Assessment of factors influencing digital transformation in Vietnamese Pharmaceutical Enterprises

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Summary

Objective: This study aimed to assess the degree of influence of key factors on influencing the digital transformation (DT) maturity level among Vietnamese pharmaceutical enterprises. *Subject and method:* A cross-sectional study was conducted on 150 pharmaceutical enterprises. Data was collected using a validated survey instrument administered to key informants (e.g., C-level executives, department heads). The survey measured eight factor groups (C1–C8) on a five-point Likert scale. Data analysis employed Cronbach's alpha, descriptive statistics, one-way ANOVA by enterprise size, and multivariate regression. *Result:* The measurement scales demonstrated high reliability (Cronbach's alpha > 0.87). A notable finding was that large enterprises (≥ 200 employees) achieved the highest DT maturity, whereas medium-sized enterprises (100-199 employees) reported the lowest. Regression analysis identified three primary drivers of DT maturity: C1 - Strategic focus on business model innovation (β = 0.246), C2 - Corporate digital strategy (β = 0.178), and C5 - Technological infrastructure (β = 0.168). Interestingly, C4 - The perceived impact of DT on current business performance was not a statistically significant predictor, suggesting that transformation is driven more by strategic foresight than by realized short-term gains. *Conclusion:* Business model innovation, a clear digital strategy, and robust technological infrastructure are the three foundational pillars for advancing DT maturity in Vietnam's pharmaceutical industry. The findings suggest that current DT initiatives are largely vision-led rather than performance-driven. Policymakers should prioritize support for medium-sized enterprises in finance, policy, and workforce training to help them overcome unique barriers and bridge the maturity gap.

Keywords: Digital transformation; pharmaceutical enterprises; Vietnam; influencing factors.

I. BACKGROUND

Digital transformation (DT) has emerged as a critical driver in the global pharmaceutical sector, underscored as a means of enhancing efficiency across the entire value chain - from research and development, manufacturing, and distribution to patient care [1], [6]. A growing body of literature highlights that DT not only improves productivity but also enables new business models, thereby strengthening the industry's competitiveness [2], [3].

In Vietnam, DT in the pharmaceutical domain has been promoted through national strategies on digital health and technological innovation. However, substantial heterogeneity remains among enterprises: while larger firms have already adopted ERP, CRM, AI, and blockchain solutions to manage their supply chains, many small - and medium-sized enterprises (SMEs) remain at an early, experimental stage. This situation mirrors experiences in other developing countries, where internal resource capacity often determines digital maturity more strongly than external policy frameworks [5], [4].

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Previous studies, both domestic and international, have largely focused on describing the current status of DT, with limited analysis of the underlying factors shaping digital maturity in the pharmaceutical sector [7]. Against this backdrop, the present study seeks to provide a quantitative assessment of the determinants influencing DT levels among Vietnamese pharmaceutical enterprises, thereby offering empirical evidence to inform corporate management strategies and policy development for the sector.

II. SUBJECT AND METHOD

2.1. Research Methodology

2.2.1. Research subjects

The study targeted 150 Vietnamese pharmaceutical enterprises as the unit of analysis. A total of 518 key personnel (C-level executives, managers, IT specialists) from these entities participated in the survey to provide a multi-perspective assessment.

2.2.2. Research design and procedure

Design: Cross-sectional, descriptive, and quantitative study.

Sample size: The minimum sample size was calculated using the following formula: where:

$$n = Z^2_{1-\alpha^2} \times (p \times (1-p))/d^2$$

Where:

Z=1,96, corresponding to a 95% confidence level (α=0,05);

p=0,5 (estimated proportion of enterprises implementing DT; selected to maximize (px(1−p));

d=0,05 (permissible margin of error).

The minimum required sample size was n=385. Adding an additional 10% to account for invalid or incomplete responses, the final required sample size was approximately 424. In practice, the research team collected 518 valid responses, which were used for analysis.

Sampling method: Convenience sampling was employed, utilizing both online surveys (via Google Forms) and direct distribution of questionnaires at enterprises.

Survey content: The questionnaire included 8 groups of independent variables reflecting factors influencing digital transformation in pharmaceutical enterprises, and 1 group of dependent variables representing the level or effectiveness of digital transformation. Each group of factors was measured using multiple criteria, encoded using a 5-point Likert scale.

