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The Dynamic Nexus of Digital Evolution, Environmental Turbulence and Environmental Performance: A Case of High-tech Industries in the Emerging 4th Industrial Revolution

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ABSTRACT

The aim of the current study lies in exploring the potential effect of environmental turbulence on environmental performance and digital evolution. Furthermore, the present study also aims to capture the fruitfulness of digitalization on sustainable environment in the emerging Fourth Industrial Revolution environment. In doing so, the statistical application of structural equation modelling leads to discover the all five variables have a significant impact on each other. Market turbulence and technological turbulence have positive and significantly impact on Environmental turbulence that confirming two hypotheses. Furthermore, environmental turbulence has a negative and significant impact on digital evolution and environmental performance. However, digital evolution has a positive and significantly impact on environmental performance in Malaysian small manufacturing enterprises. This model explains 63.80% variance of environmental performance by all the factors of environmental turbulence and digital evolution. Therefore, the current study suggested to expand their horizon of intellect towards digital commerce as it underlies the potential to generate improved and effective environmental conditions.

Keywords: 4th Industrial Revolution, Environmental Turbulence, Environmental Performance, Malaysia

JEL Classifications: Q55, Q50

1. INTRODUCTION

The emergence of Fourth industrial revolution (4IR) has witnessed the shift of organizations' profound interests towards transferring their market image as environmentally flexible and prone to technological advancements. This results in frequent operational changes, knowledge modifications and processes improvements from the orthodox practices to digitalized productions and tactical management. With the rising digital evolution, businesses and industries are handled with advanced technologies and benefitted in terms of improved man oeuvres, efficient procedures, innovative management and obliging market image (Bastow and Leonelli, 2010). Digitalization does not only expand business potentials but also brings optimism in the external

settings (Miller and Wilsdon, 2001; Saudi et al., 2019a). With advancements in information technology, digital evolution tends to cause both positive or negative influence on the environment. In this regard many believe that digital evolution is making its way to reach the skies without giving any due concerns to the society and the environment (Miller and Wilsdon, 2001). However, the other view suggests that as the modern businesses are prone to sustainable development concerns, digital evolution also carries eco-friendly inventions with enhanced levels of energy efficiencies to corresponds well towards the sustainability goals (Saudi et al., 2019b).

Proposing the framework of digital sustainable cities, Hall et al. (2013) elaborated the importance of distribution

network in capturing the wireless access need of the metropolitan environments to ensure the accomplishment of “digital cities” by resolving the major issue of power utilization. Similarly, emphasizing the role of IT in digitalization, Wilsdon (2001) also stated that with the rise in electronic organization and businesses, virtual traffic could get the option to replace actual traffic. The author further suggested that this will enable the policy makers to expand their horizon of intellect towards digital commerce as it underlies the potential to generate improved and effective logistics and distribution structures.

Technological production, similar to many other industries aimed to reduce negative pressures on the environment. Product developments in high tech industries involved solving the related procedure queries. For instance, how to initiate the process of technical knowledge, how to fabricate the ideas into application, how to utilize the resources, how to start industrial manufacturing, the methods involved in recycling and disposing products etc; in the most ideal way that will eliminate any possible adverse effects on environment and ensure the benefit of the society (Chen et al., 2015). From societal point of view, a standout amongst the most widely recognized meanings of sustainable development and practical improvement was given by the Brundtland (1987). The defined assertion of sustainability in Brundtland’s view is referred to the reasonable advancement in the society that addresses the issues of the present without bargaining the capacity of future ages to address their very own issues. Similarly, fourth industrial revolution also maintains the similar thoughts on the notion of sustainability and ensures that progress is not achieved at the expense of environmental quality (Sinaga et al., 2019a).

With the rise in digital evolution, business and societies familiarize technological innovations from industrial and societal insurgency. However, many forms of digitalization often face disruptions through changes in external environment. Turbulences in surrounding exteriors tends to bring uncertainty and complexity in the smooth transition of digital evolutions (Slater and Narver, 2009; Abdullah et al., 2018; Sinaga et al., 2019b). Environmental turbulence confines peripheral alterations which are the outcomes of several market and technological turbulences. Such unrest produces instabilities and makes the process of planning problematic to implement, thereby enhancing the gap between the actual and desired outcomes (Pavlou and El Sawy, 2011).

