

Digital Transformation, Innovation and Sustainable Growth

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ABSTRACT

The current era is considered as the most dynamic and competitive era in term of technology and innovation. More desperation can be seen by countries to modernize their arsenal of technologies and innovation. As these two dimensions have been proved as the corner stone of economic heights for the regions and countries. Therefore, many countries, especially richer countries are more proven towards technological transformation and innovation to achieve competitive advantage. This research investigates the impact Digital Transformation on Sustainable Growth and to examine the mediating role of Innovation. This study collected annual data from Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and UAE. This study collects annual data from Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and UAE. We used data from 2008-2021. Following quantitative research design, different statistical techniques i.e. Quantile Regression, GMM and Dynamic Fixed effect models were applied. The results of our analysis showed that a long-run and short run association exists between the variables and further evidenced that digital transformation and innovation positively affect the sustainable growth of the Gulf countries. The findings have certain meaningful contributions to the policy makers.

Keywords: Digital transformation, Innovation, Sustainable growth

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INTRODUCTION

In today's world development of information and communication and information technology and environmental sustainability are considered important for global economics (Ciocoiu, 2011). Technological changes in the field of communication and informatics are bringing immense evolutions to post industrial economy. Technological advancement is bringing diverse impact on economy, society and environment. It is also considered that sustainable development cannot be attained without adopting technological advancements in global communication technology and knowledge exchange (Maclean, Andjelkovich and Vetter, 2007). Adapting to changes in advancements in communication technology is therefore an opportunity for development and at the same time a threat for sustainable advancement. To further achieve and sustain development every country need to shift traditional economy to digital economy (Varnavsky, 2015). Countries lagging behind in such technological shift towards digital economy may lag behind their competitors which will further result in socio economic crisis. Digital transformation therefore is the inception of new and advance technologies in diverse business processes of every socio economic setup (Druzhinin, 2019). Digital transformation includes installation of modern equipments and softwares that can bring substantial alterations to corporate culture, management and communications.

Digital transformation is bringing rapid changes in operational activities for every economy (Huang, 2018). It is due to this fact that digital economic activities have become part of daily life which includes booking for airline and train tickets, online shopping, and calling through digital apps for taxi, online conference participation, calling for food delivery and using online apps for payments. All this have become possible by using various digital economic tools including smart phones, apps and internet that individuals feel difficulty without these tools. Modern day digital transformation emerged the present day e commerce and social media platforms which can easily be termed as main drivers of fourth industrial revolution. Digitalization of business processes is a move forward to enhance competitiveness and efficiency of every industry. Adoption of digital technologies in the area of health care, transport, business development, environmental protection and culture ensures human development and improves quality of life. On the other hand transformation to digital technologies at the same time improves economic growth by increasing labor productivity and efficiency.

Transformation and adoption of digital technologies drastically changed habits of people and methods of doing work in every organization. The recent economic crisis as a result of COVID-19 pandemic has further brought in light the importance, adoption, readiness and required skills of digital technologies in organizations and its far reaching implications. Adoption and transformation to digital technology is imperative to attract, deliver and create value to customers. In this context digital infrastructure must be developed by every government to provide benefits of digital advancements to various stakeholders in every country. This digital transformation will be utilized by every firm to develop skills, knowledge and competencies of their employees. This will further enhance competitiveness of enterprises and individuals. A flexible education system and

level of investment by every country in science and technology ensures efficient digital transformation and development of required competencies and skills. Providing opportunities by every country to develop digital citizenship improves enterprise competitiveness and achieve social, environmental, economic and consumer benefits.

Literature Review

Digital Transformation and Innovation

An important success factor in knowledge economy is innovation and is determined by research and development (Mustapha and Abdullah, 2004). Athina et al (2018) is of the opinion that research and development is essential to determine business innovation in every country. Romer (1990) asserted that increasing level of investment in research and development leads to technological development and is linked with economic growth and national income. Salman et al (2020) are of the opinion that substantial R & D fund allocations are required in order to transform an economy from resource dependent to economy based on innovation and practices of sustainability. Geff and Judd (2004) are of the opinion that mutual collaboration between marketing and R & D departments ensures the effectiveness of technology transfer and innovation from laboratory to the market. Lv et al (2020) are of the opinion that excessive levels of R & D inputs are needed for technical innovations which are imperative to develop knowledge economies. At the same time they asserted that impact of R & D investment on technological innovation need to be asserted at the country level. They provided evidence that manpower and R & D input efficiency are lower in South East Asia and South Asia. They also gave policy level implications for these countries to improve this efficiency level for uplifting their technological innovation level. Polanski (2015) is of the opinion that 3% of GDP is needed to be spent on R & D activities in Europe by 2020. This will help produce potential innovations and new ideas to develop digital environment in Europe. Bloom et al (2012) concluded that R & D investment in ICT innovations influences digital transformation rate, economic growth and firm productivity.

