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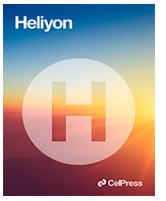

Research article

Access to online business opportunities: Enhancing digital technology capacity for women with disabilities in the Red River Delta of Vietnam

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ABSTRACT

This study investigates the digital technology capacity of women with disabilities and the impact of access to digital business opportunities on their entrepreneurial satisfaction. A sample of 50 women with disabilities in the Red River Delta region of Vietnam provided 35 valid responses, which were analyzed using Exploratory Factor Analysis and Structural Equation Modeling. The results showed that five key factors, including course relevance, course expectancy, instructor quality, learning outcomes, and course satisfaction, accounted for 78.39 % of the variance in the data. The proposed model explained 61.3 % of the amount of variation and the study's findings supported the predicted relationships among the factors, except for two hypotheses. H1, which postulated a positive relationship between course relevance and instructor quality, and H5, which predicted a positive relationship between learning outcomes and course satisfaction. Possible reasons for these non-significant relationships were discussed, highlighting the need for further research in these areas. The findings contribute to our understanding of the factors that affect the digital technology capacity of women with disabilities and their satisfaction with digital business opportunities.

1. Introduction

According to the World Health Organization, roughly 1.3 billion people worldwide are severely disabled, representing 16 % of the global population [1]. People with disabilities confront significant obstacles in various aspects of life despite concerted efforts to address these challenges. Discrimination, stigmatization, and social exclusion are just a few of the hurdles that impede their opportunities and overall well-being [2,3]. Specifically, women with disabilities face compounded discrimination due to their gender and disability status [4,5], leading to limited access to resources and opportunities. For instance, women with disabilities may face barriers when it comes to accessing education, employment, and reproductive health services [6,7]. In addition, it is found that approximately one in five women worldwide, amounting to roughly 700 million disabled women, experience various challenges and disabilities. Moreover, women exhibit a higher disability prevalence rate of 19.2 % compared to men's rate of 12 %. This implies that it is imperative for society to provide care and support for women with disabilities, particularly in facilitating their meaningful participation in business operations and social activities.

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The digital transformation and Industry 4.0 have ignited a paradigm shift in global business operations. The incorporation of Information and Communication Technology (ICT) has become a critical component of modern business practices [8]. However, while this evolution has presented numerous opportunities for businesses, it has also posed challenges for researchers seeking to comprehend the effects of digital transformation on marginalized groups [9], particularly women with disabilities [10]. This group, facing significant disparities in the business community, encounters impediments to participating in business activities, particularly in accessing digital technology and digital skills [9]. Therefore, research on women with disabilities in digital business is essential as it provides valuable information to ensure that digital business development is inclusive and leaves no one behind, particularly women with disabilities.

Fig. 1 illustrates the spatial and temporal network of emerging keywords spanning the period from 2012 to 2020. The analysis excludes keywords that appear less than five times to ensure the inclusion of robust and significant patterns. The graphical representation provides a visual overview of the evolving research focus over time. Initially, the scholarly attention predominantly centered around small business/enterprise in specific regions, notably Sweden and the United Kingdom. However, as time progressed, there has been a discernible shift towards the exploration of micro and family businesses. More recently, the spotlight has shifted to the intersection of entrepreneurship and education, particularly in relation to entrepreneurial intentions and motivations. Moreover, an analysis of the data presented in Fig. 2 indicates that the top four keywords researched (*sudden topic increased*) in the past three years are "innovation, empowerment, education, and employment." This highlights the significance of an innovative educational approach in addressing the needs of marginalized populations.

There have been few studies conducted to assess the impact of digital transformation on women with disabilities in online businesses [9–11]. However, some recent scientific publications have attempted to provide a deeper understanding of the inequalities faced by women with disabilities and encourage the development of online business activities that are inclusive of everyone. For example, a study by Ref. [11] focused on understanding the digital divides within and between disability groups. The study showed that individuals with disabilities related to language and understanding reported more difficulties using the internet than other disability groups. Women with autism used the internet more than any other disability group, while women with aphasia used the internet the least. Recent studies have shown that providing training and support for women in digital business can bring significant economic and social benefits [12–14]. World Bank's report highlighted that advancing women's participation in the workforce can have a significant impact on economic growth [15]. Previous work [16] reinforced this notion by presenting evidence that enhancing women's economic parity could potentially contribute between $12 and $28 trillion to the global annual GDP by 2025.

The research problem is that despite the growing interest in online business, the research on women with disabilities in this domain remains *understudied*. This is a **significant gap**, as women with disabilities face unique challenges and barriers when it comes to entrepreneurship and participation in the digital economy. **Addressing this research problem** could yield valuable insights to help empower women with disabilities, promote their economic inclusion, and ensure equitable access to the opportunities presented by the growth of online business [17,18]. Therefore, **the objective of this study** is to understand the underlying factors related to the digital technology capacity of women with disabilities and how access to digital business opportunities influence their entrepreneurial satisfaction. This study seeks to **contribute** to the existing literature by shedding light on the experiences of an understudied population and providing insight into strategies for promoting their success in online business. As a result, two research questions emerge

