The Impact of Digital Transformation on Business Performance: A field study

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Abstract

Digital disruptions are caused by the usage of digital technologies such as social media, mobile, analytics, and IoT, which cause changes in customer behavior, the competitive environment, and data availability.

Numerous research contend that DT positively influence business performance by digitizing the production and communication processes, which potentially results in greater operational efficiency.

So, this study aims to investigate the effects of DT on business performance in Egypt. Based on the results of the statistical analysis, the study finds that, There is a significant positive and moderate correlation between business performance and industry performance, BD has a significant positive influence on the performance of Egyptian business firms, SF has a significant positive influence on the performance of Egyptian business firms, CPS has a significant positive influence on the performance of Egyptian business firms, IoT has a significant positive influence on the performance of Egyptian business firms, IOP has a significant positive influence on the performance of Egyptian business firms, and business performance has a significant positive influence on the performance of Egyptian service and production industry.

Key words: Digital Transformation, Business Performance, Egypt

الملخص

تنجم الاضطرابات الرقمية عن استخدام التقنيات الرقمية مثل وسائل التواصل الاجتماعي، والتطبيقات المحمولة، والتحليلات، وإنترنت الأشياء، والتي تؤدي إلى تغييرات في سلوك العملاء، والبيئة التنافسية، وتوافر البيانات.

تشير العديد من الدراسات إلى أن التحول الرقمي (DT) يؤثر بشكل إيجابي على أداء الأعمال من خلال رقمنة عمليات الإنتاج والتواصل، مما يساهم في تعزيز الكفاءة التشغيلية.

تهدف هذه الدراسة إلى استكشاف تأثير التحول الرقمي على أداء الأعمال في مصر. وبناءً على نتائج التحليل الإحصائي، توصلت الدراسة إلى وجود علاقة إيجابية معتدلة وذات دلالة إحصائية بين أداء الأعمال وأداء القطاع الصناعي. كما أن أداء القطاع الصناعي له تأثير إيجابي ملحوظ على أداء الشركات المصرية. بالإضافة إلى ذلك، تبين أن التحول الرقمي يلعب دورًا كبيرًا في تحسين أداء الشركات المصرية في مختلف القطاعات، بما في ذلك قطاعي الخدمات والإنتاج.

الكلمات المفتاحية: التحول الرقمي، أداء الأعمال، مصر.

1. Introduction

Digital technologies are emerging across the globe, reshaping many facets of the business environment. Simultaneously, globalization compels businesses to integrate through increased reliance on digital technology (Kraus et al., 2021). Therefore, Businesses must incorporate digital technology and leverage their capabilities in order to evolve into new flexible and adaptable business models (Schwertner, 2017). Such technology-based transformation, which would enhance business competitiveness, profitability, and efficiency, is referred to as “Digital Transformation”.

The term "Digital Transformation (DT)" refers to a process that attempts to improve an entity by causing major changes to its attributes using a combination of information, computation, communication, and networking technologies (Vial, 2019). DT is driven by a set of disruptions (e.g., customer behavior) that require businesses to define a clear business and DT strategies, before utilizing a set of digital technologies to implement such strategies (Mikalef & Parmiggiani, 2022; Schwertner, 2017; Vial, 2019). Although DT may boost business performance through the efficient use of the Internet of Things (IOT), blockchain, Artificial Intelligence (AI), and Big Data (BD), it comes with various undesirable side effects. Accordingly, this study seeks to examine the influence of DT on business performance, notably manufacturing firms, in Egypt.

2. Research problem

Digital disruptions are caused by the usage of digital technologies such as social media, mobile, analytics, and IoT, which cause changes in customer behavior, the competitive environment, and data availability. Businesses respond by adjusting their business strategies to incorporate digital technologies and defining their DT strategy. This provides firms with new value creation avenues, which, although improving corporate performance, may have negative implications (Vial, 2019).

Therefore, the influence of DT on business performance has been given adequate attention in the literature (Llopis-Albert et al., 2021; Mubarak et al., 2019; Nwankpa & Roumani, 2016; Timonen & Vuori, 2018). Numerous research contend that DT positively influence business performance by digitizing the production and communication processes, which potentially results in greater operational efficiency (e.g., lower business cost, improved business processes, and automation) (Andriole, 2017; Gust et al., 2017; Pagani, 2013), greater competitiveness (Neumeier et al., 2017; Schwertner, 2017), better reputation (Kane, 2014; Yang et al., 2012), higher business growth (Tumbas et al., 2015), and thus higher profitability (Karimi & Walter, 2015). Despite such benefits, several research contend that DT suffers from security and privacy issues (Newell & Marabelli, 2015; Piccinini et al., 2015).

The Egyptian government is taking serious and huge steps towards DT, which necessitates examining that potential influence of DT technologies, notably BD, Smart Factory (SF), Cyber Physical System (CPS), IoT, and Interoperability (IOP), on the performance of Egyptian businesses. Therefore, this study seeks to respond to the following main question:

"What is the influence of DT on the performance of Egyptian businesses?"

