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Students' perceptions of skills needed for labor in digital economy

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K E Y W O R D S

Digital economy,
Essential skills in the digital economy,
Education and training in the digital economy.

A B S T R A C T

This study examines the skills required for individuals to thrive in the digital economy and emphasizes the significance of education and training in developing these skills. The study focuses on four key skills: information technology (IT) skills, creative thinking skills, teamwork skills, and problem-solving skills. This study explores the definition and impact of the digital economy on workers, economic development, job creation, and sustainability. The research employed multiple correspondence analysis and random forest regression to analyze the data and evaluate the research model. The results demonstrated the reliability and meaningfulness of the scales used in the study, with evaluation metrics indicating a high level of accuracy in the research model. The article concludes by emphasizing the importance of equipping individuals with the necessary skills to succeed in the digital economy, and suggests future research directions.

1. Introduction

Digital economy is becoming an increasingly important part of the global economy. Understanding the skills needed to adapt to and succeed in the digital economy can give individuals and businesses a competitive advantage. Additionally, technology is advancing at a rapid pace, requiring workers to have new and flexible skills to keep up with changes. Research on these skills can help us better understand the challenges and opportunities of the digital economy.

In the digital economy, education and training play a crucial role in developing necessary skills. This research will help us to understand how education and training can meet the needs of workers in the digital age.

The objective of this study is to analyze the skills needed for individuals to adapt and succeed in the digital economy, such as IT, creative thinking, teamwork, and problem-solving skills.

There are several reasons why we have included these skills in the proposed research on skills needed for the labor force in the digital economy.

First, IT skills are an important factor in success in the digital economy. With the rapid development of technology, understanding and mastering new technologies have become a necessary requirement for individuals in the workforce.

Second, creative thinking is an important skill

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in adapting to the digital business environment. In an economy based on innovation, the ability to imagine, seek new solutions, and create value leads to individual success.

Third, teamwork skills are crucial in the digital economy. With the complexity and globalization of technical and business projects, the ability to work in teams and communicate effectively is important for achieving good results.

Finally, problem-solving skills are important in a digital business environment. With constant change and uncertainty, the ability to analyze problems, seek solutions, and adapt quickly leads to individual success.

2. Theoretical Foundations

2.1. Overview of the digital economy

2.1.1. Definition of the digital economy

The digital economy is an economic activity that relies on information in the form of numbers and utilizes digital computer technologies for online services, electronic payments, internet trade, and other industries (Qizi, 2023).

The digital economy focuses on the utilization and exploitation of digital technologies, such as the Internet, artificial intelligence, big data, blockchain, and digital communication, to generate value and promote economic development.

The digital economy has transformed the way businesses operate and created new opportunities for economic growth (Kseniia, 2019). This has given rise to new business models, from e-commerce to online services and mobile applications. The digital economy has also enhanced the connectivity and communication between individuals and organizations through social media platforms, email, online video conferences, and other technologies.

2.1.2. The impact of the digital economy on the necessary skills of workers

Digital technology is changing the way we work and creating new opportunities for workers (Parcheva, 2022). However, it also introduces new challenges and risks, especially for those without digital skills (Reinsalu, 2022).

One of the main impacts of the digital economy is a change in how we work. Digital technology has created new, diverse jobs. Workers can work remotely, participate in the sharing economy, and work in nontraditional forms. This provides flexibility and freedom of choice for workers while also enhancing connectivity and diversity in the labor market.

However, the digital economy presents both challenges and risks. Digital technology can replace traditional jobs and reduce labor demand. This can lead to unemployment and job loss for many people. Digital skills have become a necessary requirement for participation in the digital economy. Those without digital skills find it difficult to adapt and find employment in an increasingly digitalized world.

Therefore, the transition to a digital economy requires investments in education and training. Workers must be equipped with the necessary digital skills to participate in the digital economy. Additionally, governments and organizations need to create policies and support programs to help workers adapt to and benefit from the digital economy.