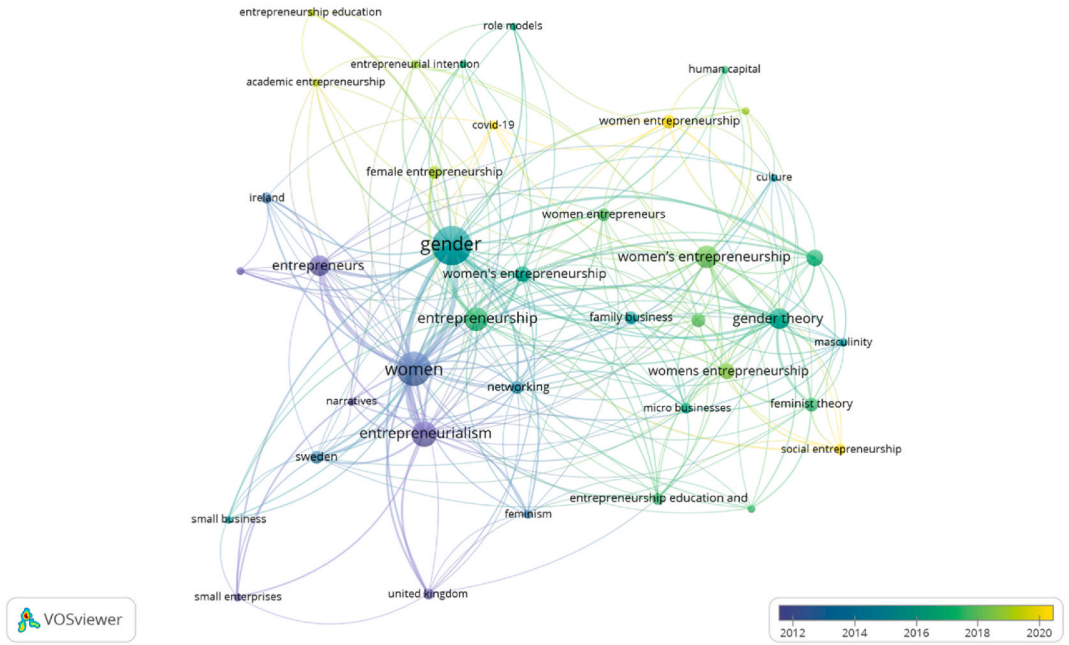

Fig. 1. Frequent keywords that appear at least 5 times.

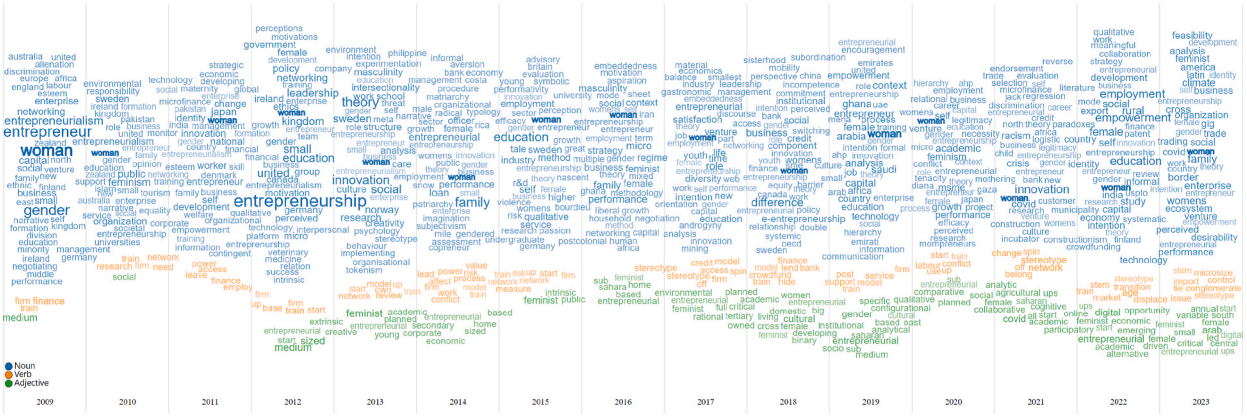

Fig. 2. The evolution of research topics related to women in doing business from 2009 to 2023.

from this issue.

- RQ1: What are the underlying factors related to the digital technology capacity for women with disabilities?
- RQ2: How do access to digital business opportunities influence the entrepreneurial satisfaction of women with disabilities?

Answering these research questions can help to provide valuable insights into the factors that contribute to the low participation of women with disabilities in online business and develop effective strategies to address this issue.

The structure of this article is outlined as follows: In Section 2, a brief review of prior research will be presented. Section 3 will describe the materials and methods utilized in this study. Findings will be reported in Section 4. Discussion is provided in Section 5. Finally, the conclusions drawn from this study will be presented in Section 6.

2. Literature review

The issue of entrepreneurship among people with disabilities has gained attention in recent years. Author in Ref. [19] explored the experiences of physically and mobility disabled entrepreneurs and found that they possess specific personal and functional competencies, including attitudinal competencies, entrepreneurial self-efficacy, entrepreneurship learning self-efficacy, entrepreneurial competencies, commitment, and social competencies. Author in Ref. [20] reported that the Turkish government has implemented a range of support programs and policies to achieve objectives related to public and private sector employment, entrepreneurship, and protected workplaces for people with disabilities. Among these, the entrepreneurship program for people with disabilities is considered particularly successful. Author in Ref. [21] reported that in Harare Central Province, Zimbabwe, most disabled entrepreneurs lacked educational qualifications, and most businesses run by disabled people were not registered with local authorities. The authors recommended that the Zimbabwean government establish a policy framework to support disabled entrepreneurs, including female disabled entrepreneurs, establish a fund to support their commercial activities, and enact laws and regulations that are inclusive and accommodating.

The studies above all examine the experiences and competencies of entrepreneurs with disabilities, with a particular focus on the challenges and opportunities they face in the business world. While each study takes a unique approach and explores different aspects of entrepreneurship among people with disabilities, there are also several common themes that emerge across the studies.

