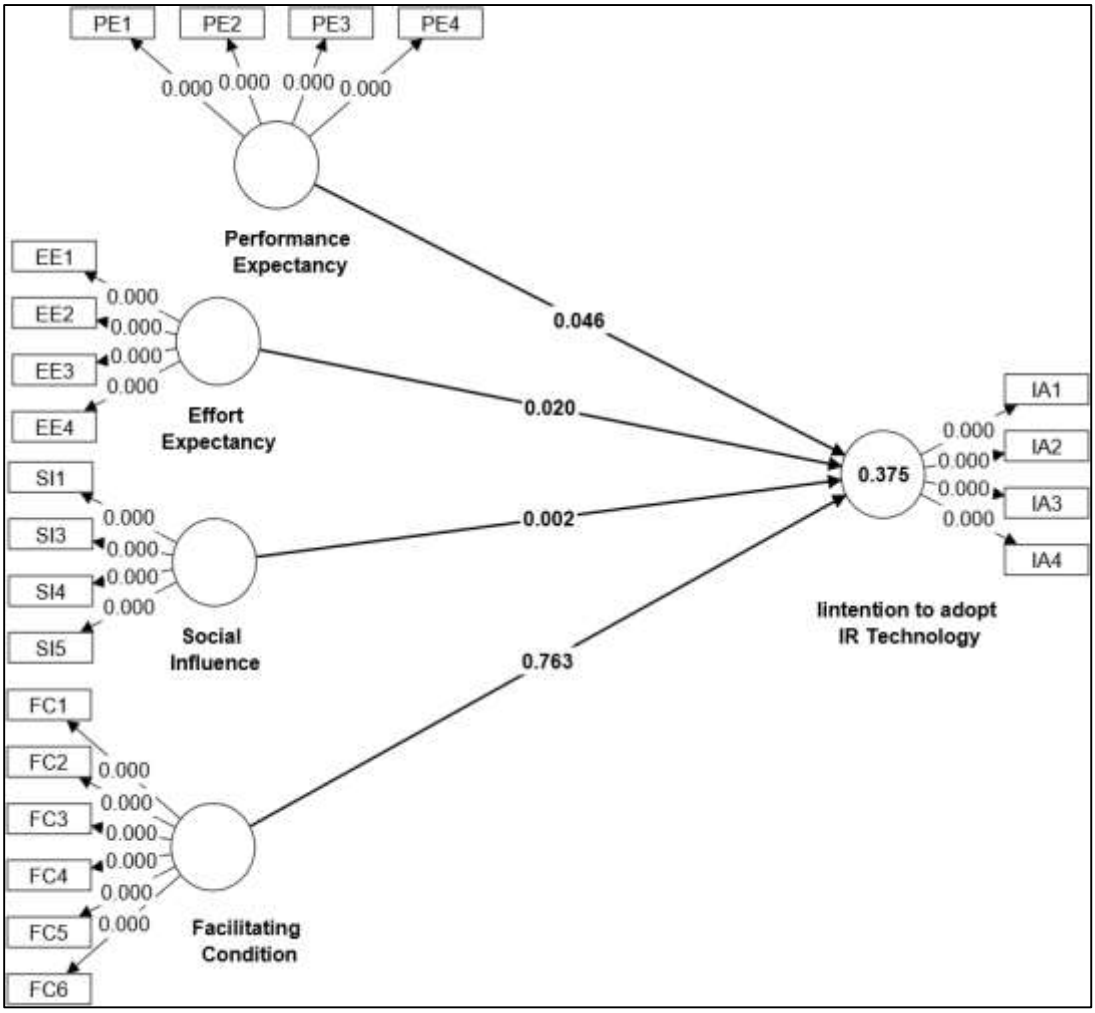
Multicollinearity Analysis
Multicollinearity occurs when two or more exogenous (independent) constructs in a model exhibit high intercorrelations, indicating possible redundancy among them. Traditionally, a VIF value exceeding 10 is considered a signal of serious multicollinearity (Radomir et al., 2023), whereas more conservative perspectives consider values above five (5) as a point of concern (Chattamvelli & Shanmugam, 2023). In this study, all VIF values fall well below these thresholds (maximum = 2.768), demonstrating that multicollinearity does not pose a substantial concern for the examined relationships.

Determinant Coefficient (R^2)
The squared multiple correlation (R^2) reflects the proportion of variance in a dependent variable that is explained by the independent or predictor variables in a regression model (Atkinson et al., 2021). The construct Intention to Adopt Next-Level Technologies demonstrates a R^2 value of 0.381, meaning that the predictor variables explain 38% of its variance. Based on established benchmarks, this value is classified as "Fair" by Cohen (2013) and Hair et al. (2021), while Chin (1998) regards it as "Substantial."

