A MODEL FOR ASSESSING THE DIGITAL TRANSFORMATION READINESS FOR VIETNAMESE SMES

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ABSTRACT

The paper aims to develop an econometric model for the routine diagnosis of enterprises' level of readiness for digital transformation (DT) on the example of small and medium-sized enterprises (SMEs) in Vietnam. The use of questionnaires allowed obtaining quantitative estimates of SMEs' level of readiness for DT in Vietnam. Factor analysis with the principal component method determines the list of factors of SMEs' readiness for DT. The ranges of the level of preparedness in Vietnam were determined, resulting in the classification of enterprises in the groups of "Newcomers," "Learners," and "Leaders" according to their use of digital technology and smart manufacturing. The integral index made it possible to quantify the impact of DT's readiness on SMEs' sustainability. The study results revealed that the nature of the impact depends on the level of SMEs' readiness for DT.

Keywords: digital transformation, small and medium-sized enterprises, Vietnam, business readiness, digital technologies, sustainable development

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INTRODUCTION

Global modern social and economic development is characterized by a radically new approach to production based on: scaling automation of business processes, the widespread introduction of information technology, and artificial intelligence in industry. According to estimates of the World Economic Forum, by 2025, more than half of the world economy will already operate based on digital technologies, which will allow businesses to earn more than 30 trillion dollars extra (World Economic Forum, 2021). Capgemini Consulting and the Sloan School of Management have found that companies will become less competitive in the marketplace by avoiding and disregarding the digitalization of economic processes, and profit levels will decrease by up to 24 percent per year (Massachusetts Institute of Technology, 2021). At the same time, more than 40% of the leading companies in their industry may be displaced from the market in the next five years if they lack the DT business model (Berman & Papas, 2021).

Global trends of active detailing of economic processes have necessitated the digitalization of production in Vietnam, where the business efficiency and competitiveness of the national economy are to be improved. Today, most companies, industries, and business structures in Vietnam are just beginning the digitalization

process; at the beginning of 2021, the country's digital economy amounted to 8.2% of GDP. At the end of 2020, the country had one of the lowest levels of e-commerce in Southeast Asia (within 3% of the country's retail turnover). Yet, it should be noted that during the 2016-2020 period, foreign investors invested about $1.9 billion in the digitalization of Vietnam's economy, which served to accelerate the pace of digital development in the country (Quynh, 2021). Vietnam approved the National DT Program up to 2025 with a focus on 2030 that implies Vietnam's among the top 50 countries in the UN's ICT Development Index and GDP growth of 30% by 2030 (Ministry of Information and Communications, 2020). Despite some losses to the Vietnamese economy due to the COVID-19 pandemic, social media account activity increased by 7 million between 2020 and 2021, reaching a penetration rate of 73.3% (Ministry of Planning and Investment, 2021). Due to Vietnam's current high level of internet access and high school students' academic performance, the progressive development and production of 5G equipment have a vast potential to blossom in the country's digitalization. According to the report, "By 2045, changes in awareness, corporate strategies, and incentives to digitalize business, administration and production activities may allow DT to provide an increase in GDP to $60.9 billion with a steady 0.38% annual growth rate, while the information economy will increase to $168.9 billion in the next 27 years (Table 1) (Cameron et al., 2019). However, these figures can only be achieved with the active participation of the SME sector in DT, which accounts for more than 97% of all enterprises and accounts for about 50% of Vietnam's GDP (Ministry of Planning and Investment, 2021).

Table 1: Scenarios for Vietnam's digital economy in 2045

Indicators		Heritage	Digitally Transformed	Digital Exporter	Digital Consumer
Accumulated additional GDP, over 27 years		US $60.9 billion	US $168.6 billion	US $66.9 billion	US $102.8 billion
Impact on annual growth		0.38%	1.1%	0.45%	0.63%
Risk of transformation of current jobs		18.4%	38.1%	19.1%	28.9%

It should be noted that big businesses in Vietnam provide the accelerated development of the DT economy. At the same time, the SME sector has faced a certain kind of pressure, as they cannot ensure rapid innovation in the production process, management system, or compete with large companies. Even though almost all the country's SMEs are aware of the DT need and benefits, about 60% of SMEs in Vietnam do not have enough resources to implement digital technology in the business process (PwC, 2021).

According to Rosenberg (2020), the digital maturity of small and medium-sized enterprises (SMEs) is only at the level of understanding and initial implementation. Because DT is a long-term process, the positive synergetic effect depends on each individual business unit, so it is relevant to seek the most effective approaches to adaptation of SMEs to digitalization. This, in turn, requires the development of a comprehensive assessment system based on a variety of correlated indicators of the economic status and digitalization potential of economic activities of companies, as well as the readiness for DT. In this paper, we developed a model to systematically evaluate companies' state-of-readiness in relation to the DT vision and assessment of its efficiency to ensure sustainable business development on the example of SMEs in Vietnam.