One similarity among the studies is the focus on the personal and functional competencies possessed by disabled entrepreneurs. For example, prior study [19] found that disabled entrepreneurs possess specific personal and functional competencies, including attitudinal competencies, entrepreneurial self-efficacy, entrepreneurship learning self-efficacy, entrepreneurial competencies, commitment, and social competencies. Similarly, existing research [20] found that visually impaired women entrepreneurs with higher education have a higher chance of finding employment and income, and most disabled entrepreneurs lacked educational qualifications [21]. These findings suggest that personal and functional competencies play a crucial role in the success of entrepreneurs with disabilities. Another similarity among the studies is the recognition of the unique challenges faced by entrepreneurs with disabilities, and the need for targeted support to address these challenges. For example, the government of Turkey has implemented a range of support programs and policies to help people with disabilities achieve employment and entrepreneurship goals [22]. These findings suggest that while there are unique challenges faced by entrepreneurs with disabilities, there are also opportunities for targeted support to help them overcome these challenges. One difference among the studies is the specific focus of each study. For example, prior research [19] focused on understanding the competencies of disabled entrepreneurs by exploring their experiences in developing the skills needed to start and manage their own businesses. These differences suggest that while there are common themes across the studies, there are also unique aspects of entrepreneurship among people with disabilities that warrant further investigation.

Regardless of differences or similarities among previous work, none of the aforementioned studies addressed the questions that we proposed in the previous section. To the best of our knowledge, there has no studies in the literature so far approaching women with

disabilities with respect to access to online business opportunities, **making this study a unique contribution**.

3. Research methodology

This study was grounded in a **positivist research paradigm**, which holds that objective, verifiable knowledge can be obtained through systematic observation and experimentation [23]. Under this paradigm, the **quantitative search** method was employed, involving the collection and analysis of new empirical data. Considering the constraints posed by the size, scope, and unique participant composition of our study, it was necessary to carefully select a set of hypotheses to investigate. Although numerous hypotheses could have been formulated, testing them all within the limitations of our study was unfeasible. Therefore, the chosen hypotheses were derived through a brainstorming process and were aligned with the objectives of the Canada Fund for Local Initiatives (CFLI). The CFLI provided funding for the training of women with disabilities in developing countries, with the aim of bridging the digital skills gap and empowering these women to thrive in the technology-driven era. In alignment with the CFLI's objectives, our selected hypotheses focused on examining the relationships between course relevance, instructor quality, course expectancy, learning outcomes, and course satisfaction within the context of women with disabilities in their training program for online business.

3.1. The training program context

An online survey was conducted in the Red River Delta region of Vietnam among women with disabilities who had participated in a training program. The program was assisted by the Canada Fund for Local Initiatives (CFLI), which sponsors diverse community-based initiatives aimed at enhancing women's involvement in local peace discussions and fostering resilience to the impacts of climate change. The training program spanned from September 2021 to March 2022 and featured four activities.

3.2. Participants and procedures

The study included a sample of 50 women with disabilities who resided in the provinces of Ha Nam, Nam Dinh, Thai Binh, Hai Duong, Ha Noi, Ninh Binh, located in the Red River Delta region of Vietnam. The Red River Delta, alternatively known as the North Central Coast region, constitutes a downstream area of the Red River and the Thai Binh River in northern Vietnam. It is the most densely populated region, accounting for approximately 22 % of the country's overall population. However, this region also has one of the highest populations of people with disabilities. Participants were recruited through local agency and met the following inclusion criteria: (1) female gender, (2) aged 18 years or older, (3) diagnosed with at least one type of disability, (4) able and willing to provide informed consent and participate in the study. Participants were excluded if they had a severe cognitive impairment that would interfere with their ability to provide informed consent or participate in the study. The majority of the study participants have mobility disabilities, with only a very small number being hearing impaired.

This study received approval from the Ethical Review Board (IRB) at the researcher's university. Participants were provided with informed consent information and were assured of the confidentiality and anonymity of their responses. Participants were also provided with the option to withdraw from the study at any time without penalty. Participants were not compensated for their participation in the study. However, transportation and accommodation expenses were provided to those who needed it to ensure their participation.

3.3. Measuring instruments

3.3.1. Overall satisfaction

This measure was used to assess overall course satisfaction. It is a self-report questionnaire that consists of 3 items [24]. Participants were asked to respond to each item on a Likert scale. This measure has demonstrated high internal consistency reliability and good construct validity in previous studies [25]. Participants can be asked to rate their overall satisfaction with the training course on a scale from 1 (very dissatisfied) to 5 (very satisfied). All the items were modified to fit with our study context. For example, "How satisfied are you with the overall quality of the training course?"

3.3.2. Course relevance

Course relevance pertains to the extent to which a specific educational program or course of study aligns with an individual's unique requirements and desired career trajectory [26]. It encompasses the evaluation of the practicality, value, and direct correlation between the course content, skills, and knowledge offered and the learner's goals, interests, and criteria. The assessment of relevance can be approached from various perspectives, with students often evaluating it based on their academic or professional objectives. A course is deemed highly relevant when it imparts knowledge and skills that are directly applicable to the student's intended field of study or future career. Conversely, a course that lacks direct applicability or fails to meet the student's learning objectives would be regarded as less relevant. For the purposes of this study, the measurement of course relevance is based on a self-report questionnaire comprising three items [27]. Participants were asked to rate how relevant the content of the training course was on a 5-point Likert scale [28], ranging from 1 (strongly disagree) to 5 (strongly agree). This measure has demonstrated high internal consistency reliability and good construct validity in previous studies [27,28]. All the items were modified to fit with our study context. For example, "How relevant was the content of the training course to your job or area of interest?".

3.3.3. Course expectancy

Course expectancy refers to individuals' personal beliefs, perceptions, and anticipations regarding a specific course or educational program [29]. It encompasses their preconceived notions about various aspects, including the course content, teaching methods, level of difficulty, expected learning outcomes, and overall learning experience. These beliefs and expectations are shaped by a range of factors, such as prior knowledge and experiences, information obtained from course descriptions or syllabi, recommendations from peers or mentors, and the reputation of the instructor or institution offering the course. These factors contribute to individuals' anticipations and expectations of what they will encounter and gain from participating in the course. The concept of course expectancy has implications for learners' motivation, engagement, and overall learning experience. When a course meets or exceeds their expectations, it can enhance learners' satisfaction, motivation, and commitment to the learning process. Conversely, if a course falls short of their expectations, it may lead to feelings of disappointment, disengagement, and reduced motivation. To measure course expectancy, a self-report questionnaire comprising three items was utilized in this study. The questionnaire was designed to capture individuals' beliefs and expectations about the course they were undertaking [30]. Participants were asked to rate how expectation the content of the training course was on a 5-point Likert scale ranging from 1 (Not at all) to 5 (Completely). This measure has demonstrated high internal consistency reliability and good construct validity in previous studies [30,31]. All the items were modified to fit with our study context. For example, "To what extent do you believe that this course will help you achieve your career goals?".