By definition, environmental turbulence refers to the enhanced occurrence and magnitude of alterations in the exterior business environment enabling higher level of uncertainties (Duncan, 1972). As mentioned above, the external disorders in the environment are caused by two major commotions. These include, (a) market turbulence which is the outcome of ambiguities in industrial demand and actions of the competitors and (b) technological turbulence that confines the higher levels of technological revolutions in the industries (Jap, 2001). The presence of turbulences in the operational surroundings obstruct sustainable development as it hurts the planning process, augments resource allocations, disrupt decision making and expected to transmit cost burden (Slater and Narver, 2009). This puts negative pressure on

company’s directives of environmental performance, thereby, upset the course of sustainability.

In high-tech industries the impact of environmental turbulence is greater in the form of enhancing idle technologies by augmenting the necessity of reconfiguring the prevailing technologies and capabilities to originate new technologies with improved external alignment. As Malaysian industries are working efficiently in assimilating the successful implementation of 4IR goals, the uncertainties around the digital evolution and sustainable organizational performance entail the major threat (Ahmed et al., 2017). Considering the adversity of external turbulence, the objective of the present study lies in exploring the potential effect of environmental turbulence on environmental performance and digital evolution. Furthermore, the present study also aims to capture the fruitfulness of digitalization on sustainable environment in the emerging 4IR environment. In doing so, the current study strives to identify the contribution of digitalization in influencing environmental performance. The existing literature in this domain scarcely studies the association between technological advancements and their link with environmental performance. In this way, the exclusivity of the present study lies in pioneering the empirical investigation regarding environmental turbulence and its effect on digitalization and sustainable performance. Similarly, the additional features present in the form of utilizing rigorous methodology applied in the present study and investigating complexed model, also add value to the existing literature and would be helpful in shedding greater insights into the studied domain.

2. THEORETICAL CHANNEL AND HYPOTHESIS DEVELOPMENT

The existing studies on sustainable performance provide due attention to performance measures (Burgos and Céspedes, 2001). Among them environmental performance is crucial to caters the ecological operational performance of the organization. In this regard, the current studies on environmental performance have identified the debates on business practices to capture the essence of “green enterprises.” However, the existing complexity in defining the required procedures of the company that conforms to the organization’s green image, still lacks in practice (Haseeb et al., 2019; Lober, 1996). Nevertheless, the most approved accord of measuring environmental performance relies on organization’s implementation of environment friendly operations. These practices heavily depend on the exertions of businesses in accommodating ecologically degrading procedures in a way that suits the goals of sustainability. Such operations include waste recycling, discharge reduction, curtailing pollution, governmental certification and organizations’ adaptive flexibility (Gholami et al., 2013; Mobus, 2005; Al-Tuwaijri et al., 2004; Patten, 2002; Cormier and Megnan, 1997).

In the above-mentioned context, the description of environmental performance in current study is confined to successful implementation of environmentally friendly procedures that contain the potentials of spreading the goals of technological advancements

across the industries with improved environmentalism. Following are the utilized dimensions of environmental performance.

- Environmental consistence enhancement, that characterizes the osmosis of managing the environmental issues associated with the business exercises through esteem included quality, intensified profitability and updated advancement
- Improved corporate image, which establishes association's general practices that supplement its objective of ecological preservation and assemble the notoriety in meeting the natural destinations
- Environmental regulations, which characterizes the accreditations of outside bodies by guaranteeing endeavour's practices in meeting benchmarks obligatory controls related with natural preservation
- Reduction of emanation and waste, which examine association's endeavours in limiting harmful outflows and releases that underlie the inclination to cause ecological disintegration
- Recycling performance, which alludes to firms' drives in disposing of changeless weights came about because of undissolved bi-items through building up hardware and plants for reutilizing or offering them to second gatherings to reprocess.

