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The Role of Technology in the Tourism and Urban Risk Nexus in South Africa

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Abstract

This study investigated the role of technology in the tourism and urban risk nexus in South Africa. The auto-regressive distributed lag model (ARDL) was used as a method of analysis whilst data on technology (the number of people with mobile cellular telephone subscriptions with access to the public switched telephone network (PSTN) technology), tourism, exchange rate, foreign direct investment, economic growth, terms of trade, inflation rate, and urban risk (the monetary value of carbon dioxide (CO_2) emission (damage) due to urbanisation) were extracted from the World Bank's database on global development indicators. The study found that the interactive role of technology with tourism did not reduce urban risk in South Africa, rather it had a positive impact and negligibly promoted urban risk in the country. The study further revealed that the exchange rate, terms of trade, and economic growth positively and significantly promoted urban risk in South Africa due to urbanisation. Frameworks should be put in place to ameliorate the problems of urban risk in South Africa and to adopt a suitable technological innovation that will assist the process. Rather than reduce urban risk, the interactive role of technology with tourism promoted urban risk in South Africa.

Keywords: Technology; Tourism; Urban Risk; ARDL Model; South Africa

Introduction

Tourism is surging in Africa with over 70 million international tourists arriving and over US$38 billion earned as international tourist receipts in 2019 up on till the global incidence of Covid-19 pandemic (UNWTO, 2020). This indicates that tourism has become a key determinant of sustainable livelihood and growth in Africa. Conversely, urbanisation has been on the increase recently and it has been projected that about 68 percent of the world population will be living in cities by 2050 (Trask, 2018). Also, Africa's population is increasingly becoming urban which makes the residents prone to vulnerability and urban disasters such as floods, fires, earthquakes, epidemic and pandemic breakouts, and high carbon emissions which have an implication for human and urban existence. It has been projected that over 854 million people will migrate from rural areas to urban cities by 2040 (UNWTO, 2020).

Conversely, sub-Saharan Africa (SSA) has been identified as the region with the most urban population growth rates worldwide. This is not only heavily determined by high rates of the population migrating from rural to urban centres, but it is coupled with high international tourist inflows (Satterthwaite, 2017; Tshidzumba et al., 2022). The number of people living in sub-Saharan Africa has been projected to rise from 294 million in 2010 to 621 million in the year 2030 (Satterthwaite, 2017).

Due to the high rate of poverty, the climate change crisis, and a faulty and inadequate ability to efficiently plan and manage rapid urbanisation, the biggest cities in SSA are currently experiencing the challenges of urban risks, including everyday hazards like disease outbreaks, high crime rates, road accident injuries, as well as disasters like landslides, tropical storms, earthquakes, and floods (Adelekan et al., 2015). Therefore, despite rapid urbanisation, SSA is confronted with weak institutions and limited capacities to address the problems of urban risks. Information communication technologies (ICTs) have been identified as a major catalyst for the promotion and transformation of tourism globally (Mxunyelwa, 2016). According to the United Nations World Tourism Organization (2011) technological innovation can promote the competitiveness and efficiency of the tourism sector of an economy. Hence, technology adoption in the tourism industry will lead to a paradigm shift and will cause the emergence of a new structure and opportunities (Mxunyelwa, 2016). As technology promotes tourism development, it is, therefore, inevitable that the sector expands. This will necessitate all stakeholders in the hospitality and tourism industry to upgrade their facilities by acquiring the latest ICT most suitable for them (Bethapudi, 2013). Studies have shown that technological innovations such as the use of mobile phones, the Internet, and ICTs had a robust impact on the economy, most especially in the tourism sector (see Alt & Klein, 2011; Dickinson et al., 2012; Lamsfus et al., 2013; Madila et al., 2022; Susanto et al., 2022; Wang & Fesenmaier, 2013).

South Africa has the largest economy in Africa with a 4.9 percent growth and it recorded 10.2 million tourists in 2019 and set a target of 21 million arrivals by 2030 (South African Tourism, 2020). Hence, tourism is now a viable sector in the economy of South Africa and a source of livelihood for many rural and urban dwellers (Huseynli, 2022; Nunkoo, 2015). The first time tourism was viewed as a viable commercial activity in South Africa was prior to the Second World War (see Visser, 2016), making South Africa a popular destination for tourists who visit Johannesburg, Cape Town, Port Elizabeth and other major cities for tourism purposes (Malleka et al., 2022; Rogerson, 2011; Wessels 2022).