3. Literature Review

Since its conception, DT's impact on corporate performance has been a fruitful ground for research. In this section, the researcher reviews the literature on the influence of DT on business performance in Egypt. Particularly, the researcher emphasizes the effect of a group of DT technologies, namely BD, SF, CPS, and IoT, on the performance of the Egyptian firms. Therefore, the researcher divides the literature review into four themes: the influence of BD on business performance, the influence of SF on business performance, the influence of CPS on business performance, and the influence of IoT on business performance.

A) The influence of Big Data (BD) on business performance

Since its conception, the influence of BD on the performance of business firms has been investigated intensively in the literature. For instance, Mubarak et al. (2019) investigated the influence of a set of DT technologies, including BD, on the performance of Pakistani Small and Medium Enterprises (SMEs). The study hypothesized that DT technologies positively influence the performance of SMEs. Using a sample of 237 observation, they concluded that BD positively influence the performance of Pakistani SMEs. Similarly, Imran et al. (2018)

examined the influence of Industry 4.0 tools, including BD, on the production and service sectors, namely Textile and Logistics industries, in Pakistan. The study hypothesized that Industry 4.0 tools positively influence the performance of business firms. Using a sample of 224 employees of Textile and Logistics companies, the study concluded that BD positively influences business performance.

Likewise, Popovič et al. (2018) studied the influence of BD on business performance using analytical approach. They found that BD positively influences a firm's high value performance. Duman and Akdemir (2021) also investigated the effects of Industry 4.0 technology components, including BD, on organizational performance. Results indicated a positive influence of Industry 4.0 components, such as BD, on business performance. According to Pereira and Sachidananda (2022), the integration of Industry 4.0 tools, such as BD, and lean manufacturing has a positive impact on the organizational performance.

Hence, the researcher follows the literature in hypothesizing that BD has a positive influence on business performance in Egypt. Therefore, the researcher develops the following hypothesis for testing:

H_1*: BD positively influences business performance.*

b) The influence of Smart Factories (SF) on business performance

SF is an intelligent production system that integrates the communication, computation, and control processes in manufacturing and services to satisfy industrial demands. It is a connected and flexible manufacturing system that uses a continuous stream of data from connected operations and production systems to learn and adapt to new demands (Shi et al., 2020). Therefore, SF may have favorable effects on the manufacturing process and, thus, on business performance. Imran et al. (2018) studied the influence of Industry 4.0, including smart factory, on business performance in Pakistan. The study hypothesized a positive impact of SF on business performance. A hypothesis that was supported by the study. Similar results were obtained by Lalic et al. (2017), who studied the influence of SF on manufacturing firm performance. Results indicated that SF concepts are significantly and positively related to manufacturing firms' performance.

Likewise, Lee (2021) hypothesized that SF operation strategy and SF system management have a significant impact on the innovative performance of business performance. The study concluded that SF system management has a significant influence on business performance using a sample of 222 employees in a variety of industries. Yang et al. (2020) studied the impact of intelligent manufacturing on the financial and innovation performance of business firms in China. Results showed that intelligent manufacturing, such as SF, promote the financial and innovative performance of business firms. Pereira and Sachidananda (2022) also highlights the significance of the integration between Industry 4.0 tools, such as SF, and lean manufacturing on the organizational performance.

Accordingly, in line with the literature, the researcher hypothesizes that SF may have a positive on business performance in Egypt. Therefore, the researcher develops the following hypothesis for testing:

H_2: SF positively influences business performance.

c) The influence of Cyber Physical Systems (CPS) on business performance

CPSs are multidisciplinary systems to conduct feedback control on widely distributed embedded computing systems by the combination of computation, communication, and control technologies. They are transformation and integration of the existing network systems and traditional embedded systems (Liu et al., 2017).

These systems have proven useful in enhancing the performance of business firms, particularly manufacturing firms. For instance, Imran et al. (2018) investigated the influence of Industry 4.0 tools, such as CPS, on business performance and found a significant positive influence of CPS on business performance. According to Pereira and Sachidananda (2022), Industry 4.0 tools, including CPS, can be integrated with lean manufacturing for a positive impact on business performance.

Similarly, Mubarak et al. (2019) examined the influence of CPS on the performance of SMEs in Pakistan. Findings revealed a significant positive influence of CPS on business performance. Similar results were obtained by Duman and Akdemir (2021), who concluded that Industry 4.0 components, including CPS, have a positive influence on business performance.

Therefore, it is evident that CPSs have a significant positive influence on the performance of business firms in Egypt and, hence, the researcher develops the following hypothesis for testing:

H_3: CPS positively influences business performance.

d) The influence of Internet of Things (IoT) on business performance

Numerous research has investigated the influence of IoT on the performance of business firms. For instance, De Vass et al. (2018) investigated the influence of IoT on supply chain performance. Using a sample of 227 firms in Australia and a Structural Equation Modeling (SEM) approach, the study concluded that IoT has a positive and significant impact on internal, customer-related, and supplier-related process integration, which in turn improves supply chain performance and organizational performance. Similarly, Asadi et al. (2022) examined the impact of IoT on the performance of manufacturing firms. The study concluded that IoT adoption enhances business efficient and performance. Relatedly, Oke et al. (2022) examined the impact of IoT on the performance of construction projects. Findings revealed a positive and significant impact of IoT on the performance of construction projects.