3.3.4. Instructor quality

Instructor quality pertains to the extent of effectiveness, expertise, and competence demonstrated by an instructor or teacher in their role of delivering educational content and facilitating the learning process [32]. It encompasses a diverse array of attributes and behaviors that collectively contribute to the overall quality of instruction and the resulting learning outcomes for students. Several key factors influence instructor quality, including extensive knowledge and expertise in the subject matter, effective teaching skills, adept classroom management abilities, high levels of engagement and enthusiasm, the provision of valuable assessment and feedback, and a commitment to continuous improvement in their teaching practices. For the purpose of assessing instructor quality, a self-report questionnaire consisting of three items was employed [24,33]. Participants can be asked to rate the quality of the instructor on a scale from 1 (poor) to 5 (excellent). This measure has demonstrated high internal consistency reliability and good construct validity in previous studies. All the items were modified to fit with our study context. For example, "How would you rate the quality of the instructor in delivering the training course content?"

3.3.5. Course organization

Course organization encompasses the deliberate structuring, arrangement, and sequencing of content, activities, and resources within an educational course or curriculum [34]. It involves the thoughtful planning and design of a course to ensure its logical and coherent presentation, ultimately facilitating effective teaching and learning experiences. Effective course organization entails presenting the course content in a systematic and meaningful manner, allowing students to progressively build upon their knowledge and skills. To assess course organization, a self-report questionnaire comprising three items was employed in this study [35,36]. Participants can be asked to rate the organization of the course on a scale from 1 (Strongly Agree) to 5 (Strongly Disagree). This measure has demonstrated high internal consistency reliability and good construct validity in previous studies. All the items were modified to fit with our study context. For example, "To what extent do you agree that the course technology (e.g., online platform, multimedia materials) was easy to use and helpful for learning?"

3.3.6. Learning outcomes

Learning outcomes refer to specific statements that precisely outline the knowledge, skills, abilities, or attitudes that learners are expected to attain or exhibit upon successfully completing a course, program, or educational experience [37]. They articulate the desired level of knowledge, understanding, or competency that learners should have acquired by the end of the learning process. Learning outcomes are typically formulated in terms of observable and assessable behaviors. They provide a clear and concise representation of the intended learning achievements and serve as a roadmap for instructional planning, assessment, and evaluation. By aligning teaching methods, content, and assessments with the learning outcomes, educators ensure that the educational experience is focused, purposeful, and effectively supports learners in achieving their goals. To assess learning outcomes, a self-report questionnaire comprising three items was used in this study [38]. Participants can be asked to rate how well the training course helped them achieve the desired learning outcomes on a scale from 1 (not at all) to 5. This measure has demonstrated high internal consistency reliability and good construct validity in previous studies. All the items were modified to fit with our study context. For example, "How confident do you feel in your ability to apply what you have learned in this course to real-life situations?"

Based on the previous studies, the following hypotheses were proposed and validated in our study.

- H1: Course Relevance positively influences Instructor Quality
- H2: Course Relevance predicts higher Course Expectancy.
- H3: Course Expectancy affects positively Learning Outcomes.
- H4: Course Expectancy predicts higher Course Satisfaction.
- H5: Learning Outcomes positively affect Course Satisfaction

3.4. Data collection

The data for this study was collected using an online survey administered via Google Form at the conclusion of the training course. It consists of 18 items targeting our main hypotheses (see Appendix for more details). The online survey method was chosen due to its convenience and accessibility, allowing participants to respond at their own convenience and from various locations. The utilization of an online survey method, despite encountering several drawbacks, was deemed the optimal approach for the research team to gather opinions. The inherent limitations of this method include response bias, stemming from factors such as non-response, limited internet access, inadequate technological resources, or insufficient digital literacy skills. Nevertheless, the selection of an online survey was justified based on the wide geographical distribution of participants and the associated challenges related to travel distances. The survey was designed to gather feedback and insights from participants regarding their experience and perceptions of the training course. The sampling method employed in this study was non-random purposive convenience sampling. This sampling approach involved selecting participants who were readily available and willing to participate in the study. The decision to use convenience sampling was based on practical considerations such as time constraints and limited resources. The researchers aimed to include as many participants as possible within the given timeframe to ensure a representative sample of the training course attendees. The survey was conducted over a period of one week in March 2022 after the training program was finished. This duration was chosen to allow sufficient time for participants to complete the survey while still maintaining a reasonable timeframe for data collection and analysis. The research team will proactively issue reminders to participants regarding the survey in the lead-up to the deadline. Specifically, reminders will be sent at intervals of 3 days, 1 day, and 6 h prior to the designated cut-off time. This approach is intended to prompt timely and comprehensive responses from participants.

3.5. Data analysis

The data collected for this study was analyzed using two statistical techniques, namely exploratory factor analysis (EFA) and structural equation modeling (SEM). EFA was used to identify latent factors in the data, which were crucial for developing a measurement model. SEM was then used to analyze the relationships among these factors, evaluating the model's fit and testing hypothesized relationships. Combining EFA and SEM allowed for a comprehensive and hypothesis-driven assessment of latent factors. Alternative methods like confirmatory factor analysis (CFA) and regression analysis were considered but were not selected due to their various constraints such as pre-specified measurement model or inability to capture complex relationships among latent constructs. The data was first checked for missing values and outliers.