LITERATURE REVIEW

Numerous methods for assessing DT readiness were presented in the scientific

literature (Mittal et al., 2018; Nick et al., 2019; Castelo-Branco et al., 2019; Hitz & Schwer, 2018; Schwer & Hitz, 2018). In his scientific work, Mittal et al. (2018) explored the problems and attendant factors of the maturity of companies and businesses in general to DT. Scientists have developed an empirical scale of qualitative and quantitative parameters for assessing an organization's readiness to implement digital technologies. A comprehensive system of criteria for evaluating readiness has been developed, for example, customer, operation, culture, innovation, performance, and resources (Jung et al., 2016; Schuh et al., 2020; Brunet-Thornton et al., 2019). Maturity parameters for organizations are highly differentiated. The SIRI's assessment questionnaire and I Bench's maturity model contain 16 items. Another includes 139 questions (Axmann & Harmoko, 2020). An exciting methodology for assessing the readiness of an organization for IT implementation VDMA. It was based on 18 points of complexity parameters, characterized by quality levels of enthusiasm and professionalism in the DT implementation process: from the readiness level of an outsider to an expert and the best performer (Lichtblau et al., 2015). This approach is beneficial for the organization's self-assessment to understand the current state of readiness for DT.

Through studying smart manufacturing models in the world, such as Singapore's SIRI model, Taiwan's iBench model, VDMA's IMPULS model, Deloitte model, Openroad model, and Acatech model, providing a solid foundation for assessing the readiness of companies in DT (Jung et al., 2016; Schuh et al., 2020; Axmann & Harmoko, 2020; Lichtblau et al., 2015; Singapore Economic Development Board, 2019).

By applying those models, which are suitable for standardized and well-founded enterprises, many important steps in the process of successfully using DT are taken. However, Vietnamese enterprises, especially SMEs, still have a large gap to apply the complete model as above. Vietnamese SME enterprises have many unique factors. The awareness of business leaders about the necessity of DT, smart production, application of basic management tools in production such as Manufacturing JIT, Lean, Total productivity management still have many limitations, and the machinery systems are still not synchronized. Therefore, it is necessary to have a suitable DT readiness assessment model to evaluate limitations and build an appropriate DT roadmap for Vietnamese SMEs.

RESEARCH METHODOLOGY

Evaluating the Readiness of Vietnamese SMEs DT

In this study, we focus on building a DT readiness assessment model suitable to the characteristics of Vietnamese SMEs through 4 main dimensions of aspects with 16 variables that correspond to the areas of digital technologies use (Table 2).

Table 2: Model for evaluating the readiness of Vietnamese SMEs DT

Dimensions	Variables
Enterprise Management	Leadership
	Customer
	Human Resources
	Innovation culture
Productivity Management	Standards, management tools
	Level of application
	Process control
	Performance measurement
Digital Transformation Platform	Infrastructure platform
	Strategy for DT
	IT applications for DT
	Innovation management
Smart Manufacturing	Using sensor system in-process monitoring
	Building IT solutions
	Building a cloud-based database
	Application of Industry 4.0 solutions

Variables of models for assessing the readiness of Vietnamese SMEs DT are generated based on (Axmann & Harmoko, 2020; Singapore Economic Development Board, 2019; Jung et al., 2016; Schuh et al., 2020). Then consulted with experts and selected 16 observed variables. The expert group of 40 people included equipment suppliers, system builders for smart production, and scholars at the country's leading universities: Hanoi University of Science and Technology, Le Quy Don University of Science and Technology, Viet Nam National University Ho Chi Minh City.

The difference between this model and previous models is that it includes enterprise management and product management dimensions in the assessment model. Since these are dimensions that many Vietnamese SMEs are still limited to and need to be assessed to measure the ability to convert to intelligent manufacturing sustainably and systematically (Axmann & Harmoko, 2020; Jung et al., 2016).

To assess the readiness of Vietnamese SMEs DT, a survey was carried out within ten months in 2020. Total 510 companies participated in the survey, in which enterprises work in a field of manufacturing and processing industry accounts for the majority (33% of the sampling frame). In addition, there is participation from many enterprises in many other fields such as wholesale, retail, auto garage (8% of the sampling frame); construction (6%); food and lodging (6%); agriculture, forest and aquaculture (6%); professional, scientific, and technical services (5%); information and communication services (4%); education and training services (4%); financial, banking and insurance services (1%); logistics (1%); water supply, waste disposal and wastewater treatment and management (1%), other services (25%). Middle and top managers of the corresponding SME enterprises participated in the survey (10-13 representatives from an enterprise). The questionnaire consisted of 16 questions, each aimed at assessing the degree of development at the enterprise of the relevant sphere of digital technology use, given in Table 1. The questionnaire can be found at the link (Google Forms, 2021). The questionnaire adopted 5 points Likert scale comprising a range of strongly agree (5 points) to disagree (1 point) strongly.