Digital Transformation and Sustainable Development

Digitalization includes a wide range of resources and makes it possible to operate and share by large groups of people and it also fosters personal relationships (Pouri and Hilty, 2021). Various innovative and smart solutions with changing mindset offer new opportunities for planning and development (Schieferdecker and Mattauch, 2014). Esses (2021) studied the relationship between sustainability and digital transformation. For this purpose digital economy and social index (DESI) and various indicators of sustainability in Visegrad group of countries. The extent of digital transformation was estimated in each country. It was concluded that countries in V4 perform better than most of European countries and considerable impact was found among study variables in V4 countries. Ciocoiu (2011) commented that there is a synergetic effect between digital economy and green economy as they provide a common solution to sustainable economic growth and climate change. Adoption to various digital technologies including robotics, artificial intelligence, IoT etc at one side improves digitalization in production and introduces new techniques and business models. On the other hand economic effectiveness of such a shift to economic digitalization must be assessed in terms of improvement in quality of life as

compared to increase in volume of GDP (Readiness for the Future of Production Report, 2018).

The study of Pasqualino et al (2021) used IN4.0-SD to study the dynamics of industrial revolution, inflation and inequality. IN4.0-SD further includes sustainable oriented innovation business (SOIB), digital asset supplier business (DASB) and household. They argue that digitalization of business activities must be accompanied with sustainability in present day socio economic landscape because of variety of risks caused by traditional manufacturing processes and restrictions imposed by governments and other stakeholders. Analysis of the study confirmed impact of digital transformation models and sustainable oriented businesses on society in terms of wealth creation, labor market transformation and creation of opportunities for employment in digital economy. Kazancoglu et al (2021) studied the impact of Industry 4.0 on sustainability in term of its social and environment dimensions by using a system dynamics (SD) model. This model analyses the relationship between various variables and estimates cause and effect of industry 4.0, CO2 emissions, productivity, work injuries and accidents. This study concluded that implementation of Industry 4.0 technologies is imperative for a sustainable business model. Li et al (2020) studied the impact of Industry 4.0 technologies including cloud computing, IoT and big data analytics on various dimensions of environment and economy. It was asserted that adoption of Industry 4.0 technologies augment economic and environmental performance. Jones and Waynn (2021) are of the opinion that adoption of digital technologies and sustainable growth for sustainable future are common trends in modern day society. They addressed the question that prominent technology companies contribute to sustainable growth or not. It was concluded that most of leading technology companies operates for commercial objectives. On the other hand promoting and supporting a circular economy provides a better opportunity for digital technologies to impact sustainable growth and development. George et al (2020) explored the role of digital technologies in sustainable development and climate change. The digital sustainable activities provided innovative applications to provide solutions to various problems faced by society. Digital sustainability as adopted by organizations and entrepreneurs can provide positive impact on society wellbeing.

Innovation and Sustainable Growth

OECD and various other institutions regularly recommend for supporting R & D to attain competitiveness, innovation and sustainable growth (OECD, 2020). Cadil et al (2018) are of the opinion that contemporary R & D policy in most of developed countries is centered to support and promote private sector R & D. There is higher propensity with this policy to strengthen innovation, competitiveness and sustainable economic growth. They further argued that supporting R & D policy in private sector although leads to innovation but does not improve productivity in short run. Therefore heavy investment in private sector R & D to attain large amount of productivity, innovation and sustainable economic growth is questionable. Inekwe (2014) classified 66 countries in various income groups during 2000 and 2009. Differences were found over the impact of R &D on economic growth in upper-middle income level countries in long and short term. This impact was relatively much larger in countries with low income levels. Salman et al (2020) examined the impact of R & D investment on sustainable economic performance in various countries of Europe and Asia. This study used various dimensions of R & D

expenditures, number of patent rights and number of researchers for estimating R & D in 20 countries during a period of 1996 to 2016. These R & D indicators were compared among high and middle income countries from Europe, Asia and the State of Kuwait. A higher amount of R & D spending, number of researchers and per capita GDP was found for European and Asian countries while these statistics were lower for the State of Kuwait. It was concluded to attain sustainable economic growth countries to enhance industrial, professional academic scientific research and higher amount of R & D expenditure for this purpose. Olaoye et al (2020) studied R & D expenditure, government effectiveness and economic growth in African countries from 2016 to 2020. R & D is measured through GDP and government effectiveness is taken as a measure for governance. It was estimated that innovation and government effectiveness are important for growth in African countries. African countries should therefore improve government effectiveness and enhance innovation through research and development expenditure to attain sustainable economic growth.