Likewise, Mubarak et al. (2019) found a positive, yet insignificant, impact of IoT on the performance of Pakistani SMEs. Imran et al. (2018), on the other hand, found a significant positive influence of IoT on the performance of textile and logistics firms in Pakistan. Similarly, Pereira and Sachidananda (2022) concluded that the integration between Industry 4.0 tools, including IoT, and lean manufacturing has a favorable influence on business performance.

In line with the literature, the researcher hypothesizes that IoT can significantly influence the performance of business firms in Egypt. Therefore, the researcher develops the following hypothesis for testing:

H_4: IoT positively influences business performance.

Following Imran et al. (2018) and Mubarak et al. (2019), the researcher extends the analysis by examining the influence of Interoperability (IOP) on business performance. Finally, the researcher follows in the footsteps of Imran et al. (2018) by examining the impact of business performance on industry performance. Therefore, the researcher develops the following hypotheses for testing:

H_5: IOP positively influences business performance.

H_6: Business performance positively influences industry performance.

E) Research Gap

After carefully reviewing the literature, the researcher concludes that despite the numerous research on the influence of DT on business performance, limited research has been conducted in developing nations, such as Egypt. Furthermore, most research did not separate the influence of each DT technology on business performance. Finally, this study is being done at a time when Egypt is adopting and executing a broad-scale vision for DT, making its findings important to Egyptian businesses.

4-Research variables

This study involves seven variables, DT technologies (BD, SF, CPS, IoT, and IOP), business performance, and industry performance. The researcher uses two distinct models to test the influence of DT on business performance. The first model is a multiple regression model that examines the influence of DT technologies on business performance, and thus involves five independent variables (DT technologies) and a single dependent variable (business performance). The second model is a univariate (simple) regression model that investigates the influence of business performance, the independent variable, on industry performance, the dependent variable. The variables of each model along with the corresponding measures are discussed below:

4-1 The impact of DT on business performance (Model 1)

This model examines how DT technologies, mainly BD, SF, CPS, IoT, and IOP, affects the performance of Egyptian firms. The model is comprised of six variables, five (independent) variables assess DT and one (dependent variable) evaluates business performance, which are:

a) The independent variables x (DT technologies)

The study defines five DT tools used to examine the influence of DT on business performance, which are:

I. Big Data ($BD\ x_1$): Big Data represents the information assets characterized by such a high volume, velocity and variety to require specific technology and analytical methods for its transformation into value (De Mauro et al., 2015). The researcher evaluates BD using <u>four items</u> adopted from Imran et al. (2018).

II. <u>Smart Factories ($SF\ x_2$):</u> Smart Factory is an intelligent production system that integrates communication process, computing process, and control process in manufacturing and services to meet the industrial demands (Chen et al., 2017). The study evaluates SF using <u>five items</u> adopted from Imran et al. (2018).

III. <u>Cyber Physical Systems ($CPS\ x_3$):</u> Cyber Physical Systems are transformative technologies for managing interconnected systems between its physical assets and computational capabilities (Lee et al., 2015). The researcher evaluates CPS using <u>four items</u> adopted from Imran et al. (2018).

IV. <u>Internet of Things ($IoT\ x_4$):</u> Internet of Things Links a set of devices together via the internet. It is An open and comprehensive network of intelligent objects that have the capacity to auto-organize, share information, data and resources, reacting and acting in face of situations and changes in the environment (Madakam et al., 2015). The researcher evaluates IoT using <u>five items</u> adopted from Imran et al. (2018).

V. <u>Interoperability ($IOP\ x_5$):</u> Interoperability is the ability for two systems to understand one another and to use functionality of one another (Chen et al., 2008). The researcher evaluates IOP using <u>three items</u> adopted from Imran et al. (2018).

B) The dependent variable y (business performance $BPerf\ y_1$)

The researcher investigates the influence of DT tools (the independent variables) on the business performance. The researcher evaluates Business Performance ($BPerf\ y_1$) using <u>four items</u> reflecting how DT tools change the production and service environment of businesses adopted from Imran et al. (2018).

4-2 The impact of business performance on industry performance (Model 2)

After examining the impact of DT on business performance, the researcher studies the influence of business performance on industry performance. In this relationship, business performance ($BPerf\ x_6$) acts as an independent variable whose effect on the dependent variable, Industry Performance ($IPerf\ y_2$), is evaluated. Industry performance is assessed using five items adopted from Imran et al. (2018).

All items are positively worded and scored over 5-point Likert scale, with 1 being strongly disagree and 5 being strongly agree. The items were restated to match the subject of the study. The measurement scales of all variables were combined in a single instrument, which was then handled to sample participants.

5. Research methodology

The study presents the methodology followed to answer the research question and achieve the research objective.