The research used SPSS 23.0 software to assist in analyzing the data set after collection and used Cronbach's alpha test method to measure the reliability of the scales. Then all observed variables were calculated factor loading to ensure that all observed variables had high reliability and were considered to be of practical significance. A Bartlett's test was run to calculate the Kaiser-Meyer-Olkin criterion (KMO) and Significance coefficient (Sig.) to determine if there are statistically significant correlations between observed variables. This is a condition for confirmation the observations are suitable for factor analysis. Exploratory Factor Analysis (EFA) with the principal component method is performed to group observed variables into factors on the principle of ensuring monism and convergence. Confirmatory factor analysis (CFA) evaluates the fit of the Model Fit according to the indicators and conditions studied (Menke, 2018).

The results of the assessment of the readiness of Vietnamese SMEs DT can be seen as representative because:

- The sample is sufficient (510 enterprises with p = 0.05 significance level for the population (Taherdoost, 2017);
- Representatives of enterprises of different categories participated in the survey: FDI enterprises, Non-state enterprises, and State-owned enterprises;
- The opinions of management representatives for each company were consistent (coefficient of variation (≤ 9.76%) not exceeding 10% (Khaw et al., 2018));

Evaluating the Performance of Vietnamese SMEs DT for Sustainable Business Development

To assess the impact of the readiness of Vietnamese SMEs DT, we used linear and nonlinear regression analysis methods in the EViews 10 software. The sustainable business development indicator was used as a dependent variable (I_{SD}), the readiness of Vietnamese SMEs DT indicator was used as an in dependent variable (R_{DT}). The independent variable was calculated based on the questionnaire points as arithmetic mean score for all the questions in the questionnaire for the

respondents (representatives of one enterprise). The calculation of the arithmetic mean value for the respondents within one enterprise is possible due to the low variability (≤9.76%) of the assessments of the respondents (representatives of the same enterprise). To identify the features of the influence of the level of the readiness of SMEs DT on the sustainability of business development, the levels of the first indicator were determined. The range of actual values of the RDT indicator using the Student's test is divided into three levels: high, medium, and low. Indicator values that were not included in these ranges were used to assess intermediate levels.

The dependent variable of the model for assessing the impact of the readiness of Vietnamese SMEs DT on the sustainability of business development is represented by the integral indicator of sustainable development calculated for 2020:

- return on assets;
- return on equity;
- growth rates of labor productivity compared to 2019;
- cost coverage;
- the growth rate of the average wage per employee compared to 2019;
- the rate of growth of the wage fund of the enterprise in comparison with 2019;
- staff retirement rate;
- the share of payments made by the company related to the emission of pollutants into the atmosphere in the company's revenue.

The list of particular indicators of business sustainability is determined based on (Chen et al., 2021; Khan et al., 2021). The cumulative percentage of the variance of the factors formed by the indicated indicators was 88.3%.

Algorithm for calculating the integral indicator for assessing sustainable business development:

1. determining the sustainable development factors and their composition based on factor loadings of indicators based on the results of factor analysis;
2. determining the levels of particular indicators of sustainable development. Low, medium, high, as well as intermediate levels of sustainable development indicators are determined using the Student criterion similar to the levels of the indicator R_{DT};
3. calculating sub-indicators of sustainable development by factors and integral indicator of sustainable development (ISD), determination of the range of their levels using the fuzzy set method (Galiakhmetova et al., 2019). The levels of these indicators are determined by dividing the range of possible values into five equal intervals (levels): low, medium, high, and intermediate.

The integral indicator of sustainable business development was calculated using the following formulas:

$$I_{SD} = \sum (w_L \times p_i^L + w_M \times p_i^M + w_H \times p_i^H) \quad (1)$$

$$p_i^L = \begin{cases} 1, SD_i \le SD_{i1} \\ \dfrac{SD_{i2} - SD_i}{SD_{i2} - SD_{i1}}, SD_{i1} < SD_i < SD_{i2} \\ 0, SD_i \ge SD_{i2} \end{cases} \quad (2)$$

$$p_i^M = \begin{cases} 0, SD_i \le SD_{i1}, SD_i \ge SD_{i4} \\ \dfrac{SD_i - SD_{i1}}{SD_{i2} - SD_{i1}}, SD_{i1} < SD_i < SD_{i2} \\ \dfrac{SD_{i4} - SD_i}{SD_{i4} - SD_{i3}}, SD_{i3} < SD_i < SD_{i4} \\ 1, SD_{i2} \le SD_i \le SD_{i3} \end{cases} \quad (3)$$

$$p_i^H = \begin{cases} 1, SD_i \ge SD_{i4} \\ \dfrac{SD_i - SD_{i3}}{SD_{i4} - SD_{i3}}, SD_{i3} < SD_i < SD_{i4} \\ 0, SD_i \le SD_{i3} \end{cases} \quad (4)$$

with w_L, w_M, w_H as correcting coefficients, which take values of 0.1 for a low level of stimulating indicators and a high level of stimulating indicators; 0.5 for the average level of indicators; 0.9 for a high level of stimulating indicators and a low level of nonstimulating indicators (Galiakhmetova et al., 2019);

p_i^L, p_i^M, p_i^H as the probabilities of attributing i indicator of sustainable development to low, medium, and high levels, respectively;