Prior to conducting EFA, the suitability of the data for factor analysis was assessed by utilizing the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. KMO measure is a statistical tool used to assess the adequacy of sampling in factor analysis. The KMO value ranges from 0 to 1, where a value closer to 1 indicates that the sampling is more adequate [39]. A KMO value greater than 0.5 is generally considered acceptable, while values ranging from 0.5 to 0.7 are classified as mediocre and values ranging from 0.7 to 0.8 are classified as good [39]. A statistically significant Bartlett's Test of Sphericity (sig. <0.05) indicates that the correlations between the variables are sufficient for further analysis. The EFA was performed using principal component analysis with varimax rotation. The number of factors was determined by applying the Kaiser criterion.

After identifying the factors, structural equation modeling (SEM) was used to test the hypothesized relationships among the factors [40]. SEM has become a popular approach in the literature for understanding complex relationships among factors. It is often used in social sciences to identify latent variables that may not be immediately observable [41,42]. There are two types of SEM - covariance-based (CB-SEM) and component-based (PLS-SEM). In this study, we employed Generalized Structured Component Analysis (GSCA), an alternative to PLS-SEM, to evaluate the proposed model [43]. GSCA is a method for modeling structural equations based on components of observed variables as proxies for latent variables, allowing examination of the direction of relationships between them. Compared to PLS-SEM, GSCA has several benefits, including fewer limitations on distributional assumptions (multivariate normality of observed variables is not required for parameter estimation), unique component score estimates, and avoidance of improper solutions in small samples [44]. Additionally, GSCA can work with small samples without requiring a rigid normal distribution, which is a distinct advantage over other SEM techniques. As such, GSCA fits our experiment for the sample size of 35 participants.

All analyses were conducted using the statistical software package SPSS (version 25) [45] and the GSCA Pro [44] for SEM.

Table 1
KMO and Bartlett's test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.588
Bartlett's Test of Sphericity	Approx. Chi-Square	483.826
	df	153
	Sig.	0.000

4. Findings

4.1. What are the underlying factors related to the digital technology capacity for women with disabilities in the Red River Delta of Vietnam?

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.588 (greater than 0.5), and Bartlett's test of sphericity was significant (Chi-Square = 483.826, $p < 0.001$), indicating that the data was suitable for factor analysis as shown in Table 1. Although the KMO value exceeds the minimum threshold recommended by Hair [39], it is relatively low (classified as mediocre) compared to many prior reports. The reporting of a low KMO value in rare sciences is not uncommon [46], and our study's small sample size may have contributed to this outcome.

Table 2 provides valuable insights into the amount of variance accounted for by each extracted factor, shedding light on the underlying structure of the dataset. The application of the Kaiser criterion, which retains factors with eigenvalues greater than 1.0, resulted in the retention of the first five factors. This criterion allows for the identification of the most significant factors that contribute meaningfully to explaining the variance in the dataset. The decision to retain these five factors was based on the principle that factors with eigenvalues above 1.0 capture a substantial amount of variance and are considered more meaningful in the analysis. By retaining these factors, the subsequent analysis can focus on the most influential dimensions present in the dataset. The retained factors collectively accounted for 78.4 % of the total variance observed in the dataset. This suggests that a significant proportion of the variability within the dataset can be attributed to these five factors. The remaining percentage of variance is likely attributable to other factors that were not retained in the analysis.

Table 3 displays the rotated component matrix resulting from an EFA on the 18-item course satisfaction questionnaire scale. As shown in Table 3, all items loaded highly on their respective components, with factor loadings ranging from 0.363 to 0.875. Overall, the rotated component matrix revealed five components with eigenvalues greater than 1, which explained 78.39 % of the total variance in the data. The items with the highest loading on Component 1 were CR2 (0.875), CR1 (0.825), and CR3 (0.652), suggesting that this component may represent a construct related to Course Relevance. Component 2 was mainly loaded by CE3 (0.863) and CE2 (0.855), indicating that it may represent a construct related to Course Expectancy. Component 3 was primarily loaded by IQ2 (0.807) and IQ3 (0.728), suggesting that this component may represent a construct related to Instructor Quality. Component 4 was mainly loaded by LO1 (0.869), LO2 (0.863), and LO3 (0.804), indicating that it may represent a construct related to Learning Outcomes. Finally, Component 5 was primarily loaded by CS1 (0.865), which may represent a construct related to Course Satisfaction.

4.2. How do access to digital business opportunities influence the entrepreneurial satisfaction of women with disabilities?

The internal consistency and convergent validity of each construct were evaluated and reported in Table 4. Internal consistency was measured using Dillon–Goldstein's rho, which assesses the reliability of each construct. All values obtained were greater than 0.7, which is higher than the recommended level for reliability estimation. To determine convergent validity, Average Variance Extracted (AVE) was examined, and values greater than 0.5 were observed for all constructs, indicating good convergent validity.

Table 5 presents the standard errors (SEs) and 95 % bootstrap percentile confidence intervals (CIs), which include the lower and upper bounds (LB and UB), for the item loading estimates obtained from the simulation. The confidence intervals were computed using 100 bootstrap samples, a method for overcoming a small sample size. To determine statistical significance, item loading estimates were considered significant if the 95 % confidence interval did not include zero at the 0.05 level. Our results indicate that all loading estimates were statistically significant, suggesting that all items were reliable predictors of the respective constructs.