5.1 Research population, sample size, and sampling technique

To capture both academic and professional perceptions, the research population is comprised of supporting staff (teaching assistants and assistant lecturers) and students listed in the Professional Postgraduate Program at Faculty of Commerce – Tanta University. The researcher used as the population frame a list of professional postgraduate students collected from postgraduate affairs and supporting staff obtained from the college website. A total 613 postgraduate students and 148 staff (Accounting: 87, Business Administration: 37, Economy and Public Finance: 14, and Statistics, Mathematics, & Insurance: 10) were obtained, making a population size of 761 individuals. Since the population is finite, the researcher used the following equation, which is based on the Central Limit Theorem (CLT), to compute the sample size:

$$n = \frac{\left(\frac{z_{\frac{\alpha}{2}}^2 P.Q}{E^2}\right)}{\left(1 + \frac{z_{\frac{\alpha}{2}}^2 P.Q}{E^2 \times N}\right)}$$

Where:

n: the sample size.
N: the population size.
P: the population proportion (the probability of getting success in any one trial). Generally, when P is unavailable in the literature, it is substituted with 0.5 to allow for greater sample size.

Q: the complement of the population proportion (the probability of getting a failure in any one trial).
E: the estimation error, it is the difference between the sample proportion $\hat{p}$ and the population proportion P.
$z_{\frac{\alpha}{2}}$: the standard z score, which equals 1.96 at a confidence interval of 95% (α = 0.05).

The application of the formula resulted in a sample size of 335. To identify sample participants and minimize sampling error, the researcher utilized the Proportionate Stratified Random Sampling (PSRS) technique. The researcher divided the population into two strata, Academics and Professionals, based on a demographic variable, particularly degree of education. **Table 5-1** summarizes the selection of sample participants based on the PSRS technique.

Table 5-1 The PSRS technique

Stratum	Population	Proportion	Sample
Academics	613	80.6%	80.6% × 335 = 270
Professionals	148	19.4%	19.4% × 335 = 65
Total	761	100%	335

A total of 335 were prepared and handled to sample participants. The researcher retrieved 217 responses, of which 23 were eliminated due to various issues (e.g., multiple answers to the same question and unanswered questions), resulting in a total sample of 194 observations.

5.2 Research hypotheses

This study aims to examine the influence of DT on business performance in Egypt. Following an intensive review of the literature, the researcher developed the following hypotheses for testing:

H_1: Big data positively influences business performance.

H_2: Smart Factories positively influence business performance.

H_3: CPS positively influences business performance.

H_4: IoT positively influences business performance.

H_5: Interoperability positively influences business performance.

H_6: Business performance positively influences industry performance.

5.3 The statistical models

The study uses regression analysis to test the research hypotheses. Since two relationships are examined (The DT – business performance link and the business performance – industry performance link), the researcher uses two regression modes. The first model is a multiple regression model that examines the influence of a set of DT tools on business performance, whereas the second model is a simple regression model to investigate the influence of business performance on industry performance. The regression models are summarized below:

Model 1: The DT – Business performance relationship

$$y_1 = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + e$$

Model 2: The Business performance – Industry performance relationship

$$y_2 = \beta_0 + \beta_6 x_6 + e$$

The researcher uses the Statistical Package for Social Sciences (SPSS) version 26 in conducting the statistical analysis.

6. Statistical results

The study reports the results of the statistical analysis including the results of the validity and reliability test, the descriptive analysis, the correlation analysis, and the regression analysis.

6.1 The validity and reliability test

To test the validity and reliability of the instrument, the study relies upon the opinions of experts and the Cronbach's α coefficient, respectively. The study conducts a set of interviews with academics and professionals to evaluate the validity of the instrument. Experts believe that the instrument is readable, comprehendible, and adequately covers the variables of the research. Furthermore, the fact that the instrument was previously used in literature further adds to its validity.

To assess the reliability of the measurement scales, the study uses Cronbach's α coefficient. A Cronbach's α of 0.7 or above supports the reliability of the measurement scales. **Table 6-** shows the Cronbach's α coefficients and Item Discrimination Indices (D) for the measurement scales. Cronbach's α coefficients for all measurement scales exceed 0.7, which supports the reliability of the scales. Furthermore, Item Discrimination Indices (D) show a moderate to strong association between the items on each scale, indicating that the items on each scale reflect the variables being assessed.

Table *6-1* Cronbach's α and Item Discrimination indices (D)

Scale	Number of Items	Cronbach's α	Item Discrimination Index (D)
$BD\ x_1$	4	0.823	0.436 (Min) – 0.756 (Max)
$SF\ x_2$	5	0.861	0.434 (Min) – 0.763 (Max)
$CPS\ x_3$	4	0.819	0.430 (Min) – 0.758 (Max)
$IoT\ x_4$	5	0.880	0.491 (Min) – 0.794 (Max)
$IOP\ x_5$	3	0.812	0.578 (Min) – 0.753 (Max)
$BPerf\ y_1, x_6$	4	0.899	0.620 (Min) – 0.873 (Max)
$IPerf\ y_2$	5	0.887	0.480 (Min) – 0.831 (Max)

6.2 Descriptive analysis

The researcher used measures of central tendency (e.g., Arithmetic mean μ) and measures of dispersion (standard deviation σ) to describe the data. **Table 6-** demonstrates the results of the descriptive analysis.