SD_i as the value of i indicator of sustainable development;

SD_{i1}, SD_{i2}, SD_{i3}, SD_{i4} as the liminal values of i indicator, which lay the basis for the classification by levels;

$SD_i \le SD_{i1}$ as the zone of 100% certainty of attributing i indicator of sustainable development to the low level;

$SD_{i2} \le SD_i \le SD_{i3}$ as the zone of 100% certainty of attributing i indicator of sustainable development to the medium level;

$SD_i \geq SD_{i4}$ as the zone of 100% certainty of attributing i indicator of sustainable development to the high level;

RESULTS

Measure the Reliability of the Scales (Cronbach's Alpha) of the Questionnaire for the Readiness of Vietnamese SMEs DT

Through the results of Cronbach's alpha (Table 3), four groups of indicators of the readiness of Vietnamese SMEs DT have Cronbach's alpha coefficient from 0.853 to 0.908 are all greater than 0.6. The variable-total correlation coefficient is from 0.617 to 0.826, proving that all four groups of variables are satisfactory for the following exploratory factor analysis to reduce observed variables belonging to the research model.

Table 3: Measure the reliability of the scales using Cronbach's alpha test

Labels of observed variable	Observed variable	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Enterprise Management	Cronbach's alpha = 0,908				
Leadership	QLDN1	7.72	11.793	.817	.873
Customer	QLDN2	7.78	11.907	.774	.887
Human Resources	QLDN3	7.82	10.964	.826	.869
Innovation culture	QLDN4	8.00	11.769	.755	.894
Productivity Management	Cronbach's alpha = 0,863				
Standards, management tools	QLNS1	6.56	11.504	.768	.802
Level of application	QLNS2	6.61	11.468	.758	.806
Process control	QLNS3	6.49	11.988	.705	.828
Performance measurement	QLNS4	6.99	12.973	.617	.862
Digital Transformation Platform	Cronbach's alpha = 0,853				
Infrastructure platform	NTCDS1	6.43	10.535	.644	.837
Strategy for DT	NTCDS2	7.16	10.520	.699	.811
IT applications for DT	NTCDS3	6.63	11.070	.724	.802
Innovation management	NTCDS4	6.81	11.050	.721	.803
Smart Manufacturing	Cronbach's alpha = 0,874				
Using sensor system in-process monitoring	SXTM1	5.49	9.170	.693	.853
Building IT solutions	SXTM2	5.40	8.644	.779	.819
Building a cloud-based database	SXTM3	5.54	8.891	.763	.827
Application of Industry 4.0 solutions	SXTM4	5.55	8.479	.694	.856

Factors the Readiness of SMEs DT

The exploratory factor analysis process is carried out through 4 testing steps as follows:

1) Factor loading of all observed variables is > 0.5, proving that these observed variables have high reliability and are considered to be of practical significance (Menke, 2018);

2) Kaiser-Meyer-Olkin criterion (KMO) = 0.96 > 0.5 satisfy the suitability of factor analysis if $0.5 \leq KMO \leq 1$ (Menke, 2018);

3) Sig. = 0.00 < 0.05 in Bartlett's test indicates that there are statistically significant correlations between observed variables, so the observations are suitable for factor analysis;

4) Cumulative variance = 67.340%, meaning 67.340% of the total variance is explained by the factors, and this cumulative variance greater than 50% is suitable for factor analysis (Menke, 2018).

After performing the tests, the next step is to perform factor rotations to ensure that the observed variables belong to the factors, have factor loading coefficients greater than 0.5, and are evenly distributed over the factors. According to the Kaiser criterion, two factors were determined that characterize the readiness of Vietnamese SMEs DT. Variable NTCDS1 "Infrastructure platform" has factor loadings with selected factors 0.565 and 0.553, which indicates the impossibility of including this variable in any one factor (Menke, 2018).

The results of the factor rotation in Table 4 show that there is a disturbance between the variables of the factor groups, formed according to the results of the analysis of the relevant literature (Table 2) and according to the results of factor analysis (Table 4). So it is necessary to rename the factors accordingly as follows, based on the results of factor analysis:

Factor F1 is formed based on observed variables (SXTM3, SXTM4, SXTM2, NTCDS4, NTCDS2, NTCDS3, SXTM1, QLNS4) belonging to the group of factors "Smart production" and "Digital transformation platform" and element "Measurement of performance" should be named "Smart production and digital operation system."