DT maturity is defined as the extent to which an enterprise has integrated digital technologies into its business model, operational processes, and customer experiences. It is measured as the dependent variable based on a composite score of digital readiness and implementation intensity.

Table 1. Summary of factor groups and observed variables

Factor Group	Code	Number of observed variables	Main Content
Business model & performance	C1	9	Degree of business model innovation, utilization of digital platforms, data exploitation, and operational efficiency optimization.
Corporate strategy	C2	4	Vision, orientation, competitive advantage, and strategic resources for digital transformation.
Human resources	C3	4	Digital skills, training, innovation culture, and talent acquisition.

Factor Group	Code	Number of observed variables	Main Content
Impact of DT on business performance	C4	10	Impact of digital technologies on revenue, profit, productivity, and customer experience including: revenue growth, cost reduction, process speed, error reduction, customer satisfaction improvement, and market share expansion.
Technological infrastructure	C5	5	IT infrastructure, cloud computing, cybersecurity, and system integration.
Digital environment	C6	4	Level of technological change, innovation pressure, and security challenges.
Pharmaceutical industry characteristics	C7	4	Industry competitiveness, legal specificity, and digitalization needs of the sector.
Government policy & regulation	C8	4	Governmental support, legal regulations, and state programs promoting digital transformation.

All indicators in the questionnaire were measured using a five-point Likert scale, reflecting the respondents' level of agreement with each statement (ranging from 1 – Strongly Disagree to 5 – Strongly Agree).

The mean score of each factor group was calculated using the following formula:

Mean score of factor group i:

$$X_{i=} \frac{\sum_{j=1}^{ni} Xij}{ni}$$

Where: X_{ij}: score of the *j*-th observed variable in factor group *i*; n_i: number of observed variables in factor group *i*.

2.3. Data Analysis

Reliability test:

Cronbach's Alpha was employed to assess the internal consistency of variables within each factor group. The reliability criteria were set as follows: Cronbach's Alpha coefficient ≥ 0.7 and Corrected Item-Total Correlation ≥ 0.3.

Exploratory factor analysis (EFA):

The Kaiser-Meyer-Olkin (KMO) measure was required to be ≥ 0,5, and Bartlett's Test of Sphericity had to show significance (sig < 0,05), ensuring the suitability of the data for EFA. Variables with a factor loading ≥ 0,5 were retained for further analysis. The extracted factors were expected to reflect the eight theoretical constructs initially proposed.

Correlation and multiple linear regression analysis:

To determine the extent to which each factor (C1–C8) influences the overall level of digital transformation (Y).

The general regression model was specified as:

$$Y=\beta_0+\beta_1C_1+\beta_2C_2+\beta_3C_3+\beta_4C_4+\beta_5C_5+\beta_6C_6+\beta_7C_7+\beta_8C_8+\varepsilon$$

Key model significance indicators - F-test, R^2, and Sig values - were examined, along with the standardized beta coefficients (β) to evaluate the relative influence of each factor on the digital transformation level of pharmaceutical enterprises.

2.4. Research ethics

Participants were fully informed about the study and voluntarily consented to take part. All data were anonymized, coded, and used solely for research purposes.

III. RESULTS

In this section, clear and concise research results should be displayed. Appendices or supplementary documents can be used if necessary.

3.1. Sample characteristics

The sample of 150 Vietnamese pharmaceutical enterprises surveyed in this study is characterized by several key features.

Structurally, the sample is predominantly composed of small (25%) and medium-sized (50%) enterprises, a composition that reflects the broader sector.

Furthermore, the firms demonstrate significant longevity and stability, with a large majority (70%) having been operational for over a decade, which may present challenges related to legacy technology systems.

From a financial and legal standpoint, the prevalence of the joint-stock company model (80%) and annual revenues commonly exceeding VND 10 billion suggests a favorable foundation for capital mobilization and investment.

Operationally, these enterprises are primarily focused on the core areas of traditional drug manufacturing and distribution (60%).