Hypothesis Testing
In empirical research, hypothesis testing constitutes a critical stage in which the proposed relationships

between variables are evaluated against actual data to determine their empirical support (Hair et al., 2021). This process entails comparing the observed outcomes with the expectations derived from the formulated hypotheses. By applying rigorous statistical procedures, researchers assess whether the detected effects are statistically meaningful or could have arisen due to random variation (Field, 2026). The findings—specifically, the confirmation or rejection of each hypothesis—are then systematically reported, providing a clear and comprehensive interpretation of the study's results. Findings of the analysis are presented in Table 3 and figure 3.

Figure 3: Structural Model.



The relationship between performance expectancy and the intention to adopt next-level technologies was analysed. The results showed a standardised beta coefficient of 0.171 with a standard error of 0.085, a t-value of 1.999, and a p-value of 0.046; the lower limit and upper limit do not straddle zero. Thus, this hypothesis was confirmed (H1). This suggests that while users expect next-level technologies to enhance their performance, other factors may be influencing their intention to adopt.

The correlation between effort expectancy and the intention to adopt next-level technologies was investigated (H2). The results displayed a standardised beta coefficient of 0.213 and a standard error of 0.092, a T-value of 2.325, a p-value of less than 0.05 (0.020), and lower and upper limits that exclude zero in between. Thus, this hypothesis was also confirmed. This suggests that as the perceived effort expectancy of the next level technologies increases. There is a corresponding rise in the intention to adopt it. The association between social influence and the intention to adopt next-level technologies was explored. The data revealed a standardised beta coefficient of 0.274, a standard error of 0.088, with a T-value of 3.097 and a p-value of 0.002, supporting the hypothesis. This suggests that social pressures

or perceived norms play a role, albeit a smaller one, in influencing the intention to adopt next-level technologies.

Table 3. Hypothesis Testing of Direct Effect

Hy	Paths	Std Beta	Std Error	T-value	P-Value	Lower Limit	Upper Limit	Decision
H1	PE → Int	0.171	0.085	1.999	0.046	0.004	0.339	Accepted
H2	EE → Int	0.213	0.092	2.325	0.020	0.046	0.405	Accepted
H3	SC → Int	0.274	0.088	3.097	0.002	0.106	0.454	Accepted
H4	FC → Int	0.025	0.084	0.302	0.763	-0.146	0.183	Rejected

The result of the last direct relationship between facilitating conditions and intention (H4) showed that the relationship is not supported, as the beta value is 0.025, the T-value is 0.302 (<1.960), and the P-value is 0.763 (>0.05). This result indicates that facilitating conditions are not significant in increasing interest in adopting new and upgraded technologies in SMEs (Table 3).

The Moderating Effect of Gender, Age, Operation' Experience, Education Level, and Operation's Duration

Moderation occurs when the relationship between two constructs varies according to the level of a third variable, known as the moderator. A moderator can alter the strength or even the direction of the association between two constructs within a model (Hair et al., 2019). In partial least squares structural equation modeling (PLS-SEM), moderating effects can be assessed using various approaches that incorporate interaction terms to capture the influence of the moderator on the focal relationship. In this study, the variables of gender, age, operation experience, education level, and operation duration serve as the moderating factors. Table 4 showed that age, experience, and operation duration moderate the relationship between performance and intention to adopt. The other relationships did not moderate the direct effects.

Table 4.: Hypothesis Testing of Moderating Effect

Hy	Paths	Std Beta	Std Error	T-value	P-Value	Lower Limit	Upper Limit	Decision
H1	GenXPE Int	0.099	0.153	0.647	0.518	-0.168	0.417	No
H2	AgeXPE Int	-0.228	0.094	2.423	0.015	-0.423	-0.051	Yes
H3	ExpXPE Int	0.268	0.112	2.388	0.017	0.075	0.515	Yes
H4	EduXPE Int	0.064	0.104	0.617	0.537	-0.133	0.279	No
	OperX PE Int	-0.315	0.120	2.619	0.009	-0.578	-0.099	Yes
	GenXEE Int	-0.088	0.109	0.808	0.419	-0.340	0.101	No
	AgeXEE Int	0.149	0.116	1.284	0.199	-0.063	0.391	No
	ExpXEE Int	-0.134	0.142	0.947	0.344	-0.434	0.126	No
	EduXEE Int	-0.096	0.115	0.834	0.404	-0.335	0.123	No
	OperX EE Int	-0.002	0.126	0.016	0.987	-0.254	0.243	No
	GenXPE Int	0.089	0.139	0.639	0.523	-0.162	0.359	No
	AgeXSI Int	-0.037	0.125	0.300	0.765	-0.305	0.184	No
	ExpXSI Int	0.096	0.129	0.749	0.454	-0.142	0.364	No
	EduXSI Int	0.047	0.099	0.474	0.636	-0.150	0.242	No
	OSIrX SI Int	0.103	0.122	0.849	0.396	-0.191	0.303	No