Factor F2 is formed based on observed variables (QLDN1, QLDN3, QLDN2, QLNS1, QLNS2, QLNS3, QLDN4) belonging to the component "Business management" and "Productivity management" so-named "Business and process management."

Table 4: Factor rotation matrix in factor analysis results

Labels of observed variable	Observed variable	Component	
		Factor F1	Factor F2
Building a cloud-based database	SXTM3	0.83	
Application of Industry 4.0 solutions	SXTM4	0.80	
Building IT solutions	SXTM2	0.75	
Innovation management	NTCDS4	0.74	
Strategy for DT	NTCDS2	0.72	
IT applications for DT	NTCDS3	0.70	
Using sensor system to monitor the process (Sensor)	SXTM1	0.66	
Performance measurement	QLNS4	0.61	
Leadership	QLDN1		0.84
Human Resources	QLDN3		0.81
Customer	QLDN2		0.76
Standards, management tools	QLNS1		0.76
Level of application	QLNS2		0.72
Process control	QLNS3		0.71
Innovation culture	QLDN4		0.69
KMO			0.96
Sig. in Bartlett's test			0.00

The considered indexes to evaluate Model Fit include: Chi squared/df = 4.251 < 5, satisfy the acceptable level; comparative fit index (CFI) = 0.909 > 0.9 satisfy the good level; goodness of fit index (GFI) = 0.950 >0.95 satisfy the very good level; root mean square error of approximation (RMSEA) = 0.080 ≤ 0.08 satisfy the good level (Menke, 2018). Thus, there is a basis to conclude that the measurement model fits well with the real data.

The Readiness of Vietnamese SMEs DT

FDI enterprises, state-owned enterprises are further along with DT than non-state enterprises. The readiness measurement shows that DT is still in the early stages of development in Vietnam (Table 5).

Table 5: Overall results for DT readiness

Enterprise groups*	R_{DT} value range, points	The share of enterprises from the corresponding level of the R_{DT} indicator			
		FDI enterprises	Non-state enterprises	State-owned enterprises	Total
Newcomers	[1.0; 2.0]	36.85%	77.03%	48.39%	72.07%
Learners	(2.0; 3.4]	31.58%	16.24%	24.19%	17.77%
Leaders	(3.4; 5.0]	31.58%	6.73%	27.41%	10.15%
Average readiness		2.84	1.91	2.71	2.04

* - DT enterprise groups

72.07% of enterprises still have only a low level of DT and belong to the "Newcomers" group in the use of digital technologies. To date, 17.77% of enterprises are classified as "Learners." 10.15% of enterprises have so far reached the level of "Leaders." Since this level is the target vision of DT, it is not surprising that very few enterprises have reached this level. Reaching this target vision is a long-term goal for most companies in the sector. However, among the three groups of enterprises, non-state enterprises have the lowest level of readiness for DT. A 77.03% of non-state enterprises are classified as "Newcomers" and are so far involved in DT to a minimal degree. The FDI enterprises and State-owned enterprises are much more advanced in DT than non-state enterprises as a whole. The current DT readiness of Vietnam's enterprises, on a scale of 1 to 5, is 2.04. The score for the non-state enterprises as a whole is lowest at 1.907.