South Africa has the largest economy in Africa with a 4.9 percent growth rate as well as having 12 cities with over 250,000 plus inhabitants as of 2010 (see Huseynli 2022; Satterthwaite, 2017). In the same vein, South Africa is prone to urban risks and has experienced some disasters in the past. This includes urban crimes, drought, floods, wildfires, and earthquakes due to extensive mining activities, disease outbreaks, road accidents, and industrial hazards in the form of spillages of harmful substances (IFRC, 2012; Malleka et al., 2022). Specifically, in the past two decades, over 65 industrial and natural hazards have occurred in South Africa with flooding being the highest having occurred 23 times, and second highest are wild storms having occurred 19 times. Some other disasters include road accidents, rail accidents, sometimes plane crashes, as well as accidents on the high seas (Pharoah et al., 2016). Due to urban risk, 15.3 million people were directly impacted negatively by disasters in South Africa in the past (Pharoah et al., 2016). Kellett and Sparks (2012) stated that more than US$866 million was spent on the provision of relief materials and other associated emergencies in South Africa caused by natural disasters. Over the last two decades, the severe disasters in South Africa cost more than US$1.5 billion (Pharoah et al., 2016). As such, South Africa is not immune from these urban risks as the recent serious flooding in the KwaZulu-Natal province demonstrated. In the disaster there were 443 deaths, 40,000 displaced, 4,000 houses destroyed, over 8,000 houses damaged, and 264 schools destroyed. This is an example of one of the urban risks distinctive to urban cities in South Africa.

Some studies have examined the implications of urban risks in Africa (see Dodman et al., 2017; Fraser et al., 2017a; Osuteye et al., 2017; Pharoah, 2016; Satterthwaite, 2017) and in South Africa (Davis-Reddy & Vincent, 2017; Pandy & Rogerson, 2019; Van Huyssteen et al., 2013; Visser & Rogerson, 2004) but these studies failed to address how the adoption of technology along with tourism could ameliorate the problem of urban risk in Africa, especially in South Africa. In the same vein, studies by Asgary and Ozdemir (2020), Malleka et al. (2022), Musavengane et al. (2020), and Neef and Grayman (2019), investigated the nature of the relationship between tourism and urban risk in South Africa. However, they failed to address the role that technology plays in the relationship between tourism and urban risk in South Africa since the importance of technological innovation in tourism production and consumption cannot be over-emphasised (see Bethapudi, 2013; Mxunyelwa, 2016; Toerien, 2020; Visser, 2016;). Therefore, this study will expand our understanding of how technology, in line with tourism, will influence urban risks in South Africa. The study comprises five sections. The literature review is contained in section two, the methodology is in section three, and sections four and five contain the analysis, conclusion, and recommendation of the study.

Literature review

Studies such as Chang (2017) and Christie et al. (2013) opine that tourism is a channel and backbone for economic, socio-economic, financial, and environmental development in any country. Therefore, the relevance of tourism sector development in a developing country like South Africa cannot be over-emphasised. The study by Proos and Hattingh (2022) examined tourism and its potential through the interpretivist paradigm and found a positive association between tourism (especially dark tourism), and economic performance in South Africa. This study revealed that tourism is a thriving market that pools great attraction from inside and outside the economy, creates employment opportunities, and yields economic development.

In the same vein, Khan et al. (2022) in a study on the discursive formations in South Africa (Cape Town) used a qualitative research methodology that established a strong association between tourism and economic development. This study further revealed that through tourism one sees business and investment thrive. In reiteration, Musavengane et al. (2020) agreed that tourism positively affects economic development in sub-Saharan Africa (SSA): South Africa included. However, this study showed that despite the positive effect of tourism, urban risks (urban growth, urbanisation, poverty, urban governance, and environmental degradation) threaten the growth and sustainability of tourism in South Africa. Khan et al. (2022) specifically noted that crime and lack of well-established safety and security strategies hamper tourism growth and economic growth. Although tourism positively affects economic development, urban risks hamper the rate of tourism growth and economic sustainability.

The study by Hellegatte (2013) examined the nexus between development and losses because of the occurrence of natural disasters in New Orleans. The study discovered that as income increases, the probability of a disaster occurring will decline due to massive investment in disaster reduction technologies. If the disaster takes place in a developing economy, when a disaster eventually occurs, the monetary cost of the disaster will be greater than the expected economic growth, while the annual loss from the impact of the disaster is expected to be higher than income. If it occurs in a developed economy, due to wide income disparities between developed and developing economies, the annual loss would be lower than income.