The emergence of 4IR welcomed superior digitalization in many industrial and sectorial levels. The significance of digital evolutions in pronouncing the goals of 4IR is evident, however, its relationship with environmental performance is critical to investigate the effect digitalization carries on environment. The significance of environmental performance during technological advancements is discussed in many studies. In this regard, Burritt (2004) established that experimental investigations in environmental systems are scarcely examined. They are mostly congregated to analyse lawfulness, computing costs, management styles, thereby ignoring the significance of information technology mechanism of the systems. In such studies, Gholami et al. (2013) explores the administrators' impression of technological frameworks and break down its impacts on ecological execution. The investigation connected the hypothetical establishments of belief-action-outcome model to catch the effect of sustainable systems implementation and its association in improving environmental execution. The results of the examination propose that coercive pressure practices the huge effect on green systems, in any case, the investigation neglected to discover the commitment of mimetic pressure in affecting technology evolution. Similarly, the experimental examination summarizing the criticalness of sustainable information systems performance in impacting ecological execution propose that grasping sustainable systems acquires the enhancement of eco-friendly digitalization. In this context, Henri and Journeault (2010) inspect the contribution of financial controls in improving ecological and monetary execution of the firms. Alluding the two measures of eco-control, the consequences of the examination locate the irrelevant effect of eco-control in impacting ecological accomplishments. Furthermore, in building up the connection between eco-control and economic, the investigation reasons that ecological advancements mediate the impact of eco-control on economic activities of the Canadian firms. Moreover, Costantini et al. (2017) also identified the importance of

innovative advancements in ensuring environmental performance (Haseeb et al., 2019). The results of the study conclude that sustainable innovations help to curtail environmental burden and enhances sectoral environmental performance of the European firms. More recently, Song et al. (2018) comprehensively analyzed the existing theoretical foundations between environmental performance and technological advancements (Dawabsheh et al., 2019). Emphasizing on the issues related with big data in terms of its quantity, velocity and diversity, the study examined the method of data envelopment investigation and offered numerous theoretical propositions and technologies to manage issues related with big data.

Reviewing the significance of technological advancements and sustainable performance, the present study hypothesized the following:

H₁: Digital evolution is significant to influence environmental performance

As, the present literature recognized that environmental performance is vital for several industries and influenced by numerous external, internal, financial and technological indicators, that are critical to endure the objectives of organization's sustainability. In this regard, Burgass et al. (2017) analysed the significance of uncertainty in information system performance. Analysing several composite indicators, the findings of the study suggest that systems modelling and systematic engagement is crucial to diminish the adverse consequences of external uncertainty. Likewise, In Taiwan, Liu (2017) empirically identified the importance of environmental uncertainty in mediating the impact of social capital in influencing organization and market performance of industries.

In an interesting framework, Pavlou and El Sawy (2011) examined the novelty of turbulent environments in affecting the relationship between dynamic and operational capabilities that subsequently impact performance. The results of the study revealed that both market and technological turbulence are significant predictor of environmental turbulence. In addition, the study also found significant influence of turbulent environment in affecting the association of dynamic and operational capabilities and similarly, operational capabilities and performance. Furthermore, the empirical results suggested that environmental turbulence positively moderated the relationship of dynamic capabilities of managers and organization's operational capabilities. On the other hand, the study concluded that turbulent environment negatively moderated the impact of operational capabilities on organizational new product development (NPD) performance (Bosupeng, 2018; Jermisittiparsert et al., 2019). In the light of the above literature, the present study hypothesized that:

H₂: Market turbulence is significant to influence environmental turbulence

H₃: Technological turbulence is significant to influence environmental turbulence

In addition, witnessing the continuous changes in external environmental in terms of technological, industrial and ecological turbulences, the process of digitalization is likely to be adversely

influenced by turbulent environment (Hussain et al., 2019). To test the association empirically, the current study hypothesized that: H₄: Environmental turbulence is significant to influence digital evolution

In addition, Han et al. (1998) investigated the impact of turbulent environment on market alignment. The findings of the study revealed that technological turbulence is significant to moderate the association between market orientation and innovations, however, market turbulence have no contribution in influencing the relationship of orientation and innovation. On the other hand, Slater and Narver (2009) found that technological turbulence adversely moderated the impact of orientation on performance. Extending the link, the theoretical association of environmental turbulence is protracted to effect performance. In this regard, Calantone et al. (2003) examined the link of market and technological turbulence on NPD performance. The results of the study suggest that both market turbulence and technological turbulence are significant predictor of performance. On the other hand,