The GSCA yielded a FIT of 0.613, AFIT of 0.586, GFI of 0.949, and SRMR of 0.3697. Both FIT and AFIT are commonly used in GSCA to evaluate the overall fit of a model to the data. FIT represents the overall fit of the model to the data. It ranges from 0 to 1, with values closer to 1 indicating a better fit. It measures the proportion of the variance in the observed variables that is explained by the model. AFIT is a modified version of FIT that adjusts for model complexity by penalizing models with more parameters. It is calculated by dividing the FIT value by the number of parameters in the model. It is also scaled between 0 and 1, with higher values indicating better fit. AFIT is a more conservative measure of fit than FIT because it takes into account the number of parameters in the model. In this experiment, FIT = 0.613 and AFIT = 0.586 imply that the model explained about 61.3 % and 58.6 % of the total variation across all

Table 2
Number of components and total variance explained.

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.267	40.373	403.73	7.267	40.373	40.373
2	2.530	14.053	54.426	2.530	14.053	54.426
3	2.025	11.252	65.678	2.025	11.252	65.678
4	1.225	6.806	72.484	1.225	6.806	72.484
5	1.064	5.912	78.396	1.064	5.912	78.396
6	0.915	5.082	83.478			
7	0.661	3.675	87.153			
8	0.422	2.342	89.496			

Table 3
Rotated component matrix.

	Component				
	1	2	3	4	5
CR2	0.875				
CR1	0.825				
CR3	0.652				
CO1	0.637	0.568			
CO2	0.623	0.542			
CE3		0.863			
CE2		0.855			
CO3		0.828			
CE1	0.491	0.743			
IQ2			0.807		
IQ3			0.728		
IQ1			0.606		
LO1				0.869	
LO2				0.863	
LO3				0.804	
CS1					0.865
CS2					0.685
CS3					0.636

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotating converged in 7 iterations.

Table 4
Internal consistency and convergent validity.

	AVE	Alpha	Rho
Course Relevance	0.616	0.902	0.926
Course Expectancy	0.642	0.889	0.92
Instructor Quality	0.576	0.761	0.862
Learning Outcomes	0.684	0.864	0.916
Course Satisfaction	0.675	0.757	0.861

Table 5
Estimate of loadings.

	Estimate	SE	95 % CI	
Course Relevance				
CR2	0.744	0.129	0.425	0.915
CR1	0.887	0.119	0.6	0.972
CR3	0.881	0.06	0.721	0.948
CO1	0.884	0.052	0.736	0.968
CO2	0.827	0.311	0.422	0.951
Course Expectancy				
CE3	0.776	0.198	0.231	0.972
CE2	0.802	0.139	0.742	0.862
CO3	0.87	0.226	0.183	0.995
CE1	0.731	0.192	0.426	1.036
Instructor Quality				
IQ2	0.814	0.112	0.552	0.927
IQ3	0.818	0.076	0.664	0.928
IQ1	0.836	0.074	0.64	0.944
Learning Outcomes				
LO1	0.839	0.096	0.602	0.955
LO2	0.899	0.032	0.828	0.969
LO3	0.915	0.046	0.804	0.979
Course Satisfaction				
CS1	0.89	0.079	0.673	0.981
CS2	0.683	0.201	0.254	0.847
CS3	0.774	0.175	0.696	0.852

variables, respectively. The overall model fit was assessed using two indices, namely, the goodness-of-fit index (GFI) and the standardized root mean square residual (SRMR). A GFI value approaching 1 and an SRMR value approaching 0 suggest an excellent fit. The GFI value in this study was almost 1, indicating a high level of fit, while the SRMR value was relatively close to 0.

Table 6 presents the path coefficient estimates from the generalized structured component analysis (GSCA) model, along with their corresponding standard errors and 95 % confidence intervals. To determine statistical significance at the alpha level of 0.05, we look for path coefficients whose 95 % confidence intervals do not include zero. Specifically, the path coefficient for Course Relevance → Instructor Quality is 0.391 (H1), with a standard error of 0.323 and a 95 % confidence interval ranging from −0.231 to 0.849. Although this coefficient suggests a positive relationship between course relevance and instructor quality, it is not statistically significant due to the confidence interval including zero. On the other hand, the path coefficient for Course Relevance → Course Expectancy is 0.741 (H2), with a standard error of 0.087 and a 95 % confidence interval ranging from 0.561 to 0.891. This coefficient is both positive and statistically significant, indicating that students who perceive a course as relevant are more likely to have higher expectations for the course. The path coefficient for Course Expectancy → Learning Outcomes is 0.429 (H3), with a standard error of 0.18 and a 95 % confidence interval ranging from 0.138 to 0.733. This coefficient is positive and statistically significant, suggesting that students with higher expectations for a course are more likely to achieve better learning outcomes. Similarly, the path coefficient for Course Expectancy → Course Satisfaction (H4) is 0.51, with a standard error of 0.191 and a 95 % confidence interval ranging from 0.413 to 0.607. This coefficient is also positive and statistically significant, indicating that students with higher expectations for a course are more likely to be satisfied with it. Finally, the path coefficient for Learning Outcomes →Course Satisfaction (H5) is 0.015, with a standard error of 0.167 and a 95 % confidence interval ranging from −0.301 to 0.356. This coefficient suggests a weak and non-significant relationship between learning outcomes and course satisfaction.

5. Discussion

5.1. Theoretical implications

One of the most significant findings of this study was the amount of variation that was explained by the exploratory factor analysis (EFA) and structural equation modeling (SEM), which were 78.4 % and 61.3 %, respectively. Although there is no established threshold for this percentage in the literature, high percentages are generally indicative of robust theoretical grounding, while lower percentages are more typical of exploratory research or rare science. Given that the main objective of this study was to explore the dimensions and interactions of digital competencies for women with disabilities, these percentages could be considered promising and indicative of moderate results. Furthermore, the results of the study have several implications that can be drawn.