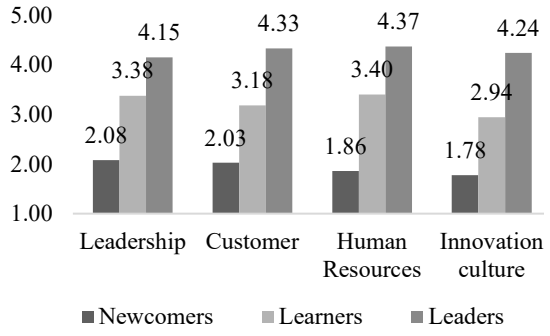


Figure 1a: The dimension of enterprise management

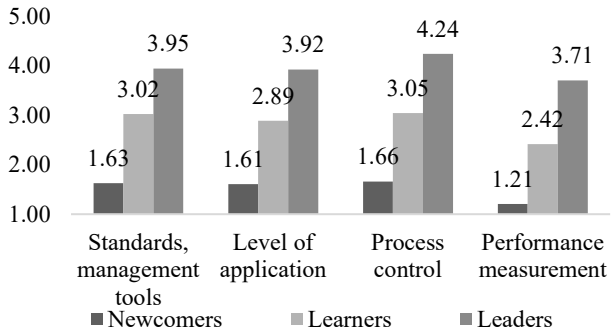


Figure 1b: The dimension of productivity management

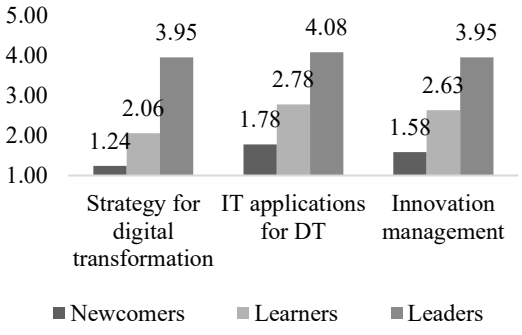


Figure 1c: The dimension of the DT platform

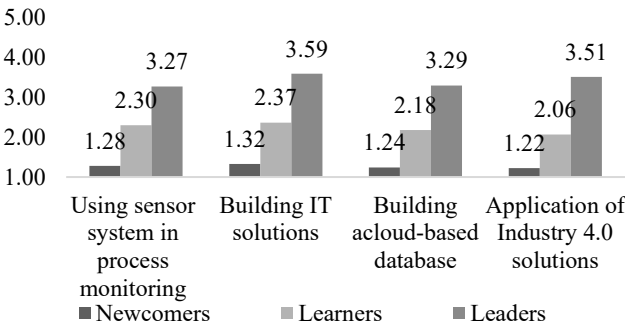


Figure 1d: The dimension of smart manufacturing

Figure 1: The readiness of Vietnamese SMEs DT indicators values

Source: Authors' work

The dimension of Enterprise Management has the highest scores in all three enterprises groups: 1.93 points for newcomers, 3.36 points for learners, and 4.41 points for leaders (Fig.

1a). This is a dimension that enterprises put on top and focus on development. In this model, this dimension is evaluated by four criteria: Leadership, Customers, Human resources, Innovation culture. Enterprises leaders moving towards DT need to identify the management principles needed for businesses, be courageous, and look toward the future. Naturally, Leaders will also be responsible for developing the vision, mission, policy, and goals in their statement. The criteria of Innovation culture is also a point needed to improve, especially the group of business learners, currently only 2.94 points.

The dimension of Productivity Management is stable when measured. In this model, this dimension is evaluated by four criteria: Standards, management tools; Level of application; Process control; Performance measurement (Fig. 1b). However, the criteria of Performance measurement are in need of improvement. Currently, this index is only 1.21 points for newcomers, 2.42 points for learners, and 3.71 points for leaders. The dimension of the DT Platform is evaluated by three criteria: Strategy for DT; IT applications for DT; Innovation management (Fig. 1c). However, the criteria of Strategy for DT has a very low score in the group of newcomers and learners, just 1.24 and 2.06, respectively. This is much lower when compared to overall scores.

The dimension of Smart Manufacturing has the lowest scores in all three enterprises groups: 1.26 points for newcomers, 2.27 points for learners and 3.53 points for leaders (Fig. 1d).

The Efficiency of Vietnamese SMEs DT to Ensure Their Sustainable Development

Using the Kaiser criterion, it was determined that the sustainable development of Vietnamese SMEs is described by two factors with values not lower than 1.0. This is a factor of economic and environmental efficiency (FEF), formed by indicators of return on assets and equity capital, cost coverage, growth rates of labor productivity, the share of payments associated with the emission of pollutants into the atmosphere in the company's income; and the factor of the development of labor potential (FLAB). This combined the indicators of the growth rates of the average wage per employee and the wage fund of the enterprise, the rate of retirement of personnel (Table 6). Factor loads between the indicated indicators and the corresponding factors are not less than 0.6; the value of the cumulative percentage of variance is 88.3%, which indicates the completeness of factorization (Menke, 2018).

Table 6: Load factors between sustainability indicators and factors of Vietnamese SMEs

Sustainable development indicators	Observed variable	Component	
		REF	F_{LAB}
Return on assets	*ROA*	0.80	
Cost coverage	*CR*	0.78	
Return on equity	*ROE*	0.75	
Labor productivity growth rates compared to 2019	*LP*	0.71	
The share of payments of the enterprise associated with the emission of pollutants into the atmosphere in the income of the enterprise	*EM*	-0.60	
The growth rate of the average wage per employee compared to 2019	*SAL*		0.91
Retirement rate	*RR*		-0.85
The growth rate of the wage fund of the enterprise compared to 2019	*WAG*		0.83
Factor dispersion,% Cumulative percentage of variance,%		46.3	42.0
Factor dispersion,% Cumulative percentage of variance,%		88.3	

The first factor characterizes the sustainability of SMEs development from the standpoint of operational efficiency. The second factor characterizes the movement of personnel (retirement rate) and includes indicators (growth rates of average wages and wages fund), which characterize the presence of financial motives to ensure the efficiency of

personnel and sustainable development of the enterprise. The selected factors were used as sub-indicators in the integrated model for assessing the sustainable development of Vietnamese SMEs (pair correlation coefficient is 0.18). The sustainable development levels of Vietnamese SMEs are summarized in Table 7.