Dodman et al. (2017) examined the implication of the risk accumulation and reduction in the African urbanisation and urbanism using the review of literature approach. The study establishes that physical forms, social structures, economic pathways, as well as the government system of cities in Africa determine the kind of urban risks to which they are prone. Furthermore, studies by Chaturuka et al. (2020), Musavengane et al. (2020), and Opfermann (2021), however, opposed the notion that the direction of causation flows from urban risks to tourism growth. It revealed that a direct relationship exists from tourism to urban risk in which tourism causes and increases the rate of crime in the country and, in turn, crime hampers the growth of tourism and economic development.

In the same vein, Perry and Potgieter (2013) in a study on crime and tourism in South Africa using a qualitative survey methodology revealed that tourism triggers and increases the rate of crime. However, Chaturuka et al. (2020), Mulamba (2021), and Santana-Gallego and Fourie (2020) revealed that the high rate of crime would further lead to a decline in the volume of inflow of tourists into South Africa, thus, threatening the security and safety of both international and local tourists and the advancement of tourism in South Africa. In addition, Boakye (2012), Opfermann (2021), and Perry and Potgieter (2013) noted that criminal activities were mostly prevalent in the urban areas of South Africa such as Johannesburg. Contrary to the findings by Khan et al. (2022) and Musavenganea et al. (2020) on the direction of causation between urban risks and tourism, the studies by Malleka et al. (2022), Perry and Potgieter (2013), and Pizam and Mansveld (2006), revealed that a strong causal relationship between urban risks (most especially crime) and tourism cannot be easily determined due to weak official statistics in South Africa.

Malleka et al. (2022) also investigated the relationship between urban crime and tourism in South Africa using qualitative survey research methods (interviews and self-administered survey questionnaires). This study opined that though tourism growth is a prerequisite for economic development; security and safety measures are necessary factors for tourism to thrive in any country. However, this study also found that despite the enormity of insecurity in South Africa (most especially in Johannesburg), tourism still grew and expanded as tourists still regarded tourism in such areas as relatively safe for visitation. Also, Musavengane et al. (2020) examined a study on the nature of the association between existing tourism and urban risk in African cities using document analysis for comparison between Zimbabwe, South Africa, and Ghana. This study noted that tourist centres in Africa must be well-structured on their inherent location-built dynamics, local settings, and spatial sensitivities to achieve the safety and security of tourists and tourist centres.

Aside from the incidences of crime, studies (Nayak et al., 2022; Rogerson & Rogerson, 2017; Shen & Yang, 2022) have also noted that other issues such as poverty and health risks (COVID-19 outbreak) have a severe effect on the tourism industry. This is in line with Rogerson (2006) on the South African pro-poor economic development where the study opined that even though tourism is a channel through which the environment is sustained and conserved, the gains forthwith are not viewed as a means for poverty alleviation in South Africa. Similarly, Nayak et al. (2022) in a study on the expenditure of domestic tourists and poverty in India using the censored Tobit model revealed that household expenditure on tourism as a result of the pattern of expenditure led to an increase in poverty. It was further noted that middle-aged indigenous tourists specifically in the rural area were mostly plunged into poverty due to the excessiveness of expenses on tourism.

Shen and Yang (2022) examined the relationship between tourism and risk perceptions of COVID-19 using the full collinearity test and partial least squares structural equation modelling (PLS-SEM). Findings from the study revealed that the pandemic outbreak increased movement restrictions, especially for foreign tourists. In addition, despite the positive attitude of residents to tourism, there was a negative relationship between their risk acuity to COVID-19 and their support for tourism and foreign tourists thereby leading to an adverse impact on the South African tourism industry. Musavengane et al. (2022) and Rogerson and Rogerson (2021) studied the policy implications emanating from the resultant effect of COVID-19 on the South African tourism sector and specified that while the impact of the global pandemic on tourism was devastating, it should result in a change in policy strategies. Policy strategies were channelled towards recovery; therefore, the focus should be shifted to the expansion leading to an improvement of the domestic tourism sector in the country.