The EFA conducted in this study resulted in the formation of five factors from the 18 variables, suggesting the potential use of these factors for data summarization. Moreover, the loading scores presented in Table 3 provide valuable information for interested researchers, who can utilize variables with high score loadings for scale development or factors as a summate score for analysis in future studies. However, it is important to note that the use of information provided in Table 3 is subjective and depends on the justification of the analysts. For instance, researchers may select one representative variable on each factor to incorporate with their other scales, giving preference to the variable with a high score as it significantly contributes to explaining its factor. The study also identified that CR2, CE3, IQ2, LO1, and CS1 could be used to represent Course Relevance, Course Expectancy, Instructor Quality, Learning Outcomes, and Course Satisfaction, respectively, in other research studies. Additionally, variables with low scores could be useful candidates for another line of research, particularly for interested digital competency analysts seeking to explore new or unexplained phenomena. Such variables could contribute to other factors that have not yet been revealed, leaving a research gap for investigation. Furthermore, cross-loading of a variable could also carry useful implications. Although it is recommended that variables with cross-loading should be excluded in EFA, this kind of information can provide insight into the relationships between constructs. Items that cross-load on two or more factors may indicate that those factors are related conceptually or empirically. For example, if an item about course expectancy cross-loads on factors related to course relevance and learning outcomes, it may suggest that course expectancy is related to these constructs and may provide insight into potential underlying mechanisms or relationships that could be explored in future research.

The findings of the current study confirm most of the predicted correlations among the factors in the conceptual model using SEM, except for two hypotheses: H1, which predicted that course relevance would be positively related to instructor quality, and H5, which predicted that learning outcomes would be positively related to course satisfaction. These findings are inconsistent with the literature where course relevance was found to significantly predict instructor quality. One possible explanation for the lack of consistent findings is that the factors contributing to course relevance and teacher effectiveness may differ, with course relevance depending on the course content and its alignment with students' interests and goals, while teacher effectiveness depending on pedagogical skills,

Table 6
Estimates of path coefficients.

	Estimate	SE	95%CI	
Course Relevance → Instructor Quality (H1)	0.391	0.323	−0.231	0.849
Course Relevance → Course Expectancy (H2)	0.741*	0.087	0.561	0.891
Course Expectancy → Learning Outcomes (H3)	0.429*	0.18	0.138	0.733
Course Expectancy → Course Satisfaction (H4)	0.51*	0.191	0.413	0.607
Learning Outcomes → Course Satisfaction (H5)	0.015	0.167	−0.301	0.356

communication skills, and the ability to motivate and engage students [47]. Moreover, previous studies may have used inadequate measures of course relevance and teacher effectiveness, including self-report measures subject to bias and social desirability effects [27,28]. The relationship between course relevance and teacher effectiveness may also be moderated by other factors, including the specific type of disability, classroom context, and teaching methods [47,48]. For instance, a course that is highly relevant to women with disabilities may not necessarily enhance teacher effectiveness if the teacher is unable to communicate the content effectively or if the classroom environment is not accessible to students with disabilities [48,49]. In terms of H5, while prior evidence [48] showed that learning outcomes was the predictor of course satisfaction, the current study finding did not support the hypothesis. One potential reason for the lack of association between learning outcomes and course satisfaction among women with disabilities could be that students may hold different expectations regarding what constitutes effective learning outcomes compared to what they perceive as satisfactory in a course [50]. Despite perceiving learning outcomes as sufficient, students may be dissatisfied with the teaching methodology or course delivery. Other variables such as the level of difficulty, workload, or teaching style may also play a role in shaping students' satisfaction with the training program, independent of their learning outcomes. An alternative explanation could be that students prioritize other variables such as the instructor's personality, course organization, or classroom environment when assessing their satisfaction with the course. The results of SEM make a twofold contribution to the existing body of knowledge: (1) it provides empirical verification of the relationship effects posited in existing theories, making it a valuable reference for similar settings; and (2) the hypotheses that were not supported suggest the need for further research to explore these non-significant findings.

5.2. Practical implications

The EFA conducted in the study revealed five distinct factors derived from the initial set of 18 variables. These factors hold practical implications and actionable insights for educational practitioners and policymakers, particularly in the areas of curriculum design, quality assessment, faculty development, student support strategies, and scale development. For instance, in curriculum design and enhancement, educators can align their course content with the identified factors, such as Course Relevance (CR2, CR1, CR3), to enhance educational relevance. In terms of quality assurance, the development of assessment metrics based on the factors can enable the monitoring and evaluation of educational programs. Furthermore, for faculty development and training, targeted initiatives can be tailored to instructors based on variables with high loadings, such as Instructor Quality (IQ2), to promote effective pedagogy. Similarly, student support strategies can focus on factors influencing learning outcomes, such as Learning Outcomes (LO1, LO2, LO3), to improve student performance. Additionally, the creation of composite scales, exemplified by the Course Satisfaction questionnaire scale, which displayed high factor loadings (CS1), can facilitate scale development and measurement.

The results obtained from the SEM analysis have significant implications for practitioners in this field. Firstly, this study provides profound insights into the relationship between course appropriateness and educators can leverage this relationship by clearly highlighting the relevance of course materials to students' future careers, personal development, or social issues. Policymakers can use this finding to make decisions regarding resource allocation and policies aimed at promoting the development of relevant teaching programs. Thirdly, confirming Hypothesis 3 indicates that educators should prioritize creating an environment that nurtures positive expectations, promotes active engagement, and provides goal-oriented support. Policymakers should instructor quality. While the study did not find a positive correlation between these two factors, it emphasizes that the level of course appropriateness and the quality of the instructor can be influenced by various factors. Practitioners can utilize this information to develop strategies that focus on improving course appropriateness and instructor quality individually, taking into account specific factors that contribute to each element. Secondly, the positive and significant relationship between Course Appropriateness and Course Expectations indicates that educators can leverage this relationship by clearly highlighting the relevance of course materials to students' future careers, personal development, or social issues. Policymakers can use this finding to make decisions regarding resource allocation and policies aimed at promoting the development of relevant teaching programs. Thirdly, confirming Hypothesis 3 indicates that educators should prioritize creating an environment that nurtures positive expectations, promotes active engagement, and provides goal-oriented support. Policymakers should consider these findings when shaping educational policies and allocating resources to support effective teaching practices and student success. Fourthly, as Course Expectations emerge as a reliable predictor of Course Satisfaction in our current study, educators should strive to create a positive learning environment that meets students' expectations and supports their progress. Policymakers should support educators in these efforts by prioritizing student satisfaction in policies and providing necessary resources for professional development and institutional support. Lastly, although Learning Outcomes did not have a significant relationship with Course Satisfaction, it highlights the need for educators and policymakers to consider a broader range of factors influencing student satisfaction. Educators should focus on creating an engaging learning environment, incorporating student feedback, and evaluating assessment methods. Policymakers should support educators in these efforts through policies that prioritize student satisfaction, provide resources for professional development, and promote a student-centered educational experience.