DISCUSSION

This research inspected the influence of performance expectancy, effort expectancy, and social influences on the intention to adopt industry revolution technology in Bangladeshi food and beverage manufacturing SMEs (H1, H2, and H3). New technology has enhanced their performance in terms of time savings, making it conceivable for this significant outcome or impact to occur (Upadhyay et al., 2021). Similar results from earlier investigations are also available, such as those reported by Merhi et al. (2019) and Chen et al. (2021). The desire to adopt cutting-edge technology is highly influenced by performance anticipation. In their opinion, citizens will be more inclined to accept these technologies if they believe that embracing new industrial settings would enhance their productivity. In Bangladesh, SME owners expect to secure their investment, capital, and resources, aside from producing more food and beverage products with their limited resources. SME owners or their management believe that adopting these state-of-the-art technologies in the production process would be very useful. Not all of these firms will be able to purchase the latest technology; however, they will be able to upgrade their manufacturing technology according to their capabilities and experience (Menon & Shah, 2020; Shao et al., 2020; Yao et al., 2020). Business owners will only use technology when it helps their operations and procedures; however, they found that the association between effort expectancy and behavioural intentions is not supportive, which contradicts earlier research (Menon & Shah, 2020).

In Bangladesh and other developing countries, utilising advanced technologies will help reduce physical effort and labour. Before using next-level technologies or machinery, intensive training is required; the owners and managers believe they can learn and utilise this technology in their business operations. One significant feature of next-level technologies is that they are easy to use, which is a consideration for SME owners. Thus, H3 and H4 were significant in the Bangladeshi context.

The finding supports existing literature that social influence is significant in the adoption of next-level technology. Such research (Al-Nuaimi & Uzun, 2023; Zhou et al., 2021) revealed that businesses are more likely to adopt technology if they find that their rivals are already using it. As social influence (SI) indicates how adopters' perceptions of their friends, family, co-workers, and other stakeholders in the utilisation of new technology, as suggested by (Rajendran & Wahab, 2022) and (Upadhyay et al., 2022), the owners and managers are inspired to adopt these technologies to meet those expectations.

The facilitating condition is not significant because the existing support is enough. Government policies, infrastructure, and organisational support are available. In the future, they may need more support. The demographic structure of SMEs in the F&B manufacturing sector in Bangladesh is minor in terms of adopting new and upgraded technologies. Their age, education level, gender differences, and organisational experience do not significantly change their intention to adopt. Only the performance expectancy on intention is moderated by the age and experience of the participants.

CONCLUSION

This section outlines the theoretical, practical, policy, and policymaking implications of the current study.

Theoretical Implications

The findings showed that the UTAUT theory used in this study utilised four relationships: performance expectancy and intention to adopt next-level technologies; effort expectancy and intention to adopt next-level technologies; social influence and intention to adopt next-level technologies; and facilitating conditions and intention to adopt new technology. The results showed that these three relationships were significant, and performance expectancy, effort expectancy, and social influences were significant factors influencing the intention to adopt next-level technologies in food and beverage manufacturing SMEs, making a significant contribution to this UTAUT model.

In contrast, the moderating effects of owners' age and experience were insignificant in this theoretical composition regarding the intention to adopt next-level technologies, except for the relationship between performance expectancy and intention. This unique finding was possibly due to the understanding of the owners or top management, given their age and experience, in that effort expectancy, social pressure, and business setting and external environment are no longer critical factors in determining whether or not to adopt next-level technologies in their business. Performance expectancy was significant due to the understanding that the age and experience of owners and top

management are vital for their business, as new technology brings ease and better performance in productivity, competitive advantage, and core competency. This requirement was established in this study.

Practical Implication

F&B manufacturing SMEs cannot afford to use advanced technologies in their industries due to their limited capital, manpower, and capabilities. Decision-makers, managers, and other stakeholders in these businesses can learn a lot from the following implications: a) Acknowledging the significance of presenting the tangible benefit and enhanced performance that next-level technologies bring to the discussion table. Emphasis on how it may improve productivity, accuracy, and efficiency in the processes used to make food and beverages. c) Reducing the perceived complexity and effort needed to install next-level technologies to expedite the adoption process. SMEs should provide thorough training courses and might utilise social media and influential individuals within the company to foster a culture that is receptive to technology adoption. These implications provide decision-makers and stakeholders with a comprehensive set of guidelines to help them successfully integrate next-generation technologies into their business processes, promoting efficiency, innovation, and long-term industry growth.

LIMITATION AND RECOMMENDATION FOR FUTURE STUDY

This study has several limitations related to the sample and sample size, as well as methodological or theoretical choices. It is suggested to choose the representative sample from the unregistered SMEs. Future studies may employ a systematic random sampling technique to collect data from unregistered F&B SMEs with a more diversified demographic profile, including male entrepreneurs, women entrepreneurs, and urban and rural SMEs. Other technology acceptance models and theories, such as the Technology Acceptance Model (TAM), the Theory of Planned Behaviour (TPB), and the Technology, Organisation, and Environment (TOE) theory, might be selected. Other constructs and variables might be included in future research.

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