Also, Pandy and Rogerson (2018) studied the risk of climate oscillations in the South African tourism sector using a qualitative methodology with semi-structured interviews for analysis. The study discovered that South Africa is susceptible to the problems of climate change, even though policies and obligations were ratified and adopted to mitigate the adverse effects of climate change. It was found that the outcome of such policies especially for the protection of key tourism assets, was less significant. Likewise, it was noted that the resultant effect of climate change dampened the prospects for investment in tourism. In sum, empirical reviews have established that urban risk is a menace to developing countries' tourism industries, especially in South Africa. However, these studies have failed to proffer a viable solution to the problem of urban risk through the incorporation of technology in the tourism administration process in South Africa.

More importantly, Erbil and Wörndl (2022), Heinonen and Pesonen (2022), and Pan et al. (2022) have emphasised the significance of technology in the relationship between tourism and urban risk debate. Specifically, Erbil and Wörndl (2022) studied the impact of technology on tourists' travel preferences using a time-limited approach. It was shown that technology has a direct impact on tourism since it serves as a much better guide for an enjoyable tourist experience. Furthermore, the changes in the physical conditions of tourists can be determined to serve as safety measures for tourists. Likewise, Heinonen and Pesonen (2022) in studying the impact of customer service experience and tourism using content analysis showed that technology serves as a tool for marketing strategy, to create and depict the great and unique service quality of tourist centres. Additionally, this study opined that apart from the positive effect of technology on the satisfaction of tourists, it paves the way for more investment and economic growth in any country.

The study by Pan et al. (2022) revealed that technology using deep learning techniques captures interactions in tourist centres either between humans (wildlife) or from humans to wildlife and vice versa. This study noted that though technology can achieve and ensure optimum protection for tourists and tourist centres, the ability of technology to effectively capture and depict acceptable and unacceptable interactions is relatively satisfactory. While Mxunyelwa (2016) examines how information communication technology may be used as a tool to promote the efficiency of operation amongst small and medium-scale tourism companies in South Africa using the literature review approach. The study finds that there is insufficient information on how ICT can be used to promote competitive advantage in the tourism sector compared to how ICT has been used to promote efficiency in the real sector. Since studies have mainly centred on the association between tourism and urban risk the role of technology in tourism has, somewhat, been neglected. However, it is essential to also consider how technology through tourism will assist to ameliorate the problem of urban risk in South Africa.

Research methods

This study adopts the revolutionary and process innovation theories, which are both components of Abernathy – Clark's (1988) model of tourism innovation and the Oslo manual approach based on Schumpeter's (1934) newness and identities of product, process, organisational, and marketing innovation. The adoption of the revolutionary innovation theory is expected to have a robust influence on the tourism industry in the areas of development of a new global distribution system and the introduction of new automation systems of reservation while the process innovation emphasises improved processes through the incorporation of technologies such as ICTs which will enhance productivity and efficiency of the tourism industry. Hjalager (2010a) posits that ICT is the backbone of technological advances in tourism. Such innovation may include the adoption of a new or improved computerised system of stocktaking, reservations, operations, and maintenance which are often used by hotels, tour operators' reservation offices, transport companies, luggage handling, automated checking systems, security, and information. Therefore, the growth of the ICT sector is enhanced through the provision of heavy technological equipment that promote effective and efficient communication that that will spur efficiency, especially in tourism (Buhalis & Law, 2008; Kumar & Kumar, 2012). The study adapts the technology, tourism, and growth model specified by Garidzirai and Matiza (2020), Kumar and Kumar (2012), and Wu et al. (2020) as the standard model used, which is shown in equation (1), where the growth in innovation through the adoption of technology will impact tourism which will ultimately impact growth through the reduction in the urban risk nexus in South Africa.

$$lnURR_t = \beta_0 + \beta_1 lnTOUR_t + \lambda_i lnX_i + \varepsilon_t \quad (1)$$

Where $lnURR_t$ is the log of urban risk, $lnTOUR_t$ stands for log of tourism receipts while, lnX_i represents the log of the relevant independent variables. To demonstrate the relevance of technology on the tourism and urban risk nexus in South Africa the interactive term and technology were introduced into the model specified in equation (1).

$$lnURR_t = \beta_0 + \beta_1 lnTOUR * TECH_t + \lambda_i lnX_i + \varepsilon_t \quad (2)$$

The linear model specified in equation (2) is expanded to include other relevant explanatory variables that explain the relationship between tourism and urban risk. Some of these variables are important explanatory variables adapted from the baseline studies by Garidzirai et al. (2020), Kumar et al. (2012), and Wu et al. (2020).