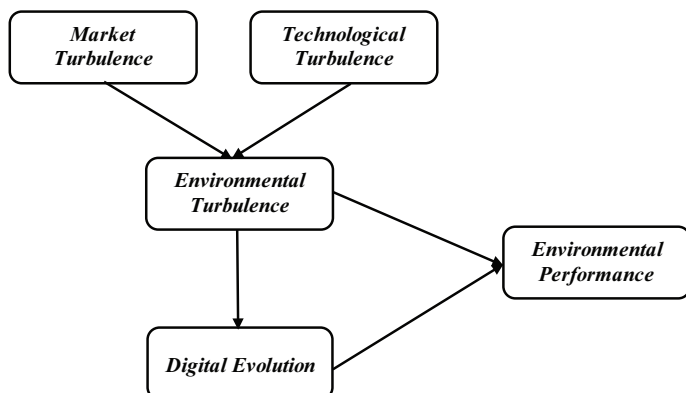
Therefore, the current study hypothesized the following: H₅: Environmental turbulence is significant to influence environmental performance

Displayed in Figure 1 is the hypothesized model of the current study.

3. METHODOLOGY

The target sample for the current study are the lower, middle and upper level managers of small manufacturing industries of Malaysia. Based on the research hypothesized model which is presented in Figure 1 the traits of variables are considered as five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The measurement items of the current research consist of five variables that include market turbulence (MKT), technological turbulence (TET), environmental turbulence (ENT), digital evolution (DIE) and environmental performance (ENP). Among the variables of digital evolution are adopted from the study of (Nylén and Holmström, 2015; Bhattarai and Carter, 2018), items of environmental turbulence, technological turbulence and market turbulence are adopted from (Pavlou, and El Sawy, 2011), whereas, items of environmental performance are adopted from (Chowdhury et al., 2014; Boutayeba, 2017).

Figure 1: Research model



The data of the current study is collected by a questionnaire transliterated in English and is gathered from a total of one hundred and thirty-five SMEs. The questionnaire is sent by an email to all the managers in small manufacturing industries by getting their email address. A total of 291 questionnaires were mailed to the employees, out of which 275 managers responded. Altogether, the process of data collection has taken a period of 4 months. Finally, the current study is not funded by any association. The investigation also has followed the rules of Dillman (1978) in the considering moral and ethical measures.

4. DATA ANALYSIS

The data analysis of the current study is done by utilizing the Statistical Package for Social Sciences (Version 23) and Analysis Moment of Structure (Version 23) statistical software's. The final valid sample used in the current study is 265 after removing univariate and multivariate outliers using Z-test score and Mahalanobis distance (D2) criteria respectively. Presented in Table 1 is the composition and structure of the answers of the sample used in current study. Likewise, Table 2 highlight the mean, standard deviation and Pearson's Correlation of the variables. Moreover, to test the problem of multicollinearity, the current research following Hair et al. (2010) found that all the values in the Pearson's correlation Matrix are <0.90. Therefore, confirms the absence of multicollinearity among the predictors (Hair et al., 2010; Sharif and Raza, 2017; Brahim and Nourredine, 2017).

The study adopted highly used principal components type of factoring that converged a total of 20 questionnaire Likert scaled items into five final variables. In order to examine sample adequacy, the value of Kaiser–Meyer–Olkin (0.923) suggest that data is appropriate in order to making the factors because the value of KMO is greater than the cut off value of 0.7 as suggested by (Barkus et al., 2006). Moreover, the results of Bartlet test of

Table 1: Descriptive statistics

Valid	Frequency	Percent (%)
Gender		
Male	175	66
Female	90	34
Total	265	100
Age		
20-30 years	157	62
31-40 years	57	23
41-50 years	19	8
51 and above	20	8
Total	253	100
Working experience		
1-5 years	189	71
6-10 years	53	20
11-15 years	15	6
More than 15 years	8	3
Total	265	100
Education		
Undergraduate	62	23
Graduate	131	49
Post graduate	26	10
Others	46	17
Total	265	100