2.2. Skills needed in the digital economy

2.2.1. Information technology skills

Information technology (IT) is among the most important skills. With the rapid development of technology, understanding and using new technologies has become necessary. IT skills involve not only the ability to use computers and software but also working with data, analyzing data, and understanding the basic concepts of artificial intelligence and machine learning. In the modern digital economy, workers need to possess IT skills to compete and succeed in an increasingly digitized work environment (Tomašević, 2023). The following are some important skills that workers need to develop: computer and software, programming, project management and data analysis, and information security.

2.2.2. Creative thinking skills

Creative thinking skills in the digital economy are important for success (Zhyvko & Petrukha, 2023). IT skills include the ability to use and work with IT tools and software, understanding computer networks and information security, and knowing how to use IT applications to create value and solve problems. In the digital economy, IT skills are not only necessary for IT professionals but also for all other professions.

Therefore, learning and developing IT skills have become important factors for competing and succeeding in the digital economy.

2.2.3. Teamwork Skills

Teamwork skills play a crucial role in the digital economy (Soboleva & Karavaev, 2020). In today's digital economy, projects and tasks are often carried out by teams, rather than by individuals. This requires employees to have the ability to work together, share information and ideas, and interact effectively. Teamwork skills help to create a positive work environment in which people can learn from each other and develop new ideas. When working on a team, members can utilize their skills to solve complex problems and develop innovative solutions. Moreover, teamwork enhances diversity and collaboration, resulting in better outcomes. In the digital economy, projects often require a combination of technical, managerial, and soft skills. Teamwork helps leverage these skills and creates effective coordination among team members. This means that work can be completed quickly and with a higher quality.

2.2.4. Problem-solving skills

Problem-solving skills play a crucial role in the digital economy (Sit et al., 2017). In the digital economy, companies and organizations face complex and rapidly changing issues, ranging from managing big data to developing new technologies. To succeed, they require employees who can approach problems from multiple perspectives and find innovative solutions. Problem-solving skills in the digital economy include the ability to analyze information, ask questions, evaluate options, and make intelligent decisions based on available data and information. Logical and creative thinking is also required to develop new problem-solving methods.

In the digital economy, problems often arise not only in the field of information technology but also in many other areas such as marketing, strategic management, and data analysis. Therefore, problem-solving skills are not only necessary for IT experts but also for all professions in the digital economy. Furthermore, problem-solving skills play an important role in creating value and competitiveness for businesses in the digital economy. Companies need employees to identify challenging issues and find optimal ways to solve them. These skills enhance productivity and benefit business. Therefore, problem-solving skills are an important factor in the digital economy, and need to be trained and developed to meet the requirements of an increasingly complex and changing business environment. Some necessary problem-solving skills in the digital economy include analytical, time management, data analysis, and logical thinking skills.

2.2.5. Successful workers in the digital economy

A successful worker in the digital economy must possess the appropriate characteristics and skills to meet the demands of the modern labor market (Urbaniec, 2022). Some important factors are as follows: workers need to have technical skills to effectively operate in a digital environment, the ability to grasp and learn new knowledge to enhance their capabilities, quick thinking skills to come up with innovative solutions and new ideas to meet market demands, and effective communication skills and teamwork abilities to achieve common goals. Workers must understand the workings of the market and have the ability to align their work with business objectives. Technology and job requirements often change rapidly; therefore, workers need to be adaptable and flexible to respond to these changes. Workers must be able to analyze information, evaluate data, and manage projects to achieve high efficiency in their work.

These questions will help assess the level of success of a worker in adapting to and operating in the digital economy.

2.3. Research models

Based on the analysis and scale, the analytical model includes four independent variables: information technology skills (KNIT), creative thinking skills (TDST), teamwork skills (KLVN), and the problem of solving the problem (GQVD). The dependent variable is successful employees in the digital economy (LDTC), as shown in Figure 1.