$$lnURR_t = \beta_0 + \beta_1 lnTOUR * TECH_t + \beta_2 lnEXR_t + \beta_3 lnFDI_t + \beta_4 lnTOT_t + \beta_5 lnINF_t + \beta_6 lnPCI_t + \mu_t \quad (3)$$

Where: β_0 represents the intercept while $\beta_1 ... \beta_6$ represents the coefficients of the independent variables. For the a priori expectations, it is given as $\beta_1 < 0, \beta_2 < 0, \beta_3 < 0, \beta_4 < 0, \beta_5 < 0,$ and $\beta_6 < 0$. This implies that interacting technology with tourism, exchange rate, foreign direct investment, terms of trade, inflation rate, and per capita income is likely to reveal a negative effect on urban risk indicating a decline in the rate of urban risk. The monetary value of carbon dioxide (CO_2) emissions (damage) due to urbanisation is used as a proxy for urban risk while a number of people with mobile cellular telephone subscriptions with access to the public switched telephone network (PSTN) technology is used as a proxy for technology in this study. Data on the following variables, technology, tourism, exchange rate, foreign direct investment, terms of trade, inflation rate, per capita income, climate change, and urban risk were extracted from the database of the World Bank (WDI, 2022) containing secondary data of development indicators.

This study adopts the preliminary tests of Augmented Dickey-Fuller (ADF), as well as Phillips-Perron (PP) to determine the stationarity of the secondary data. These tests' statistics are adopted because they allow for control of higher-order autocorrelation (Harris & Sollis, 2003). Thereafter, the ARDL model was deployed to analyse the data. The ARDL was used because it is a consistent estimate that allows for long-run normal coefficient regardless of whether the variables are stationary at order zero, i.e., *I(0)* or order one, i.e., *I(1)*, or if the variables are a mixture of both (Harris & Sollis, 2003; Pesaran et al., 2001). In other words, the ARDL model places less emphasis on the degree of integration of the variables but yields an unbiased estimate of the long-run model even when the size of the sample is small (Harris & Sollis, 2003).

Therefore, the ARDL model for this study is specified in equation (4).

$$lnURR_t = \alpha_0 + \sum_{i-1}^{d} \alpha_1 \, \Delta lnURR_{t-i} + \sum_{i=1}^{e} \alpha_2 \, \Delta lnTOUR * TECH_{t-i} + \sum_{i=1}^{f} \alpha_3 \, \Delta \text{lnEXR}_{t-i} + \sum_{i=1}^{g} \alpha_4 \, \Delta lnFDI_{t-i} + \sum_{i=1}^{h} \alpha_5 \, \Delta lnTOT_{t-i} + \sum_{i=1}^{i} \alpha_6 \, \Delta INF_{t-i} + \sum_{i=1}^{j} \alpha_7 \, \Delta GDP_{t-i} + \beta_1 lnTOUR * TECH_t + \beta_2 lnEXR_t + \beta_3 lnFDI_t + \beta_4 lnTOT_t + \beta_5 INF_t + \beta_6 lnGDP_t + \varepsilon_t \quad (4)$$

Where Δ stands for the first difference, *t* represents the time, *t-i* stands for the lag length, *ln* means the natural logarithm, β_0 means constant, $\sum$ is the summation sign, and $\alpha_1 \ldots \alpha_7$ and $\beta_1 \ldots \beta_6$ are coefficients of variables. The study utilised the long-run model in equation (5) to demonstrate the impact of the interactive effect of tourism and technology on urban risk in South Africa.

$$lnURR_t = \alpha_0 + lnTOUR * TECH_t + \beta_2 lnEXR_t + \beta_3 lnFDI_t + \beta_4 lnTOT_t + \beta_5 INF_t + \beta_6 lnGDP_t + \varepsilon_t \quad (5)$$

The study then states the short-run error correction model in equation (6) after the long-run relationship is established.

$$lnURR_t = \alpha_0 + \sum_{i-1}^{d} \alpha_1 \, \Delta lnURR_{t-i} + \sum_{i=1}^{e} \alpha_2 \, \Delta lnTOUR * TECH_{t-i} + \sum_{i=1}^{f} \alpha_3 \, \Delta \text{lnEXR}_{t-i} + \sum_{i=1}^{g} \alpha_4 \, \Delta lnFDI_{t-i} + \sum_{i=1}^{h} \alpha_5 \, \Delta lnTOT_{t-i} + \sum_{i=1}^{i} \alpha_6 \, \Delta INF_{t-i} + \sum_{i=1}^{j} \alpha_7 \, \Delta GDP_{t-i} + EC_{t-i} \quad (6)$$

Where EC = the ARDL model error correction term.