Table 7: Ranges of levels of private and integral indicators of sustainable development of Vietnamese SMEs

Indicator	Levels			Indicator	Levels		
	Low	Medium	High		Low	Medium	High
ROA	(-∞; -0.02]	[0; 0.08]	[0.18; +∞)	*WAG*	[0; 0.83]	[0.95; 1.05]	[1.12; +∞)
ROE	(-∞; 0]	[0; 0.12]	[0.23; +∞)	*RR*	[0; 0.16]	[0.24; 0.49]	[0.63; 1]
LP	[0; 0.92]	[1.01; 1.09]	[1.20; +∞)	*EM*	[0;0.19]	[0.24; 0.36]	[0.48; 1]
CR	[0; 0.19]	[0.29; 0.38]	[0.44; +∞)	F_{EF}, F_{LAB}, I_{SD}	[0.1;0.26]	[0.42; 0.58]	[0.74; 0.9]
SAL	[0; 0.87]	[0.92; 1.08]	[1.19; +∞)				

ROA is the return on assets; *ROE* is the return on equity; *LP* is the growth rates of labor productivity compared to 2019; *CR* is the cost coverage ratio; *SAL* is the growth rate of the average wage per employee compared to 2019; *WAG* is the growth rate of the company's wage fund compared to 2019; *RR* is the staff retirement rate; *EM* is the share of payments of the company associated with the emission of pollutants into the atmosphere in the company's income; F_{EF} is the factor of economic and ecological efficiency; F_{LAB} is the factor in the development of labor potential; I_{SD} is the integral indicator of sustainable business development.

Private indicators of sustainable development are mainly stimulators of development, and high levels indicate sustainable business development. It serves as the indicator of the share of payments of the enterprise associated with the emission of pollutants into the atmosphere in the enterprise's income. Also, the rate of retirement of personnel is disincentives. The high level of these indicators indicates a low level of sustainable development due to ineffective use of labor potential and ineffective environmental management at the enterprise.

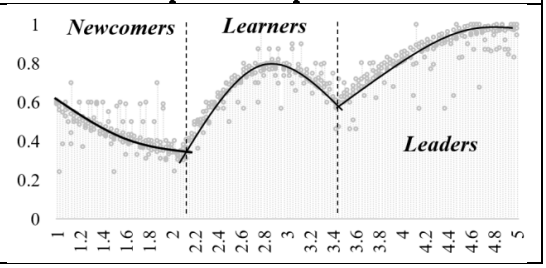
The grading of Vietnamese SMEs by the level of sustainable development is shown in Table 8.

Table 8: Distribution of Vietnamese SMEs by sustainability level

Sustainable development level	The share of enterprises from the corresponding level of the I_{SD} indicator			
	FDI enterprises	Non-state enterprises	State-owned enterprises	Total
Low	30.56%	52.98%	34.21%	50.00%
Intermediate	2.78%	2.98%	5.26%	3.14%
Medium	36.11%	33.49%	31.58%	33.53%
Intermediate	2.78%	2.75%	2.63%	2.75%
High	27.78%	7.80%	26.32%	10.59%
Mean value	0.48	0.35	0.47	0.36

The construction of linear regression models did not confirm a direct relationship between the readiness of Vietnamese SMEs DT (R_{DT}) and the integral indicator of sustainable development of enterprises (I_{SD}). In this regard, nonlinear estimation was used (Table 9).

Table 9: Models for assessing the impact of the readiness of Vietnamese SMEs DT readiness on the sustainability of their development

Enterprises*	Model	t-statistic**	Graphic interpretation
Newcomers	$I_{SD} = 0.46/R_{DT} + 0.13$	$t(R_{DT})=7.24$	
Learners	$I_{SD} = -0.69 \times R_{DT}^2 + 3.99 \times R_{DT} - 4.98$	$t(R_{DT}^2)=-2.94$ $t(R_{DT})=5.62$	
Leaders	$I_{SD} = -0.17 \times R_{DT}^2 + 1.65 \times R_{DT} - 3.13$	$t(R_{DT}^2)=-2.98$ $t(R_{DT})=4.15$	

* - DT enterprise groups;

** - t-criterion level.

The adequacy of the models was confirmed by the size and variability of the sample of the surveyed SME business units in Vietnam. It represented 368 enterprises from the "Newcomers" group, 91 enterprises from the "Learners" group, and 52 enterprises from the "Leaders" group. The number of observations exceeds the number of variables by at least 26 times, which indicates the sufficiency of the sample (Jenkins & Quintana-Ascencio, 2020). The empirical values of the t-criterion exceed the critical ones at a significance level of p = 0.05 and are in the |2.94|-|7.24| range.