Most academics and professionals perceive DT tools as essential to enhance$BPerf$. This is evident by the mean scores of DT tools and $BPerf$, which are pulled towards the maximum score of 5. For instance, the mean $BD\ x_1$ score is 3.9588 with a standard deviation of .96418, a minimum of 1, and a maximum of 5. The average score of $SF\ x_2$ is 4.0108 with a standard deviation of .94542, a minimum of 1, and a maximum of 5. The average $CPS\ x_3$ score is 3.9485 with a standard deviation of .89756, a minimum of 1, and a maximum of 5. The mean score of $IoT\ x_4$ is 4.0340 with a standard deviation of .93802, a minimum of 1, and a maximum of 5. The average $IOP\ x_5$ score is 4.0292 with a standard deviation of .92727, a minimum of 1, and a maximum of 5. Finally, the mean $BPerf\ y_1$ score is 4.0271 with a standard deviation of .92859, a minimum of 1, and a maximum of 5.

Table *6-2* Descriptive analysis

Scale	**Mean μ**	**Standard Deviation σ**	**Min**	**Max**
$BD\ x_1$	3.9588	.96418	1	5
$SF\ x_2$	4.0108	.94542	1	5
$CPS\ x_3$	3.9485	.89756	1	5
$IoT\ x_4$	4.0340	.93802	1	5
$IOP\ x_5$	4.0292	.92727	1	5
$BPerf\ y_1, x_6$	4.0271	.92859	1	5
$IPerf\ y_2$	3.9237	.88906	1	5

Furthermore, the mean score of $IPerf\ y_1$ suggests that both academics and professionals agree that business performance, on average, enhances industry performance. This is demonstrated by the mean score of $IPerf\ y_1$, which is 3.9237 with a standard deviation of .88906, a minimum score of 1, and a maximum score of 5.

6.3 Correlation analysis

The study examines the correlation among research variables using the Spearman's rho correlation coefficient. **Table 6-3** shows the correlation among research variables.

Table 6-3 Correlation matrix

Scale	Correlation	BD x_1	SF x_2	CPS x_3	IoT x_4	IOP x_5	$BPerf$ y_1, x_6	$IPerf$ y_2
BD x_1	Corr.	1.000						
	Sig.	-----						
SF x_2	Corr.	.522**	1.000					
	Sig.	.000	-----					
CPS x_3	Corr.	.556**	.566**	1.000				
	Sig.	.000	.000	-----				
IoT x_4	Corr.	.611**	.633**	.548**	1.000			
	Sig.	.000	.000	.000	-----			
IOP x_5	Corr.	.543**	.596**	.581**	.616**	1.000		
	Sig.	.000	.000	.000	.000	-----		
$BPerf$ y_1, x_6	Corr.	.518**	.566**	.535**	.546**	.542**	1.000	
	Sig.	.000	.000	.000	.000	.000	-----	
$IPerf$ y_2	Corr.	.479**	.556**	.597**	.473**	.494**	.618**	1.000
	Sig.	.000	.000	.000	.000	.000	.000	-----
**Correlation is significant at the 0.01 level (2-tailed).								

The correlation coefficients between DT tools and $BPerf\ y_1$ are moderate, positive ($BD\ x_1$: .518; $SF\ x_2$: .566; $CPS\ x_3$: .535; $IoT\ x_4$: .546; $IOP\ x_5$: .542), and significant at α = 0.01 (.000). Meaning that DT tools have a significant positive correlation with business performance. Similarly, $BPerf\ x_6$ is moderately, positively (.618), and significantly (.000) correlated with $Perf\ y_2$.

6.4 Regression analysis results hypotheses testing

In this section, the study reports the results of the regression analysis. For each model, the study, first, examines the strength and predictability of the regression model by assessing the significance of the overall regression model using the F test, the significance of the regression coefficients using t test, and the predictability of the regression model using measures of fit (e.g., R^2, adjusted R^2, and S_e). Finally, the study reports the results of the hypotheses testing. The study also highlights the degree to which the regression models meet two of the assumptions underlying the regression analysis, namely autocorrelation and multicollinearity.

6.4.1 *Model 1 (DT tools – Business performance)*

This model examines the influence of DT tools ($BD\ x_1, SF\ \ x_2, CPS\ \ x_3, IoT\ \ x_4, IOP\ \ x_5$) on business performance ($BPerf\ y_1$).

Table *6-4* shows the results of regression Model 1. The overall regression model is significant at α = 0.01 (F = 258.176, Sig. 0.000) and the regression coefficients (β_1= .192, β_2= .202, β_3= .181, β_4= .215, β_5= .185) are also significant (Sig. for β_1= .002, β_2= .006, β_3= .004, β_4= .007, β_5= .007) at α = 0.01. These results indicate that the regression model, using DT tools as factors, adds significant predictability of business performance, the dependent variable, as compared to a null model containing only the regression constant.