Findings and discussion of results

The preliminary tests of Augmented Dickey-Fuller (ADF) plus Phillips-Perron (PP) were examined and presented in Table 1 with the major aim of determining the unit root properties inherent in the variables. Since the ARDL bound test exists and is premised on the hypothesis that the variables are either of *I(0)* series *or I(1)* series (Ouattara, 2004). Therefore, to establish the stationarity properties, Oteng-Abayie and Frimpong (2006) warned that no variable should be integrated of order two.

Table 1 Stationarity test

Augmented Dickey-Fuller (ADF) Test			Phillips Perron (PP) Test			
Variables	Level	1st Difference	Status	Level	1st Difference	Status
ln(URR)	-3.24**	-3.78**	I(0)	-3.22**	-10.90*	I(0)
ln(TOUR)	-5.70*	-8.10*	I(0)	-5.17*	-8.08*	I(0)
ln(TECH)	-5.12*	-	I(0)	-12.99*	-	I(0)
ln(TOUR*TECH)	-6.56*	-4.32*	I(0)	-8.52*	-4.31*	I(0)
ln(EXR)	-1.01	-3.85*	I(1)	-1.00	-3.63**	I(1)
ln(FDI)	-3.81*	-7.47*	I(1)	-3.81*	-9.42*	I(0)
ln(TOT)	-2.23	-3.49**	I(1)	-2.28	-3.44**	I(1)
INF	-3.42**	-5.11*	I(0)	-2.65	-5.48*	I(1)
ln(GDP)	-1.69	-3.39**	I(1)	-1.06	-3.47*	I(1)
Critical Values						
1%	-4.12	-4.29		-4.12	-4.20	
5%	-3.14	-3.21		-3.14	-3.17	
10%	-2.71	-2.74		-2.71	-2.72	

Source: Authors' computation
Where: * = 1%, ** = 5% as well as *** = 10% significant level.

The outcomes of the unit root test are presented in Table 1, which shows that all the variables are a mixture of series that are *I(0)* and *I(1)* which is the rationale for the use of the ARDL model.

Table 2 shows the bound testing/cointegration estimation of the ARDL. The result confirms the rejection of the null hypothesis which indicates the existence of a long-run relationship amongst the variables where it shows the magnitude of the F-statistic of the impact of the interactive role of technology along with tourism on urban risk in South Africa.

Table 2 Bound testing/cointegration test

t – statistic	Value	K
F – statistic	8.91	6
Critical Value Bounds		
Significance	(I0) – the lower bound	(I1) – the upper bound
10%	1.75	2.87
5%	2.04	3.24
2.5%	2.32	3.59
1%	2.66	4.05

Source: Authors' computation

The F-statistic of the ARDL bound testing and cointegration indicates the computed F-statistic (8.91) which is higher than the upper critical bound of 1 percent critical values as presented in Table 2. This provides sufficient proof to reject the null hypothesis of the absence of cointegration at a 1 percent significance level for the model. The study, therefore, concludes from the ARDL bound testing that there is a long-run relationship amongst the variables at 1 percent critical values.

Furthermore, this study determines the maximum number of lags that should be used through the following criteria: (i) the Akaike Information Criterion (AIC); (ii) the Schwartz Information Criterion (SIC); and (iii) the Hannan-Quinn Information Criterion (HQC). Both the Akaike Information Criterion (AIC) and Hannan-Quinn Information Criterion (HQC) suggested a maximum lag length of two lags while the Schwartz Information Criterion (SC) recommended one as the maximum lag length. Hence, the long-run estimate of the role of technology on tourism and urban risk nexus in South Africa is based on a maximum lag of two.