Table 2: Means, SDs, Pearson correlations

	Mean	SD	MKT	TET	ENT	DIE	ENP
MKT	3.75	1.28	-				
TET	3.23	1.02	0.517**	-			
ENT	3.85	1.15	0.503**	0.313**	-		
DIE	4.12	1.08	0.422**	0.372**	-0.342**	-	
ENP	4.34	1.03	0.336**	0.468**	-0.211**	0.390**	-

N=265. **Correlation is significant at the 0.01 level (2-tailed). SD: Standard deviation

Sphericity are also found significant ($P < 0.05$), thus rejecting the null hypothesis representative the nonappearance of correlation identity matrix (Afshan et al., 2018; Johari et al., 2018). These five final factors successfully defined 71.23% of the total variance explained. The explanation of rotated component matrix highlights a total of twenty-eight items that showed the factor loadings more than 0.70 and are above the benchmark of 0.55 as suggested by Tabachnick and Fidell, (2007).

The results of factor analysis and factor loading for each items of the endogenous and exogenous variables are presented in Table 3. Moreover, the gathered data is further investigated for reliability, discriminant validity and convergent validity. Convergent validity endorses that an instrument connects greatly with other factors with which it should hypothetically connected. On the other hand, the Cronbach alpha, the composite reliability is reflected an advance measure of confirming construct validity which investigate the overall reliability of a combination of heterogeneous but same construct (Fornell and Larcker, 1981; Ya'acob et al., 2017).

Furthermore, we examine all measures to confirm the construct validity. The results of construct and convergent validity with composite reliability (CR), Cronbach alpha ($C\alpha$) and average variance explained (AVE) is shown in Table 4. The value of CR and $C\alpha$ should be >0.7 as recommended by (Afshan et al., 2018; Frooghi et al., 2015; Sharif and Raza, 2017; Afshan and Sharif, 2016; Sharif and Bukhari, 2014; Waseem et al., 2013). In our case the results of value of CR and $C\alpha$ are >0.70 . Likewise, the value of AVE is considered good if it is >0.50 as suggested by Molina et al. (2007); Arif et al. (2016). In our case the value of AVE for all the fifteen factors are greater than 0.50 it also fits the goodness of fit criterion.

The present research applied confirmatory factor analysis (CFA) by using twenty items that explain five factors which are market turbulence (MKT), technological turbulence (TET), environmental turbulence (ENT), digital evolution (DIE) and environmental performance (ENP). The CFA measurement model base on the valuation of its measurement model fitness. In the present study, we use four critical indices of measuring model fitness which include Chi-square minimum/degree of freedom (CMIN/DF), the root mean square error of approximation (RMSEA), comparative fit index (CFI) and the standardized root mean residual (SRMR) as suggested by Kline (2005). These all indices have an edge over rest of indices as they are the foremost impervious to the sample size, parameter estimations and misleading (Kline, 2005). Results of Table 5 explains the hypothesized model by using these four indices.

Table 3: Factors loading and variance explained^a

Variables	MKT	TET	ENT	DIE	ENP
Eigen value	8.32	5.31	2.14	1.21	1.02
% variance	23.67	18.45	10.23	9.54	9.34
Cum. %	23.67	42.12	52.35	61.89	71.23
Market turbulence					
MKT1	0.932				
MKT2	0.902				
MKT3	0.893				
MKT4	0.864				
Technological turbulence					
TET1		0.928			
TET2		0.901			
TET3		0.892			
TET4		0.864			
Environmental turbulence					
ENT1			0.894		
ENT2			0.856		
ENT3			0.842		
ENT4			0.801		
Digital evolution					
DIE1				0.854	
DIE2				0.821	
DIE3				0.801	
DIE4				0.793	
Environmental performance					
ENP1					0.832
ENP2					0.812
ENP3					0.802
ENP4					0.783