3. Research method

3.1. Data

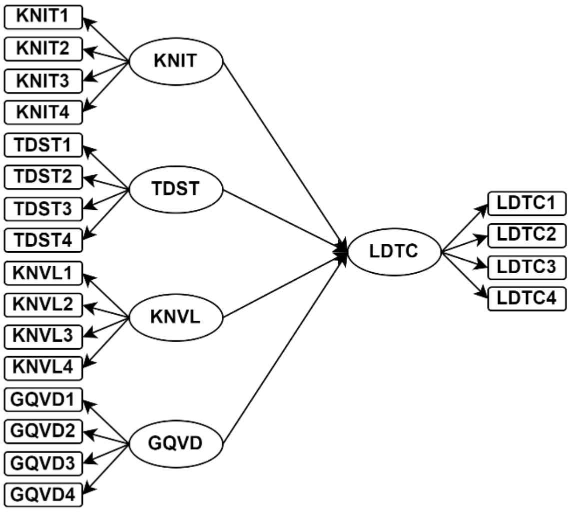

Figure 1. Analytical model

This study used a convenience sampling method. The survey included students and young staff from 4 universities in Ho Chi Minh City, Vietnam. Among these are two public and four private schools. The study used questionnaires and proceeded through two main steps: (1) preliminary research and (2) formal study to collect the primary data. An official survey was conducted between December 2023 and January 2024. The survey participants were young adults, primarily university students. In total, 220 printed questionnaires were sent. A total of 212 printed ballots were obtained (96.4%). After filtering data, 212 valid responses were obtained.

3.2. Analysis method

This study used the following analytical methods:

Initially, this study sought to establish the dependability of the scales by using McDonald's omega coefficients. The scale reaches quality when the McDonald's coefficient is greater than or equal to seven and the Corrected Item-Total Correlation is greater than three.

Subsequently, the present work undertakes an analysis of Multiple Correspondence (MCA), a statistical methodology employed to examine categorical data and concurrently investigate the interrelationships among many variables. This tool offers a graphical depiction of the associations between the different categories and variables.

Finally, the Random Forest regression technique was employed. The Random Forest Regression algorithm is a supervised machine learning technique that is commonly used to interpret research data. One of the primary benefits of Random Forest regression is its capacity to handle numerical and categorical variables effectively, thus obviating the need for substantial preprocessing. Missing values and outliers can be efficiently addressed using surrogate splits and aggregating predictions from several trees. Moreover, Random Forest Regression offers a means of assessing the significance of features, facilitating feature selection, and enhancing comprehension of underlying data relationships. An additional benefit of Random Forest Regression is its ability to mitigate overfitting. By employing a methodology in which each tree is trained on a randomly selected subset of data and features, the potential of individual trees to memorize extraneous information or anomalous data points within the training set is mitigated. The collective aspect of Random Forest regression aids in mitigating individual errors and generating predictions that are more resilient. The dataset was divided into two subsets to construct a Random Forest Regression model: 136 instances were allocated for training, 34 for validation, and 42 cases were set aside for testing. Various evaluation measures can be employed to evaluate the efficacy of a Random Forest regression model in terms of its quality. The metrics often used to assess the accuracy and goodness of fit of a model include mean squared error (MSE), root mean square error (RMSE), mean absolute error-to-mean total deviation ratio (MAE/MAD), mean absolute percentage error (MAPE), and R-squared. Owing to the novelty of breakthrough technologies, there is a need for more comprehensive research available for reference. In this study, five-point Likert scales were established through an expert debate involving 12 individuals possessing a profound comprehension of breakthrough technology and its implications for adolescent entrepreneurship.

4. Research Results

4.1. Scale test results

It is common for researchers to use Cronbach's alpha coefficient to test the reliability of the scale. However, recent studies have shown many limitations, such as Cronbach's alpha coefficient (α), which is rarely met depending on the assumptions. Cronbach's