Table 3: Lag length selection criteria

Endogenous variables: ln(URR) ln(TOUR*TECH) ln(EXR) FDI ln(TOT) INF ln(GDP)						
Sample: 1990 2020						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-691.63	NA	1.99	48.18	48.51	48.28
1	-520.71	247.53	4.91	39.77	42.41*	40.60
2	-439.63	78.28	1.05	37.56*	42.51	39.11*
* indicates the lag order selected by the criterion						

Source: Authors' computation

After the long-run cointegrating association has been confirmed amongst the variables used in this study, then the estimate of the ARDL long-run and short-run regression was conducted. The estimate of the long-run coefficient is presented in Table 3 which shows that the interactive influence of technology and tourism on urban risk, i.e., ln(tour*tech) has a positive but insignificant effect on urban risk in South Africa ($t = 0.88; p > 0.05$). This outcome indicates that a 1 percent ln(tour*tech) will lead to a marginal increase of about 0.2 percent in urban risk. The positive impact of tourism along with technology on urban risk has shown that South Africa has not realised the important role that technology plays in bringing the desired increased efficiency and innovation that will reduce urban risk. Hence, the benefit of technology in the tourism sector has not been adequately and fully harnessed as observed by Madila et al. (2022) and Susanto et al. (2022). However, this outcome is in line with the earlier findings of Chaturruka et al. (2020), Musavengane et al. (2020), Opfermann (2021), and Perry and Potgieter (2013) that tourism promotes urban risk in South Africa, most especially in the urban areas. This is, however, contrary to the findings by Mulamba (2021) and Santana-Gallego and Fourie (2020) who argued that urban risk tends to discourage the inflow of international tourists, especially in developing countries like South Africa. Our findings are in line with the summation by Malleka et al. (2022), Perry and Potgieter (2013), as well as Pizam and Mansveld (2006) that studies on the relationship between tourism and urban risk are somewhat indeterminate due to the unavailability of the actual data on urban risk in South Africa.

Similarly, the study finds that the coefficient of the exchange rate (lnEXR) has a positive and significant effect on urban risk in South Africa ($t = 2.45; p < 0.05$). This suggests that a 1 percent increase in the South African exchange rate will result in about a 0.3 percent increase in the urban risk. This finding agrees with the study by the Department for International Development (2004) that international donors such as UNDP, WHO, UNICEF, AfDB, IMF, World Bank, and bilateral and multilateral donors respond positively and swiftly with financial support to disasters due to urban risk. Such funding has a robust impact not only on the life of the people impacted by the natural disaster, but on the economy as a whole, hence, a positive response of the exchange rate to the urban risk in South Africa. Evidence has shown that South Africa is a major recipient of international donors, especially during a major disaster such as the HIV/AIDS support as well as the call for both local and international donors during the aforementioned flooding in the KwaZulu-Natal Province.

In the same vein, the coefficient of terms of trade (lnTOT) has a positive and significant effect on urban risk in South Africa ($t = 2.32; p < 0.05$). This implies that a 1 percent increase in South African terms of trade will result in about a 0.2 percent increase in the urban risk. Aside from tourism, South Africa relies on the mining sector for the exploitation of coal, gold, and platinum which form a major component of the country's exports and it is a viable source of revenue and employment for the teeming population. The continuous exploitation of these natural endowments improves the country's terms of trade which consequently holds an implication for the promotion of the aggregate national productivity (see Osberghaus, 2019) and, hence, urban risk due to its positive externality. This observation conforms to the study by Thia (2015) who posits that urban risk is an offshoot of urbanisation that promotes vertical linkages amongst industries and materials and also increases the export capacity of the country, especially a country like South Africa.

Furthermore, the coefficient of economic growth (lnGDP) has a positive and significant effect on urban risk in South Africa ($t = 11.42; p < 0.05$). This suggests that a 1 percent increase in the rate of economic growth in South Africa will result in about a 0.7 percent increase in urban risk due to urbanisation. This finding is in support of the UN-Habibat (2016) which states that a direct relationship between economic development and urbanisation is existent which is the major catalyst of urban risk due to the continuous influx of human capital, financial capital, increased service sector as well as a vibrant real estate sector in urban cities, especially, in South Africa where there is a massive influx of people to the cities like Johannesburg, Pretoria, Cape Town and Durban due to opportunities and economic reasons.

Table 3 ARDL long-run estimates

Variables	Coefficients	Standard Error	t - Statistic	Probability
C	7. 918	0.759	10.426	0.000
ln(TOUR*TECH)	0.02	0.03	0.88	0.38
ln(EXR)	0.56	0.09	6.32	0.00
FDI	-0.00	00	-0.92	0.36
ln(TOT)	0.48	0.20	2.32	0.03
INF	0.00	0.00	0.95	035
Ln(GDP)	0.71	0.06	11.42	0.00

Source: Authors' computation

However, despite the positive relationship between economic growth and urban risk, Hellegatte (2013) cautioned that mechanisms and institutions that will ameliorate the occurrence of natural disasters associated with urbanisation should be established because more often than not, the economic losses caused by the urban risk is usually higher than the rate of economic growth that will slow down the growth process experienced in the country.