Extraction method: Principal component analysis

Rotation method: Varimax with Kaiser normalization

^aRotation converged in 8 iterations

Generally, the results of measurement model recommend that the explained five factors model fits the data very well. Also, the threshold value for CMIN/DF should be <2 as explain by Tabachnick and Fidell (2007). In our results the value of CMIN/DF is 1.326 and it fits the goodness of measurement model. Along with this, the Comparative Fit Index value should be >0.90 which consider as good and >0.95 which consider as excellent as suggested by Hu and Bentler (1999). In our case the value of CFI is 0.962 and it also fits the goodness of fit standard. Also, the value of root mean square error of approximation should be <0.07 as recommended by Steiger (2007). In our results the value of RMSEA is 0.038 which is <0.07 . The results of RMSEA suggested that our collected data fit very well with our hypothesized framework. Finally, the standardized root mean square residual is also significant if it is smaller than 0.08 as suggested by Hu and Bentler (1999). Our results explain that the value of SRMR is 0.039 and it also fits the goodness of fit criterion. It is also reported that our ultimate framework has involved various correlated error term inside a variable.

Table 4: CA, CR and AVE

Constructs	CA	CR	AVE
MKT	0.934	0.903	0.642
TET	0.927	0.893	0.602
ENT	0.894	0.836	0.583
DIE	0.903	0.801	0.532
ENP	0.941	0.895	0.582

Source: Authors' estimation. CA: Cronbach alpha, CR: Composite reliability, AVE: Average variance explained

Table 5: Confirmatory factor analysis measurement model fit indices

Indices	Final measurement model
Chi-square minimum/degree of freedom	1.326
Comparative fit index	0.962
Root mean square error of approximation (P-close)	0.042 (0.673)
Standardized root mean residual	0.039

Source: Authors' estimation

Table 6: SEM hypothesis testing

Hypothesized path	Path coefficient	Composite reliability	P-value	Remarks
ENT←MKT	0.251	4.224	0.000	Supported
ENT←TET	0.201	3.895	0.000	Supported
DIE←ENT	-0.274	-4.034	0.000	Supported
ENP←ENT	-0.324	-5.295	0.000	Supported
ENP←DIE	0.224	2.957	0.000	Supported
Level of significance (5% i.e., 0.050)				

Source: Authors' estimation

In order to check the structural relationships, Table 6 described the outcome of SEM regression path, critical ratio, significance value and remarks of the hypothesis. The results of SEM explain that market turbulence ($\beta = 0.251$, $P < 0.000$) and technological turbulence ($\beta = 0.201$, $P < 0.000$) have positive and significantly impact on environmental turbulence that confirming two hypotheses (Taib et al., 2018). This model explains 52.45% variance of environmental turbulence by market turbulence and technological turbulence. On the other hand, the results also suggested that digital evolution ($\beta = -0.274$, $P < 0.000$) and environmental performance ($\beta = -0.324$, $P < 0.000$) have a significant and negative impact by environmental turbulence however, digital evolution ($\beta = 0.224$, $P < 0.000$) have positive and significantly impact on environmental performance therefore confirming the remaining three hypotheses. This model explains 63.80% variance of environmental performance by all the factors of environmental turbulence and digital evolution.

5. DISCUSSION AND CONCLUSION

In high-tech industries the impact of environmental turbulence is greater in the form of enhancing idle technologies by augmenting the necessity of reconfiguring the prevailing technologies and capabilities to originate new technologies with improved external alignment. As Malaysian industries are working efficiently in assimilating the successful implementation of 4IR goals, the uncertainties around the digital evolution and sustainable

organizational performance entail the major threat. Considering the adversity of external turbulence, the objective of the present study lies in exploring the potential effect of environmental turbulence on environmental performance and digital evolution. Furthermore, the present study also aims to capture the fruitfulness of digitalization on sustainable environment in the emerging 4IR environment. In doing so, the statistical application of exploratory factor analysis lead to discover the all five variables are described by total twenty items in which all items factor loading is >0.70 . Furthermore, the results of measurement model fitness of CFA explain that all four considered model fitness explain that the collected data is fit for making the factors. Finally, the results of structural equation modelling recommended that initially, market turbulence and technological turbulence have positive and significantly impact on Environmental turbulence that confirming two hypotheses. Furthermore, environmental turbulence has a negative and significant impact on digital evolution and environmental performance. However, digital evolution has a positive and significantly impact on environmental performance in Malaysian small manufacturing enterprises. This model explains 63.80% variance of environmental performance by all the factors of Environmental turbulence and digital evolution.

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