3.2. Results of the assessment of factor groups influencing digital transformation maturity

Table 2. Results of factors influencing digital transformation maturity and reliability testing of the measurement scales

Factor	Code	No. of items	Mean ± SD	Cronbach's Alpha
Business model & performance	C1	9	4.05 ± 0.73	0.903
Corporate strategy	C2	4	4.01 ± 0.74	0.889
Human resources	C3	4	3.99 ± 0.73	0.876
Impact of DT on business performance	C4	10	4.07 ± 0.70	0.919
Technological infrastructure	C5	5	4.07 ± 0.71	0.894
Digital environment	C6	4	4.04 ± 0.73	0.873
Pharmaceutical industry characteristics	C7	4	4.10 ± 0.74	0.880
Government policy & regulation	C8	4	4.05 ± 0.73	0.881

Table 2 presents the mean scores and standard deviations (Mean ± SD) of the eight factor groups influencing the level of digital transformation (DT) maturity in Vietnamese pharmaceutical enterprises. Overall, all factors were rated relatively high, with mean scores ranging from 3.99 to 4.10 (out of 5) and standard deviations between 0.70 and 0.74, indicating a relatively strong consensus among enterprises regarding the importance of these factors.

Reliability analysis using Cronbach's alpha was conducted for the eight factor groups in Section C of the survey tool (C1–C8). Results showed that all groups achieved Cronbach's alpha coefficients above 0.87, surpassing both the conventional acceptability threshold (0.70) and the "good" level (0.80) as recommended by Nunnally & Bernstein (1994). This confirms that the observed variables within each group exhibit high internal consistency and that the scales were appropriately designed for studying factors influencing digital transformation in pharmaceutical enterprises in Vietnam. Consequently, the collected data are considered reliable and suitable for subsequent analyses (descriptive statistics, group comparisons, regression) without the need to eliminate any observed variables.

Following the confirmation of scale reliability, descriptive analysis was performed on the eight factor groups in Section C. The results indicated that the mean values of all factors fell between 3.9 and 4.1 on a five-point scale, with standard deviations around 0.7. This suggests that Vietnamese pharmaceutical enterprises, in general, place high importance on the factors influencing digital transformation, and the relatively low dispersion of responses reflects a notable degree of consensus among managers and executives.

3.3. Comparison by enterprise size

Table 3. Results of comparison by enterprise size

Factor	Code	Small (10-99 employees)	Medium (100-199 employees)	Large (≥200 employees)
Business model & performance	C1	4.06 ± 0.74	3.62 ± 0.55	4.25 ± 0.65
Corporate strategy	C2	3.98 ± 0.75	3.62 ± 0.65	4.23 ± 0.65
Human resources	C3	3.97 ± 0.73	3.72 ± 0.63	4.24 ± 0.67
Impact of DT on business performance	C4	4.01 ± 0.72	3.68 ± 0.64	4.19 ± 0.69
Technological infrastructure	C5	4.02 ± 0.71	3.60 ± 0.62	4.26 ± 0.66
Digital environment	C6	4.03 ± 0.73	3.82 ± 0.66	4.18 ± 0.68
Pharmaceutical industry characteristics	C7	4.07 ± 0.74	3.84 ± 0.67	4.22 ± 0.69
Government policy & regulation	C8	4.02 ± 0.74	3.78 ± 0.57	4.21 ± 0.67

Average scores for all eight factors were highest among large enterprises (4.18–4.25), lowest among medium-sized enterprises (3.60–3.84), and moderate among small enterprises (3.97-4.07) (Table 3). The largest differences appeared in C1 (business model & performance), C2 (strategy), and C5 (infrastructure), confirming that these dimensions are strongly resource-dependent. Meanwhile, C3 (human resources) remained relatively weak across all sizes, suggesting a systemic skill gap. Overall, the analysis indicates that large enterprises lead in DT readiness, while medium firms represent a vulnerable group requiring targeted support to narrow the digital capability gap within Vietnam's pharmaceutical sector.

- C1 (Business model & performance), C2 (Strategy), and C5 (Technological infrastructure): the largest gaps appeared between large and medium enterprises, highlighting the crucial role of resources in these three pillars.

- C3 (Digital human resources): relatively low across all three groups (~3.7–4.0), suggesting a common weakness across the sector.

- C6 (Digital environment) and C8 (Policy): showed smaller differences across groups, indicating these external factors affect enterprises more uniformly.