Research Methodology

Data and Description of Variables

Annual data for this research study for various variables are collected from six countries of Gulf Cooperation Council. These six countries include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and UAE. Data for this study is collected from 2008 to 2021. Digital transformation is measured through Network Readiness Index (NRI). The NRI as a measure of digital transformation shows level of various opportunities provided by information and communication technology (ICT). NRI is measured using four pillars of technology, governance, people and economy. NRI exhibits how technology and people are integrated in a specific country within the spectrum of an appropriate governance mechanism and to ascertain its impact on society, economy and environment. NRI was initially published by World Economic Forum in collaboration with INSEAD from 2002 to 2016. From 2019 onward it is redesigned and managed by Portulans Institute. Innovation is measured through Global Innovation Index (GNI) which shows state of global innovation and it benchmarks the innovation performance and ecosystem in a particular country. It is published by World Intellectual Property Organization (WIPO). Data for sustainable growth is collected from Sustainable Development Index (SDI). SDI measures human development in terms of ecological efficiency. SDI postulates that development should be achieved with the spectrum of planetary boundaries. Its measurement and ranking is based on life expectancy, income level, education and carbon emissions. Missing values are calculated using growth formulas.

Data Estimation Techniques

We have applied numerous techniques. We have used penal quintile regression as baseline and GMM and Dynamic fixed effect for robustness.

Panel Unit Roots Test

We have used Levine et al. (2002) for LLC and Maddala & Wu (1999) for ADF, both determine the cross sectional independence. These tests are for homogenous and heterogeneous unit root test in penal. To capture cross sectional dependence we applied Pesaran (2007) test, so CIPS is used as the 2nd generation unit root techniques.

Cross Sectional Dependence Test

To explore the CD in data we used Pesaran (2004). As it is used in many previous studies to deal with cross sectional dependence in data (Zeshan et al., 2021).

Panel Cointegration Test

In modern day researches after assessing the penal unit root in data the penal cointegration is vital, which can be determined through numerous techniques in modern day penal data based studies i.e Westerlund (2007) and Pedroni (1999). This study applied Pedroni (1999) test for assessing cointegration among variables as this cointegration test is valuable when data exhibit heterogeneity.

Panel Quantile Regression for Hypothesis Testing

We analyses the hypothesis by using a novel Quantile regression in the spirit of Powell (2016). This technique is preferred when independent variables are judged at different points with respect to the conditional distribution of the dependent variable. This estimator is above the traditional regression techniques due the attribute of its suitability when data is having outlier (Zhu et al., 2016). This also works in the presence of the violation of the assumption of liner regression (Sharwood and Wang, 2016). This study uses the following panel quantile technique with fixed effect.

$$Y_{it} = \alpha_i + \beta(q)X_{it} + \mu_{it} \text{-----} (1)$$

GMM Estimation Technique

We also apply GMM for the robustness of our results. We explore digital transformation and innovation impact on the sustainability. We use the data of different Gulf countries hence we assume that data is subject to some issues like cross sectional dependence, autocorrelation and heteroscedasticity. Due to these issues it is likely a better tool to analyze the data. We use the following GMM estimation technique.

$$Sustainability_{it} = \beta_1(DT_{it}) + \beta_2(INNOV_{it}) + \varepsilon_{it} \text{-----} (2)$$

Dynamic Fixed Effect Model

The penal data can be treated with numerous techniques, like DOLS, FMOLS, GMM, GLS, OLS but one of the restriction of these models is that it only provide the results of short run relationship of the variables and not valid for capturing long run relationship (Murthy & Nath, 2009). DFE plays a key role the data contain heterogeneity and the researcher determines short run as well as long run relationship. This model is based on ARDL correction that manage both short as well as long run variables association.

$$\Delta(Y_i)_t = \sum_{j=1}^{P-1} \gamma_j^i \Delta(Y_i)_{t-1} + \sum_{j=0}^{P-1} \delta_j^i \Delta(X_i)_{t-1} + [(Y_i)_{t-1} - \beta_1^i (X_i)_{t-1}] + \beta_0^i + \mu_t + \varepsilon_{it} \text{ (3)}$$

Data Analysis and Results

Table 1 depicts that the data is stationary or non-stationary. The results report the stationary of the variables at first difference.

Table 1: Unit Root test of the Data

Variable	LLC		ADF		CIPS	
Sustainability	4.345	-7.235***	7.543	122.110**	2.15	2.982***
DT	3.102	-6.111***	8.778	145.440***	2.56	3.232***
INNOV	5.189	8.454***	9.443	153.222***	2.76	3.661***

The table 2 analyses cross sectional dependence in the data. Our results demonstrate that data has the problem of CD and serial correlation that is why we have used these techniques instead of the OLS to test hypothesis.