Table *6*-4 Regression analysis: Model 1

Model 1 ($BPerf\ y_1$) ($y_1, x_1, x_2, x_3, x_4, x_5$)		Sig. of coefficients			Collinearity	
		β	t	Sig.	Tolerance	VIF
Constant		.130	1.155	.250		
$BD\ x_1$		.192	3.135	.002	.168	5.953
$SF\ x_2$		.202	2.777	.006	.124	8.074
$CPS\ x_3$		.181	2.891	.004	.184	5.437
$IoT\ x_4$		.215	2.720	.007	.106	9.424
$IOP\ x_5$		.185	2.677	.008	.141	7.075
Overall Significance (F test)	F	258.176				
	Sig.	.000				
Autocorrelation (Durbin-Watson test)	Durbin-Watson	2.129 (Between 1.5 and 2.5, non-sig.)				
Measures of Fit (Adjusted R^2 and S_e)	Adj. R^2	.869				
	S_e	.33546				

The adjusted coefficient of determination (adjusted R^2) equals .869, meaning that DT tools, the independent variables, explain 86.9% of the variability in business performance, the dependent variable, and that only 13.1% of the variability in business performance are explained by other variables that are out of the scope of this study. The standard error of the estimate S_e is relatively low (.33546), indicating the accuracy of the regression model.

The model is also free from Multicollinearity (Variance Inflation Factors (VIF) are below 10 and Tolerance values are above 0.1) and Autocorrelation (Durbin Watson value is between 1.5 and 2.5, hence insignificant (2.129)), meaning that the main assumptions underlying the multiple regression model are met.

The regression coefficients are of BD (β_1= +.192, Sig. 0.002), SF (β_2= +.202, Sig. 0.006), CPS (β_3= +.181, Sig. 0.002), IoT (β_4= +.215, Sig. 0.007), and IOP (β_5= +.185, Sig. 0.008) are positive and significant at α = 0.01. **Therefore, hypotheses H_1 through H_5 are accepted.**

6.4.2 Model 2 (Business performance – Industry performance):

Table 0- shows the results of regression *Model 2*, which examines the influence of business performance on industry performance. The overall regression model is significant at α = 0.01 (F = 542.968, Sig. .000) and the regression coefficient β is significant at α = 0.01 (β_6 = .823, Sig. 0.000), meaning that the regression model, using business performance as a factor, adds significant predictability of industry performance than does a null model containing only the regression constant.

The coefficient of determination (R^2) equals .739, meaning that business performance, the independent variable, explains 73.9% of the variability in industry performance, the dependent variable, and that only 26.1% of the variability in industry performance are explained by other variables that are out of the scope of this study. The standard error of the estimate S_e is relatively low (.54563), indicating the accuracy of the regression model.

The regression coefficient of business performance (β_6= +.823) is positive and significant (0.000) at α = 0.01. **Therefore, H_6 is accepted.**

Table 0-*5* Regression results: Model 2

Model 2 ($IPerf\ y_2$) (y_2, x_6)		**Sig. of coefficients**		
		β	**t**	**Sig.**
Constant		.610	4.178	.000
$BPerf\ x_6$		.823	23.302	.000
Overall Significance (F test)	**F**	542.968		
	Sig.	.000		
Measures of Fit (R^2 and S_e)	**R^2**	.739		
	S_e	.54563		

7. Research results

This study aims to examine the influence of DT on business performance. Based on the results of the statistical analysis, research findings reveal that:

1- On average, academics, and practitioners perceive DT technologies (μ_{BD} = 3.9588, μ_{SF} = 4.0108, μ_{CPS} = 3.9485, μ_{IoT} = 4.0340, μ_{IOP} = 4.0292) as essential for enhancing business performance.

2- On average, academics, and practitioners perceive the performance of Egyptian business firms is growing (μ_{BPerf} = 4.0271).

3- On average, academics, and practitioners perceive the performance of Egyptian service and manufacturing industry is growing (μ_{IPerf} = 3.9237).

4- There is a significant (Sig. .000 at 0.01) positive and moderate correlation between DT technologies ($Corr_{BD}$ = .518, $Corr_{SF}$ = .566, $Corr_{CPS}$ = .535, $Corr_{IoT}$ = .546, $Corr_{IOP}$ = .542) and business performance.

5- There is a significant (Sig. .000 at 0.01) positive and moderate correlation between business performance ($Corr_{BPerf}$ = .618) and industry performance.

6- As perceived by academics and practitioners, BD has a significant (Sig. .000 at 0.01) positive (β_1 = +.192) influence on the performance of Egyptian business firms.

7- As perceived by academics and practitioners, SF has a significant (Sig. .000 at 0.01) positive (β_2 = +.202) influence on the performance of Egyptian business firms.

8- As perceived by academics and practitioners, CPS has a significant (Sig. .000 at 0.01) positive (β_3 = +.181) influence on the performance of Egyptian business firms.

9- As perceived by academics and practitioners, IoT has a significant (Sig. .000 at 0.01) positive (β_4 = +.215) influence on the performance of Egyptian business firms.

10- As perceived by academics and practitioners, IOP has a significant (Sig. .000 at 0.01) positive (β_5 = +.185) influence on the performance of Egyptian business firms.

11- As perceived by academics and practitioners, business performance has a significant (Sig. .000 at 0.01) positive (β_6 = +.823) influence on the performance of Egyptian service and production industry.

8-Research recommends

Based on the results of the study, the researcher recommends that:

1- In line with Egypt vision 2030, Egyptian business firms should consider DT as a tool for remaining competitive, sustainable, and profitable.