In summary, large enterprises demonstrate the highest readiness for DT, small enterprises show dynamism but remain constrained by resources, while medium-sized enterprises represent the most vulnerable group ("digital gap") that requires priority support to avoid falling behind in the digitalization process of the pharmaceutical sector.

3.4. Results of baseline regression analysis

To examine the relative influence of each factor on digital transformation (DT) maturity, we constructed a multivariate linear regression model with DT maturity as the dependent variable and the eight factor groups (C1–C8) as independent variables. Based on the Technology-Organization-Environment (TOE) framework and specific characteristics of the pharmaceutical industry (highly regulated), eight factor groups were selected for the regression model to comprehensively cover internal and external drivers.

Table 4. Results of regression analysis

Factor	β	p-value	CI low	CI high
Business model & performance	0.246	0.000	0.178	0.315
Corporate strategy	0.178	0.000	0.117	0.238
Human resources	0.072	0.015	0.014	0.129
Impact of DT on BP	0.004	0.915	-0.072	0.080
Technological infrastructure	0.168	0.000	0.108	0.228
Digital environment	0.089	0.001	0.036	0.142
Industry characteristics	0.071	0.019	0.012	0.131

Note: β: Standardized Beta coefficient; CI: Confidence Interval.

The results highlight several key findings.

C1 - Business model & performance (β = 0.246; p<0.001): This emerged as the strongest predictor, indicating that innovation in business models and efficiency gains from digital solutions act as a core driver of DT maturity.

C2 - Corporate strategy (β = 0.178; p < 0.001): A clear digital strategy serves as the second most important pillar; firms with well-defined strategic orientations tend to achieve higher levels of DT maturity.

C5 - Technological infrastructure (β = 0.168; p<0.001): Investment in foundational technologies (e.g., ERP, CRM, cloud, big data) exerts a significant and tangible effect on DT maturity.

C6 - Digital environment (β = 0.089; p = 0.001): This factor contributes meaningfully, reflecting the influence of rapid technological developments in the broader ecosystem.

C8 - Government policy (β = 0.089; p=0.003): Supportive regulation and coherent legal frameworks reinforce the DT process.

C3 - Human resources (β = 0.072; p=0.015): Although positive, its effect is more modest compared with the core factors above.

C7 - Industry characteristics (β = 0.071; p=0.019): Changes in market demand and competitive pressures also encourage DT adoption.

C4 - Impact of DT on business performance (β = 0.004; p=0.915): This factor lost statistical significance when included in the model, likely due to overlap with fundamental drivers such as C1, C2, and C5.

In summary, C1 (business model & performance), C2 (corporate strategy), and C5 (technological infrastructure) stand out as the most influential and reliable factors underpinning DT maturity. Other factors (C3, C6, C7, C8) provide complementary support, while C4 appears to be an outcome rather than an independent driver. The overall model demonstrated a strong fit with R^2 = 0.885, explaining 88.5% of the variance in DT maturity across firms, with all coefficients tested at the 5% significance level.

3.5. Pivotal determinants of DT maturity and strategic implications

The regression analysis elucidated three factors with positive and statistically significant (p < 0.05) standardized regression coefficients (β), establishing them as pivotal determinants of digital transformation (DT) maturity.

First and foremost, C1 – Business Model & Performance (β ≈ 0.246) emerged as the most instrumental predictor. This strong, positive correlation indicates that the DT maturity of pharmaceutical enterprises is intrinsically tied to their capacity for business model innovation. Such innovation manifests through the integration of digital channels into core activities, including the development of e-commerce platforms, the provision of online services, and the adoption of data-driven operational frameworks. This finding is empirically supported by the data in Table 5, which shows that the sample's leading firms in DT maturity also scored highest on the C1 construct.

Table 5: Detailed ranking of Factor C1 across the top five enterprises in the survey sample

Factor_C	Rank	Enterprise name	Score
C1_MHKD	1	Bayer Vietnam	5.00 ± 0.21
C1_MHKD	2	Hau Giang Pharmaceutical JSC	4.89 ± 0.15
C1_MHKD	3	Imexpharm	4.85 ± 0.18
C1_MHKD	4	Savipharm	4.80 ± 0.23
C1_MHKD	5	Santafa	4.75 ± 0.27

Second, C2 - Corporate Strategy (β ≈ 0.178) was confirmed as another critical predictor. This finding underscores that a well-articulated DT strategy, holistically integrated into the firm's overarching corporate objectives, is a significant correlate of advanced DT maturity. In contrast, fragmented or ad-hoc digital initiatives are unlikely to yield substantial progress.