Table 2: Cross-sectional Dependence Test

Tests	Decision Value	Prob
Breusch-Pagan LM (Lagrang Multiplier)	28.90	0.000***
Pesaran Scaled LM	22.56	0.000***

, * show significance at 5% and 1%.

Table 3 showing the Pedroni cointegration test results. Our results depicts that four stats are significant. These statistics are significant in both between dimension and within dimension. Due to the significance of these four tests it is concluded that cointegration exist among variables.

Table 3: Pedroni Cointegration Test

Common AR coefficients (within-dimension)				
	Statistics	Prob	Weighted statistics	Prob
P.V-Stat	- 3.123	0.887	-3.123	0.543
P.rho-Stat	2.012	0.654	2.109	0.862
P.PP-Stat	-7.998	0.000***	-7.321	0.000***
P.ADF-Stat	-8.564	0.000***	-8.543	0.000***
Individual A.R coefficient				
G- rho-Stat	3.098	0.989		
G- PP-Stat	-8.453	0.000***		
G- ADF-Stat	-8.855	0.000***		

*** Significant at 1 percent level

Table 4: Quantile Regression Estimator

Variables	q0.05	q0.25	q0. 50	q0.75	q0. 90
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DT	0.345**	0.202*	0.389***	0.377***	0.398***
INNOV	0.201*	0.232**	0.221**	0.228**	0.111*

*, **, *** significant at 10%, 5% and 1% respectively

Table 4 demonstrates the results of the novel penal QR that show the impact of the digital transformation and the innovation on the sustainability. The results show the coefficients of the model in respect to digital transformation are statistically significant in almost all quantiles which imply that digital transformation has significant effect on sustainability of these selected Gulf countries. Schieferdecker and Mattauch (2014) and Esses (2021) also validated that digital technology has positive effect on sustainable development. Our results also confirm the positive and statistically significant effect of the innovation in all quantiles that determine that innovation drive these countries towards sustainability. Olaoye et al. (2020) also confirmed that innovation is very significant to influence the sustainable development. Based on these results we affirm that both digital transformation and innovation are the driving forces towards the sustainability.

Table 5 depicts the short run as well as long run effect of DT and innovation on sustainability. Our results portray that digital transformation is significantly affecting the sustainability both in short run and long run. Similarly the innovation also exhibits positive nexus with sustainability both in short run and long run. Hence this estimator validates the results of the Quantile Regression.

Table 5: Dynamic Fixed Effect Estimator

Variables	Long-Run	Short Run
ΔDT		0.432* (0.083)
$\Delta INNOV$		0.232* (0.075)
DT	0.675*** (0.006)	
INNOV	0.542** (0.004)	

Note: The standard errors are in parenthesis *, **, *** represented significant level at 10%, 5% and 1%.

The table 6 shows the results of GMM which validate the results of our main stream estimator QR. This estimator also confirmed that DT and INNOV have positive significant effect on the sustainable development.

Table 6: GMM results

GMM

DT	0.234**
	(0.042)
INNOV	0.167*
	(0.070)
<i>Sustainability_{i t-1}</i>	0.231**
	(0.032)
J-stat	0.412
AR (1)	0.000
AR (2)	0.512

Discussion and Conclusion

Our results show that a short as well as long run effect of digital Transformation exists on Sustainable Growth and that innovation positively mediates the relationship between digital Transformation and Sustainable Growth. These results are consistent with the findings of previous studies. Digital technologies are considered as the game-changer and are vital to achieve the sustainable goals of the country (Nambisan et al, 2019). Digital transformation helps in transforming and evolving the business models to make the country distinctive in this regard. The pace of economic growth can be achieved through sustainable and fast track digitalization efforts by a particular country or region. As technological transformation creates opportunities and achieve the revenue milestones (European Commission, 2020). Sustainability and digitalization are essential for the firms in the current socio-economic landscape due to risks caused by traditional manufacturing practices, and rules imposed by stakeholders and governments. Across the world many firms and countries have hugely invested in digital technologies with a view to lower the business risk and encourage optimizing and to establish framework that could be effective in revenue generation. Digital technologies also have impactful performance to impact the traditional way of doing business, the environment and quality of life. Likewise, our results also show that innovation is positively effecting the sustainable growth of these Arab countries. While going through the literature there are studies that confirm the existence of innovation with sustainable growth. In this regard, Salman et al (2020) confirmed that innovation is critical to the sustainable economic growth of the European and Asian countries. Based on the findings, it is suggested that transformation of digital technologies from traditional technologies should be focused by these Gulf countries to ascertain economic uplift. More innovations and R&D efforts to be ensured to get competitive advantage in business processing and mechanism. Digital transformation and innovation will make these Gulf countries richer and would obtain

economic heights. Future studies to compare the regions for their technological transformation and innovation.

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