2- Egyptian firms should implement new business models for the successful implementation of DT.

3- Egyptian business firms should rely on digital technologies, such as BD, SF, CPS, and IoT, to promote business performance, which leads to better industry performance.

4- Relying solely on DT technologies would not achieve the full potential of DT. Therefore, Egyptian business firms should align business strategy with emerging digital technologies to gain competitive advantage.

5- Therefore, Egyptian business firms should consider exploiting digital technologies in achieving their targets by transforming into Digital Business Strategy (DBS) or Digital Transformation Strategy (DTS) to integrate business vision and strategy with the emerging digital technologies.

6- Egyptian business firms should undergo contextual (structural and cultural) changes to be able to implement DT.

7- Egyptian business firms should consider overcoming technology acceptance issues among employees.

8- Egyptian business firms should consider developing defense mechanisms against security and privacy challenges related to DT.

9-Future research opportunities

This study sought to uncover the influence of DT on the performance of Egyptian business firms. Future research should:

1- The influence of DT on innovation performance of Egyptian firms.
2- The influence of DT of external audit on corporate governance.
3- Examining the acceptance rate of DT in Egyptian business firms using Technology Acceptance Model (TAM).
4- Investigating the influence of DT on business models.

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Appendix 1: Data collection instrument

The influence of Digital Transformation (DT) on Business Performance (BP)					
The following questions concern your beliefs about the influence of **Digital Transformation** on **Business Performance**. This instrument is designed to capture the beliefs of both academics and professionals. Please, take a few minutes to answer the following questions:	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Digital Transformation (DT) tools					
Big Data (BD)					
1. Firms should continuously examine the innovative opportunities for the strategic use of big data analytics.	1	2	3	4	5

2. When firms make big data analytics investment decisions, they should think about and estimate the effect they will have on the productivity of the employees' work.	1	2	3	4	5
3. In business firms, business analysts and line people should meet frequently to discuss important issues.	1	2	3	4	5
4. In business firms, the responsibility for big data analytics development should be clear.	1	2	3	4	5
Smart Factory (SF)					
5. It offers ways that can successfully address the issues.	1	2	3	4	5
6. It provides the ability to work in real time.	1	2	3	4	5
7. It provides the ability to adjust and learn from data.	1	2	3	4	5
8. It has a significant relationship with responsive, proactive, and predictive practices which enhance the accuracy.	1	2	3	4	5
9. It enables business firms to avoid operational downtime and other productivity challenges.	1	2	3	4	5
Cyber Physical System (CPS)					
10. It provides significant computational resources which contributes to operations and services.	1	2	3	4	5
11. It enhances the processing capability and local storage.	1	2	3	4	5
12. It provides unprecedented opportunities for innovation.	1	2	3	4	5
13. It provides the ability to handle challenges, barriers, and threats.	1	2	3	4	5
Internet of Things (IoT)					
14. It provides lower lead times for customers and lower overall costs.	1	2	3	4	5
15. It helps to improve the production capacity.	1	2	3	4	5
16. It provides the linkage of all devices to the internet which help in production processes.					
17. It provides a better communication between employees.	1	2	3	4	5
18. It provides a link between customers and company and increases the customer satisfaction level.	1	2	3	4	5
Interoperability (IOP)					
19. It has the ability to automatically interpret the information exchanged meaningfully and accurately.	1	2	3	4	5
20. It implies exchanges between a range of products, or similar products from several different vendors.	1	2	3	4	5

21. It provides better technology to boost inter organizational activities.	1	2	3	4	5
Business Performance (BP)					
22. Effective production inside business firms increases the overall industry performance.	1	2	3	4	5
23. Effective services to the customer increase the overall industry performance.	1	2	3	4	5
24. Effective production and services increase the customer satisfaction level.	1	2	3	4	5
25. Effective production and services bring accuracy in the operations of business firms.	1	2	3	4	5
Industry Performance (IP)					
26. Overall performance of business firms last year should be far above average.	1	2	3	4	5
27. Overall performance of business firms relative to major competitors last year should be far above average.	1	2	3	4	5
28. Overall sales growth of business firms relative to major competitors last year should be far above average.	1	2	3	4	5
29. Relative to their largest competitor, during the last year, business firms should have a larger market share.	1	2	3	4	5
30. Relative to their largest competitor, profitability should increase.	1	2	3	4	5

Appendix 2: Results of the statistical analysis using SPSS V. 26

First: Validity and Reliability

Reliability Statistics

Cronbach's Alpha	N of Items
.823	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Big Data Q1	11.3608	12.636	.436	.865
Big Data Q2	11.1804	10.232	.674	.764

Big Data Q3	10.8969	10.362	.742	.733
Big Data Q4	11.1598	10.135	.756	.725

Reliability Statistics

Cronbach's Alpha	N of Items
.861	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Smart Factor Q1	14.8505	21.143	.434	.889
Smart Factor Q2	14.5979	17.496	.724	.819
Smart Factor Q3	14.3299	18.119	.737	.817
Smart Factor Q4	14.6134	17.845	.751	.813
Smart Factor Q5	14.6804	17.607	.763	.809