Table 1. Mcdonald’s Omega Integration of factors

Factor	Corrected Item-Total Correlation	McDonald’s Omega if Item Deleted	McDonald’s Omega
KNIT1	0.831	0.823	0.889
KNIT2	0.739	0.870	
KNIT3	0.723	0.865	
KNIT4	0.712	0.876	
TDST1	0.744	0.824	0.870
TDST2	0.756	0.824	
TDST3	0.738	0.829	
TDST4	0.650	0.863	
KLVN1	0.776	0.820	0.870
KLVN2	0.710	0.851	
KLVN3	0.758	0.831	
KLVN4	0.676	0.867	
GQVD1	0.780	0.830	0.881
GQVD2	0.741	0.847	
GQVD3	0.674	0.870	
GQVD4	0.760	0.842	
LDTC1	0.571	0.751	0.779
LDTC2	0.609	0.725	
LDTC3	0.587	0.747	
LDTC4	0.599	0.731	

alpha coefficient (α) is an estimated score that does not indicate variation in the estimation process (Bonniga & Saraswathi, 2021). In comparison, McDonald’s Omega coefficient has more reliable characteristics.

The results show that McDonald’s coefficient ω for all variables is > 0.7, and the correlation coefficient between the remaining items is more significant than 0.3 (Table 1). The author concludes that these scales are suitable for analysis.

4.2. Multiple Correspondence Analysis

After testing the reliability of the scales, the required observed variables were included in the multiple correspondence analysis for the following results:

The results of the multiple correspondence analysis of independent variety scales showed that five factors (Table 2) were extracted from the original variables.

Table 2 presents the discrimination measures for four dimensions: KNIT, KLVN, TDST, and GQVD. Discrimination measures indicate the mean discrimination scores for each sub-dimension. The table 3 also provides the total scores for each dimension, labeled as “Active Total.” The values for KNIT, KLVN, TDST, and GQVD were 3.865, 3.669, 3.491, and 3.312, respectively. These values represent the sum of the mean discrimination scores for each sub-dimension within a dimension.

Furthermore, the table includes the percentage of the variance explained by each dimension. The values for KNIT, KLVN, TDST, and GQVD were 24.157, 22.930, 21.819, and 20.701%, respectively. These values indicate the proportion of the total variance in the data accounted for by each dimension.

In conclusion, the analysis results in the table provide information about discrimination measures for different dimensions and their subdimensions. The total scores for each dimension provide an overall measure of discrimination within that dimension, whereas the percentage of variance explained by each dimension indicates the importance of the dimension in explaining the overall variability in the data.

The results of the multiple correspondence analysis of dependent variety scales showed that five factors (Table 3) were extracted from the original variables.

Table 2. Discrimination Measures of the independent variables

	Dimension				Mean
	KNIT	KLVN	TDST	GQVD	
KNIT1	0.516				0.236
KNIT2	0.524				0.249
KNIT3	0.442				0.229
KNIT4	0.414				0.235
TDST1			0.548		0.236
TDST2			0.490		0.225
TDST3			0.525		0.222
TDST4			0.475		0.229
KLVN1		0.575			0.204
KLVN2		0.553			0.200
KLVN3		0.619			0.209
KLVN4		0.571			0.184
GQVD1				0.439	0.244
GQVD2				0.405	0.251
GQVD3				0.371	0.201
GQVD4				0.396	0.230
Active Total	3.865	3.669	3.491	3.312	3.584
% of Variance	24.157	22.930	21.819	20.701	22.402

Table 3. Discrimination Measures of the dependent variables

	Dimension	Mean
	LDTC	
LDTC1	0.771	0.771
LDTC2	0.700	0.700
LDTC3	0.632	0.632
LDTC4	0.653	0.653
Active Total	2.755	2.755
% of Variance	68.882	68.882

4.3. Random Forest regression Analysis

4.3.1. Assess the quality of the research model

This study used Evaluation Metrics, including MSE, RMSE, MAE/MAD, MAPE, and R^2, to evaluate the quality of the research model (Table 4).

The Mean Squared Error (MSE) is a commonly employed metric in regression models that quantifies the average squared discrepancy between the predicted and actual values. The approach emphasizes precise predictions while imposing stricter penalties for errors of greater magnitude. The non-negativity, sensitivity to outliers, and differentiability of this metric have contributed to its widespread adoption in assessing model performance. The mean squared error (MSE) data analysis yielded a value of 0.382. Hence, the disparity between the projected and observed values was relatively minor.