Third, C5 - Technological Infrastructure (β ≈ 0.168) was identified as a fundamental enabler. The significant coefficient for C5 highlights that an insufficient or legacy IT infrastructure constitutes a critical impediment to enhancing DT maturity, a challenge observed to be particularly acute for medium-sized enterprises.

Collectively, these three factors - C1, C2, and C5 - form a triad of core pillars that directly shape DT maturity. The remaining significant variables (C3, C6, C7, C8) likely serve as enabling conditions or contextual moderators within this framework.

Of particular note is the non-significance of C4 - Impact of DT on business performance as a predictor in the model. This suggests that improved business performance should be viewed not as an antecedent but rather as a resultant outcome of a successfully executed transformation, contingent upon prior strategic and infrastructural investments.

IV. DISCUSSION

This study assessed the determinants of digital transformation (DT) maturity in Vietnamese pharmaceutical enterprises. Multivariate regression results identified three factor groups with the strongest effects: C1 - Business model & performance, C2 - Corporate strategy, and C5 - Technological infrastructure. These are "root factors" that shape and guide the DT process. Other factors - C3 (human resources), C6 (digital environment), C7 (industry characteristics), and C8 (government policy) - provide complementary support. Notably, C4 (impact of DT on business performance), although rated highly in descriptive analysis, lost significance in the full model, suggesting it is more of an outcome than a primary driver.

These findings are consistent with the international literature. Vial, 2019 [1] emphasized that successful DT requires business model innovation and integration of digital technologies across the system. Miozza [2] focusing on the pharmaceutical industry, argued that a clear digital strategy is a prerequisite to avoid fragmented implementation. Bamakan, 2021 [3] highlighted that investment in digital infrastructure such as blockchain and smart management systems not only enhances transparency but also improves supply chain efficiency. In Indonesia, Arief [4] showed that the Pharma 4.0 model can only be deployed effectively when enterprises combine long-term strategic planning with infrastructure investment and the strengthening of core capabilities.

In developing countries, internal enterprise factors often outweigh external ones. Al-Kahtani [5] demonstrated that in Saudi Arabia's healthcare sector, policy and technology environments exert indirect effects, while strategy and digital infrastructure directly determine digital maturity. Our findings align with this: in Vietnam, larger enterprises with modern IT infrastructure and clear digital strategies achieved significantly higher DT maturity than SMEs.

This study also contributes to addressing the evidence gap in Vietnam, where empirical data on DT in the pharmaceutical sector remain limited. The results suggest that enterprises should prioritize redesigning business models, integrating digital channels and data-driven services, and developing long-term digital strategies linked with KPIs and ROI to avoid fragmented implementation. Investment in digital infrastructure (ERP, CRM, cloud computing, big data, cybersecurity) is fundamental for sustainability. At the policy level, support programs for SMEs in finance, digital workforce training, and technology standards are needed to close the gap with larger enterprises and strengthen overall sectoral competitiveness [6, 7].

This study employed convenience sampling, which may limit generalizability. Additionally, the cross-sectional design captures DT status at a single point in time, whereas DT is an evolving process. Future studies should consider longitudinal designs.

V. CONCLUSION

This study identified three core factors that exert the strongest influence on digital transformation (DT) maturity in Vietnamese pharmaceutical enterprises, namely innovation in business models and performance (C1), a clearly articulated digital strategy (C2), and technological infrastructure and digital systems (C5).

These dimensions serve as foundational drivers, shaping the trajectory and effectiveness of DT initiatives. Other elements, including human resources, regulatory policies, the digital environment, and industry-specific characteristics, play supportive roles that reinforce the transformation process.

The comparative analysis further highlights differences by enterprise size: large firms demonstrate higher DT maturity, reflecting stronger resources and strategic commitment, while medium-sized enterprises consistently exhibit lower scores across most dimensions. This suggests that medium-sized firms represent a "vulnerable group" within the sector, requiring targeted support in capacity building, financial resources, and policy facilitation to avoid being left behind in the ongoing digitalization of the pharmaceutical industry in Vietnam.

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