6. Conclusion

This study explored the dimensions and interactions of digital competencies among women with disabilities using EFA and SEM. Our experiment yielded five factors including Course Relevance, Instructor Quality, Learning Outcomes, Course Expectancy, and Course Satisfaction. These factors have implications for curriculum design, quality assessment, faculty development, student support strategies, and scale development. The SEM analysis revealed the complex nature of these constructs and provided insights into their relationships. Practitioners can use this information to develop targeted strategies for improving course appropriateness, instructor quality, and student expectations. Policymakers can make informed decisions regarding resource allocation and policies to promote

relevant teaching programs and positive learning environments for the marginalized groups. The study emphasizes the importance of creating an environment that fosters positive expectations, active engagement, and goal-oriented support. Educators should meet students' expectations and support their progress, while policymakers should prioritize student satisfaction and provide resources for professional development and institutional support.

Despite the contributions mentioned above, the conclusions drawn from this study may be constrained by several factors. These limitations, combined with unexpected results, present an opportunity for future research. The sample in this study was limited to women with disabilities, selected using non-probability sampling, a technique commonly employed in the literature. In contrast to studies involving a substantial sample size, the recruitment of participants for our research presents significant challenges due to the unique characteristics associated with disability. As a result, the generalizability of our findings to broader populations is limited. Nevertheless, our study contributes to the existing body of knowledge by providing evidence that supports future investigations. Furthermore, the study's examination of factors and their interactions was conducted over a brief period and within a specific region, thus further study is called to reexamine the factors in other regions so that the results could be reinforced and generalized. Furthermore, it is crucial to acknowledge that the conceptual framework employed in this study exclusively relied on the intended variables and factors. Consequently, to achieve a more profound comprehension of the patterns and behaviors exhibited within the digital environment, it is imperative to consider additional factors such as AI-powered tools. By doing so, a more comprehensive understanding can be attained, facilitating the reduction of the digital divide, and preventing the risk of lagging significantly behind in the era of artificial intelligence.

Ethical statement

This study was reviewed and approved by the Ethical Research Council of Thai Nguyen University of Information and Communication Technology (ERB02072022). All research subjects signed an informed consent form.

Data availability statement

Data associated with the study has not been deposited into a publicly available repository. Data are available from the corresponding author on reasonable request.

CRediT authorship contribution statement

Nguyen Thi Hai Anh: Writing – review & editing, Resources, Project administration, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Nguyen The Vinh:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDIX

No	Item	Scale – Likert (5)
Course Satisfaction		
1	How satisfied are you with the extent to which your needs are met in the online learning environment?	1 – Not at all 5 – Strongly satisfied
2	How satisfied are you with the overall quality of the training course?	1 – Not at all 5 – Strongly satisfied
3	How likely would you be to recommend this course to other women with disabilities who are interested in starting an online business?	1 – Strongly not recommend 5 – Strongly recommend
Course Relevance		
4	How relevant was the content of the training course to your job or area of interest?	1 – Strongly not relevant 5 – Strongly relevant
5	How strongly do you agree that the course provided practical and applicable information for starting an online business as a woman with disabilities?	1 – Strongly not agree 5 – Strongly agree

(*continued on next page*)

(*continued*)

No	Item	Scale – Likert (5)
6	How strongly do you agree that the course content was relevant to your specific needs as a woman with disabilities?	1 – Strongly not agree 5 – Strongly agree
Course Expectancy		
7	To what extent do you believe that this course will help you achieve your career goals?	1 – Strongly not believe 5 – Strongly believe
8	To what extent do you agree that the course met your expectations in terms of the topics covered and the skills taught?	1 – Strongly not agree 5 – Strongly agree
9	To what extent do you agree that the course content was aligned with what you anticipated based on the course description?	1 – Strongly not agree 5 – Strongly agree
	Instructor Quality	
10	How would you rate the quality of the instructor in delivering the training course content?	1 – Very low 5 – Very high
11	To what extent do you agree that the instructor provided valuable insights and guidance that were specific to women with disabilities in online business?	1 – Strongly not agree 5 – Strongly agree
12	To what extent do you agree that the instructor was approachable and responsive to your questions or concerns throughout the course?	1 – Strongly not agree 5 – Strongly agree
Course organization		
13	To what extent do you agree that the course technology (e.g., online platform, multimedia materials) was easy to use and helpful for learning?	1 – Strongly not agree 5 – Strongly agree
14	To what extent do you agree that the business training materials were well-structured and organized?	1 – Strongly not agree 5 – Strongly agree
15	To what extent do you agree that the course provided clear instructions and guidelines for each module or lesson?	1 – Strongly not agree 5 – Strongly agree
Learning Outcomes		
16	How confident do you feel in your ability to apply what you have learned in this course to real-life situations?	1 – Strongly not confident 5 – Strongly confident
17	To what extent do you agree that you feel more confident in your ability to run a successful online business after completing this course?	1 – Strongly not agree 5 – Strongly agree
18	To what extent do you agree that the course equipped you with practical skills and strategies that are applicable to your online business?	1 – Strongly not agree 5 – Strongly agree

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