The root mean square error (RMSE) is a commonly employed statistical metric that quantifies the precision of prediction or forecast models. The computation of the square root of the mean-squared discrepancies between the predicted and actual values yielded a singular metric that effectively encapsulated the model's overall performance. The root mean square error (RMSE) the analytical results was 0.415. Hence, the discrepancy between the anticipated and

Table 4. Evaluation Metrics

Evaluation Metrics	Value
MSE	0.382
RMSE	0.415
MAE/MAD	0.464
R^2	0.602

Table 5. Feature Importance

Feature	Mean decrease in accuracy	Total increase in node purity	Mean dropout loss
KNIT	0.394	20.329	0.860
KLVN	0.305	20.080	0.826
TDST	0.099	12.045	0.667
GQVD	0.133	11.970	0.670

observed values was relatively minimal.

The mean absolute error (MAE) or mean absolute deviation (MAD) is a statistical metric employed to evaluate the precision of a forecasting model or methodology. The calculation divides the mean absolute error (MAE) by the mean absolute deviation (MAD). The Mean Absolute Error (MAE) quantifies the average size of errors within a given collection of forecasts. In contrast, the Mean Absolute Deviation (MAD) assesses the average dispersion of the data points around their mean values. The ratio of the Mean Absolute Error (MAE) to the Mean Absolute Deviation (MAD) was utilized as a composite metric to evaluate the accuracy of a measurement in terms of its variability. A more significant Mean Absolute inaccuracy (MAE) or Mean Absolute Deviation (MAD) percentage indicated a greater degree of inaccuracy concerning the variability in the dataset, thereby indicating a lower level of accuracy.

However, a decreased ratio of the mean absolute error (MAE) to the mean absolute deviation (MAD) signifies enhanced accuracy, as it suggests a reduced level of error concerning the overall variability. The analysis yielded an MAE/MAD value of 0.464, indicating a diminutive magnitude. This demonstrates that the analysis results exhibited a high level of accuracy.

The coefficient of determination (R^2) is a statistical metric used to quantify the proportion of variability in the dependent variable that can be accounted for by independent variables in the regression model. This factor facilitates the evaluation of the model's goodness of fit and predictive capacity. Nevertheless, it is imperative to use this metric with other statistical indicators to derive significant inferences from the regression analysis. According to the findings of this study, the coefficient of determination (R^2) was 0.92, indicating that the independent variables included in the model accounted for 60.2% of the observed variation in the digital competition.

4.3.2. Random Forest Regression result

Table 5 presents an overview of the significance of the properties of the variables in the model. By analyzing these metrics, we can determine the relative importance of each feature in the random forest regression model.

Table 5 provides the results of the three metrics used to measure the importance of each feature: mean decrease in accuracy, total increase in node purity, and mean dropout loss.

The mean decrease in accuracy measures the average decrease in the prediction accuracy when a particular feature is randomly permuted. A higher value indicated that the feature had a greater impact on the accuracy of the model.

The total increase in node purity measures the total increase in node purity (a measure of impurity or heterogeneity) when a particular feature is used to split nodes. A higher value indicates that the feature results in more pure and homogeneous splits.

The mean dropout loss measures the average increase in model performance when a particular feature is randomly removed. A higher value indicates that a feature has a greater impact on the performance of the model.

Based on the results, we can conclude that the features KNIT and KLVN have higher values across all three metrics than TDST and GQVD. This suggests that KNIT and KLVN are relatively more important features in predicting the target variable than TDST and GQVD.

4.4. Discussion of the research results

The results show that the McDonald's coefficient ω for all variables is > 0.7, and the correlation coefficient between the remaining items is more significant than 0.3. Multiple correspondence analysis of the independent variety scales showed that four factors (Table 2) and one factor (Table 3) were extracted from the original variables.

This study used Evaluation Metrics including MSE, RMSE, MAE/MAD, MAPE, and R^2 to evaluate the quality of the research model. The evaluation metric results show that the disparity between the projected and observed values is relatively minor. The discrepancy between the anticipated and observed values was relatively minimal. The average percentage difference between the predicted and actual values was comparatively low, indicating a high level of accuracy of the forecast findings. The independent variables included in the model accounted for 60.2% of the observed variation in the digital competition.