DISCUSSION AND CONCLUSION

As part of the study, an empirical model was developed, which made it possible to conclude that the studied Vietnamese SMEs are predominantly at a low level of sustainable development (50%). Non-state enterprises mostly represent this group of enterprises, 52.98% of which have a low level of sustainable development. 33.53% of enterprises are at the average level, 10.59% are at the high level. Intermediate levels are represented by 3.14% of enterprises for the transitional level between low and medium, 2.75% of enterprises for the level intermediate between medium and high. The results indicate the need to improve economic and environmental efficiency and develop labor potential to ensure sustainable business development. In contrast to the existing ones, the developed model considers the peculiarities of the functioning and the current level of development of SMEs in a particular country (Hitz & Schwer, 2018; Castelo-Branco et al., 2019; Schwer & Hitz, 2018). It can serve as a tool for ongoing diagnostics for effective adaptation to DT at any stage of enterprise development. It allows one to assess the differentiated nature of the impact of the level of use of digital technologies on the sustainability of SME development (Shahrom et al., 2021).

The analysis results showed the differentiated nature of the influence of the DT readiness indicator on the sustainability of business development. For enterprises at the stage of episodic implementation of digital technologies, the expansion of the scale of their use leads to a decrease in sustainable development. The revealed pattern is explained by the fact that for these enterprises, the positive effect of digital technologies is leveled out due to the significant costs associated with the introduction of technologies, the rejection of new technologies by workers, and psychological tension negatively affects labor productivity. Further implementation of digital technologies (for the "Learners" group of enterprises) allows you to experience such positive results as increased labor productivity, capital productivity, environmental friendliness of the production process, which leads to sustainable business development. This positive impact on the sustainability of development is observed until a certain point, after which the decline in the integral indicator of sustainable development begins. The turning point comes as a result of the fact that the use of digital technologies makes it necessary to optimize the workforce of enterprises because some of the work previously performed by personnel becomes automated and requires less labor force participation. There is a reduction in staff and a decline in

sustainable development in terms of its social component in such conditions.

For "Leaders" enterprises, the development of digital technologies has a positive effect on the dynamics of the integral indicator of sustainable development. The use of digital technologies makes it possible to increase economic efficiency by increasing labor productivity, reducing the cost of manufacturing products or providing services, reducing the percentage of rejects resulting from using newer and improved technologies, and increasing the validity of management decisions. In the environmental component, a positive impact on the sustainability of development is reflected by reducing environmental pollution and associated costs. Social development is ensured because, despite the reduction in the number of personnel, the demand for highly qualified workers with a higher level of remuneration is growing at enterprises. The revealed patterns indicate that the introduction of digital technologies in the long term ensures sustainable business development.

The results obtained are based on a sample of Vietnamese enterprises, which does not allow their implementation in the practice of SMEs in other countries. In addition, within the framework of this study, a forecast of sustainable development of the SME sector was not carried out depending on the level of DT and the potential level of effect for the country's economy. These issues require extensive research and will be studied by us in our prospective studies.

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Appendix 1: Questionnaire

Dear respondents,

Indicate to what extent you can agree with the statements of the questionnaire regarding the DT readiness of the enterprise where you work:

1. *Leadership:* The leadership of your enterprise is aware of the need to digitalize business and supports digital transformation initiatives. The management defines the management principles aimed at business digitalization.
2. *Customer:* The use of digital technologies allows you to optimize relationships with customers and increase their satisfaction.
3. *Human Resources:* The reason for the improvement in the quality and satisfaction of work is the use of digital technologies.
4. *Innovation culture:* Your enterprise has a developed innovative culture. Innovation is well received by management and employees.
5. *Standards, management tools:* Your enterprise has developed standards that govern the digital transformation process.
6. *Level of application:* Your enterprise pursues the course on digitalization and innovation.
7. *Process control:* The process of introducing digital technologies is regulated, the stages and tasks of digitalization are determined, the digitalization process is monitored.
8. *Performance measurement:* The use of digital technologies has boosted labor productivity in your enterprise, while there is potential for further productivity gains.
9. *Infrastructure platform:* Your enterprise has a well-developed infrastructure for effective digitalization.
10. *Strategy for DT:* Your enterprise has its strategy for DT.
11. *IT applications for DT:* The enterprise operates IT applications for DT, expanding their functionality.
12. *Innovation management:* The activities of your enterprise are aimed at the introduction of new products and services, production and management processes.
13. *Using sensor system in-process monitoring:* Your enterprise is using sensor system in-process monitoring.
14. *Building IT solutions:* Your enterprise uses and creates new IT solutions to improve business efficiency.
15. *Building a cloud-based database:* Your enterprise uses a cloud-based database.
16. *Application of Industry 4.0 solutions:* Your enterprise uses Industry 4.0 solutions.

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