Reliability Statistics

Cronbach's Alpha	N of Items
.819	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Cyber Physical System Q1	10.7938	13.823	.430	.860
Cyber Physical System Q2	10.6340	11.083	.659	.764
Cyber Physical System Q3	10.3351	10.898	.758	.716
Cyber Physical System Q4	10.6546	11.108	.737	.727

Reliability Statistics

Cronbach's Alpha	N of Items
.880	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Internet of Things Q1	13.8196	25.392	.491	.902
Internet of Things Q2	13.8041	21.039	.764	.842
Internet of Things Q3	13.4948	21.671	.762	.842
Internet of Things Q4	13.8660	22.189	.764	.842
Internet of Things Q5	13.8608	21.374	.794	.834

Reliability Statistics

Cronbach's Alpha	N of Items
.812	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Interoperability Q1	6.8144	7.986	.578	.823
Interoperability Q2	7.0258	5.994	.753	.642
Interoperability Q3	6.6340	6.782	.668	.735

Reliability Statistics

Cronbach's Alpha	N of Items
.899	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Business Performance Q1	9.2784	19.684	.620	.921
Business Performance Q2	9.6907	15.800	.873	.831
Business Performance Q3	9.4175	16.742	.778	.869
Business Performance Q4	9.7474	17.143	.839	.846

Reliability Statistics

Cronbach's Alpha	N of Items
.887	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Industry Performance Q1	11.7268	29.868	.480	.913
Industry Performance Q2	12.0928	23.815	.831	.837
Industry Performance Q3	11.6598	25.262	.703	.868
Industry Performance Q4	12.0000	25.306	.809	.844
Industry Performance Q5	12.0670	24.736	.826	.839

Second: Descriptive analysis

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Big Data	194	1.00	5.00	3.9588	.96418
Smart Factory	194	1.00	5.00	4.0108	.94542
Cyber Physical Systems	194	1.00	5.00	3.9485	.89756
Internet of Things	194	1.00	5.00	4.0340	.93802
Interoperability	194	1.00	5.00	4.0292	.92727
Business Performance	194	1.25	5.00	4.0271	.92859
Industry Performance	194	1.20	5.00	3.9237	.88906
Valid N (listwise)	194				

Third: Correlation analysis

Correlations

		Big Data	Smart Factory	Cyber Physical Systems	Internet of Things	Interoperability	Business Performance	Industry Performance
Big Data	Correlation Coefficient	1.000	.522**	.556**	.611**	.543**	.518**	.479**
	Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.000
	N	194	194	194	194	194	194	194
Smart Factory	Correlation Coefficient	.522**	1.000	.566**	.633**	.596**	.566**	.556**
	Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.000
	N	194	194	194	194	194	194	194
Cyber Physical Systems	Correlation Coefficient	.556**	.566**	1.000	.548**	.581**	.535**	.597**
	Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000

	N	194	194	194	194	194	194	194
Internet of Things	Correlation Coefficient	.611**	.633**	.548**	1.000	.616**	.546**	.473**
	Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000
	N	194	194	194	194	194	194	194
Interoperability	Correlation Coefficient	.543**	.596**	.581**	.616**	1.000	.542**	.494**
	Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.000
	N	194	194	194	194	194	194	194
Business Performance	Correlation Coefficient	.518**	.566**	.535**	.546**	.542**	1.000	.618**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000
	N	194	194	194	194	194	194	194
Industry Performance	Correlation Coefficient	.479**	.556**	.597**	.473**	.494**	.618**	1.000
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.
	N	194	194	194	194	194	194	194

**. Correlation is significant at the 0.01 level (2-tailed).

Fourth: Regression analysis – Model 1

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.934[a]	.873	.869	.33546	2.129

a. Predictors: (Constant), Interoperability, Big Data, Cyber Physical Systems, Smart Factory, Internet of Things
b. Dependent Variable: Business Performance

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	145.264	5	29.053	258.176	.000[b]
	Residual	21.156	188	.113		
	Total	166.420	193			

a. Dependent Variable: Business Performance
b. Predictors: (Constant), Interoperability, Big Data, Cyber Physical Systems, Smart Factory, Internet of Things

Coefficients[a]

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.	Collinearity Statistics

Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	.130	.112		1.155	.250		
	Big Data	.192	.061	.199	3.135	.002	.168	5.953
	Smart Factory	.202	.073	.205	2.777	.006	.124	8.074
	Cyber Physical Systems	.181	.063	.175	2.891	.004	.184	5.437
	Internet of Things	.215	.079	.217	2.720	.007	.106	9.424
	Interoperability	.185	.069	.185	2.677	.008	.141	7.075

a. Dependent Variable: Business Performance

Fifth: Regression analysis – Model 2

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.860[a]	.739	.737	.45559	1.580

a. Predictors: (Constant), Business Performance
b. Dependent Variable: Industry Performance

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	112.699	1	112.699	542.968	.000[b]
	Residual	39.852	192	.208		
	Total	152.551	193			

a. Dependent Variable: Industry Performance
b. Predictors: (Constant), Business Performance

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	.610	.146		4.178	.000		
	Business Performance	.823	.035	.860	23.302	.000	1.000	1.000

a. Dependent Variable: Industry Performance