Based on the results of Random Forest Regression, it can be seen that the scales are meaningful and that the initial research hypotheses are accepted.

5. Conclusion and management implications

5.1. Conclusion

This study emphasizes the significance of specific skills in the digital economy and their role in individual adaptation and success. This research highlighted the importance of IT, creative thinking, teamwork, and problem-solving skills in navigating digital landscapes. Education and training were found to be crucial in the development of these skills. The use of multiple correspondence analysis and random forest regression demonstrated the reliability and meaningfulness of the scales used. The evaluation metrics further confirm the high accuracy of the proposed model. Overall, this study provides valuable insights into education and training programs aimed at preparing individuals for the challenges and opportunities of the digital economy. Further research is recommended to delve deeper into the identified skills and explore the additional dimensions of their impact. By understanding and cultivating these skills, individuals can enhance their prospects of thriving in the digital age.

5.2. Management implications

Based on the research findings, management implications are proposed to help workers equip themselves with the skills necessary to succeed in the digital economy. Workers should first focus on acquiring information technology (IT) skills. With the rapid development of information technology (IT), IT skills have become crucial for workers. To seize job opportunities and improve competitiveness in the labor market, workers should equip themselves with basic IT skills such as computer usage, office software, Internet access, and popular software tools such as Microsoft Office. Additionally, workers should familiarize themselves with emerging IT skills such as programming, data analysis, interface design, IT project management, and information security. They can acquire these skills through specialized training courses or through self-learning from resources and online courses. IT-related skills help workers work more efficiently and enhance their ability to analyze information, communicate, and utilize digital tools to perform work tasks. This strengthens competitiveness and career development in an increasingly technology-driven environment.

Workers need to be equipped with teamwork-related skills. Teamwork skills are crucial in the digital economy. Jobs in a digital environment often involve complex projects that require collaboration among team members. Effective teamwork requires communication skills, analytical and problem-solving skills, listening to and sharing opinions, and the ability to work in a multicultural environment. Education and training play vital roles in equipping workers with teamwork skills. Education and training programs should focus on developing communication skills, a teamwork mindset, negotiation and conflict resolution skills, and the ability to work in a multicultural environment. Technology also plays an important role in supporting teamwork in the digital economy. Modern information and communication technology provide tools and platforms to create an effective teamwork environment and facilitate online interactions. By using tools such as email, online video conferencing, and team collaboration applications, teams can work together efficiently, even when they are not physically present in the same location.

Furthermore, workers must be equipped with problem-solving skills. Problem solving skills are an essential aspect of the digital economy. With the rapid development of technology and constant changes in the business environment, the ability to effectively solve problems has become a necessary requirement for workers. In the digital economy, new problems often arise and require rapid resolution. Workers need to have the ability to analyze situations, identify the root causes of problems, and develop creative and effective solutions. Problem-solving skills also involve the ability to evaluate and choose between options based on available information. To equip workers with problem-solving skills, they must be trained and learned from real-life situations. Training programs should focus on developing analytical skills and logical and creative thinking skills. Additionally, participating in real-life projects and working in teams helps workers hone these skills.

Finally, workers must be equipped with creative thinking skills. Creative thinking skills are considered important for success in the digital economy. In the digital economy, creative thinking helps workers generate new ideas, develop innovative solutions to complex problems, and reshape traditional ways of working. Creative thinking skills also enable workers to leverage digital technologies and tools to create value for businesses and society. To develop creative thinking skills, workers must explore and tap into their creative potential. This can be achieved by learning from external inspirations, participating in courses and training programs on creative thinking, and practicing regularly to hone these skills. Additionally, workers must have an open mindset and be willing to embrace risks and failures in the creative thinking process. Policies and training programs also need to recognize the important role of creative thinking skills and ensure that workers are equipped with these skills. Schools and training organizations can actively promote creative thinking by providing innovative learning environments, encouraging students to engage in creative activities, and developing teaching programs based on creative thinking approaches.

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