The short-run estimate reveals that the exchange rate ($\Delta\ln(EXR)$) and economic growth ($\Delta\ln(GDP)$) have a positive and significant effect on urban risk in South Africa ($t = 2.45$, $p < 0.05$; $t = 2.62$, $p < 0.05$) this emphasises the current situation in the country where the problem of urban risk is highly pronounced, while the other explanatory variables have no any significant effect on urban risk in South Africa. The coefficient of the error correction term which measures the speed of adjustment back to the long-run path due to short-run disequilibrium is negatively signed (*-0.55*) and statistically significant ($t = -2.95$; $p < 0.05$) as seen in Table 4. The coefficient of the error term -0.55 suggests that the model amends its short-run disturbances by about 55 percent speed of adjustment to return to long-run equilibrium. Also, the negative sign of the error correction indicates the return to equilibrium.

Table 4 ARDL short-run estimates

Variables	Coefficients	Standard Error	t - Statistic	Probability
Δln(TOUR*TECH(-1))	0.299	0.162	1.843	0.086
Δln(EXR)	-0.174	0.131	-1.321	0.207
Δ(FDI)	0.094	0.083	1.124	0.279
Δln(TOT)	-0.138	0.185	-0.747	0.467
Δln(TOT(-1))	-0.056	0.067	-0.829	0.420
Δ(INF)	-0.990	0.187	-5.291	0.000
Δln(GDP)	-0.710	0.458	-1.549	0.143
EC_{t-1}	-0.55	0.19	-2.96	0.000

Source: Authors' computation

The stability test of the macroeconomic variables used in this study was carried out using the plots of the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMsq) which is a residuals test based on the Schwarz Bayesian Criterion. The plots on Figures 1 and 2 reveal that the CUSUM and the CUSUMsq remains relatively stable and inside the bounds of the 5% level of significance throughout the study. Given this, we conclude that all variables used in this study are very stable.

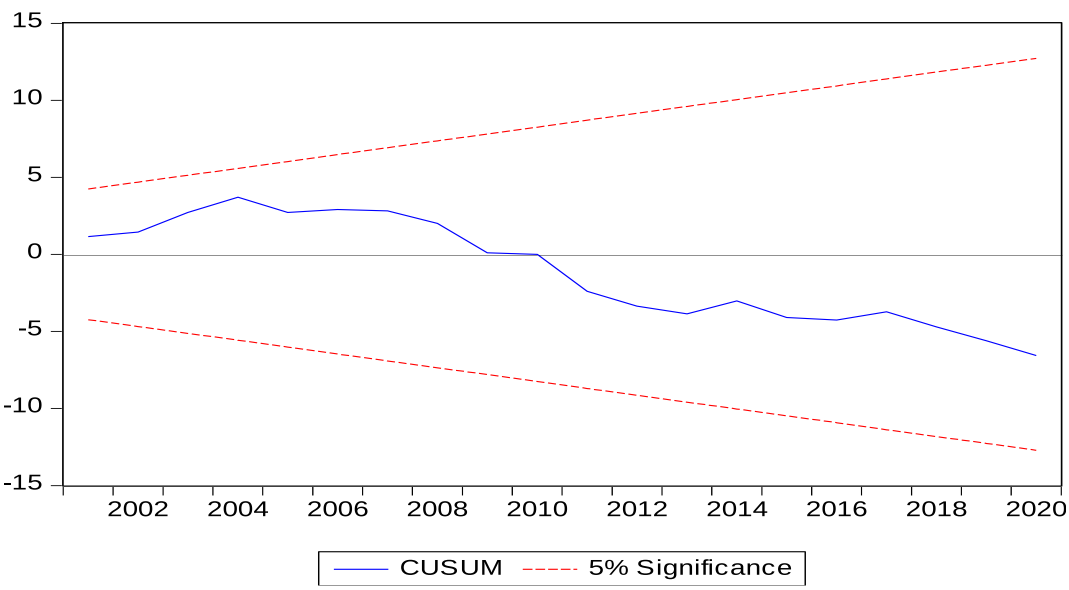

Figure 1 CUSUM at 5% significance level

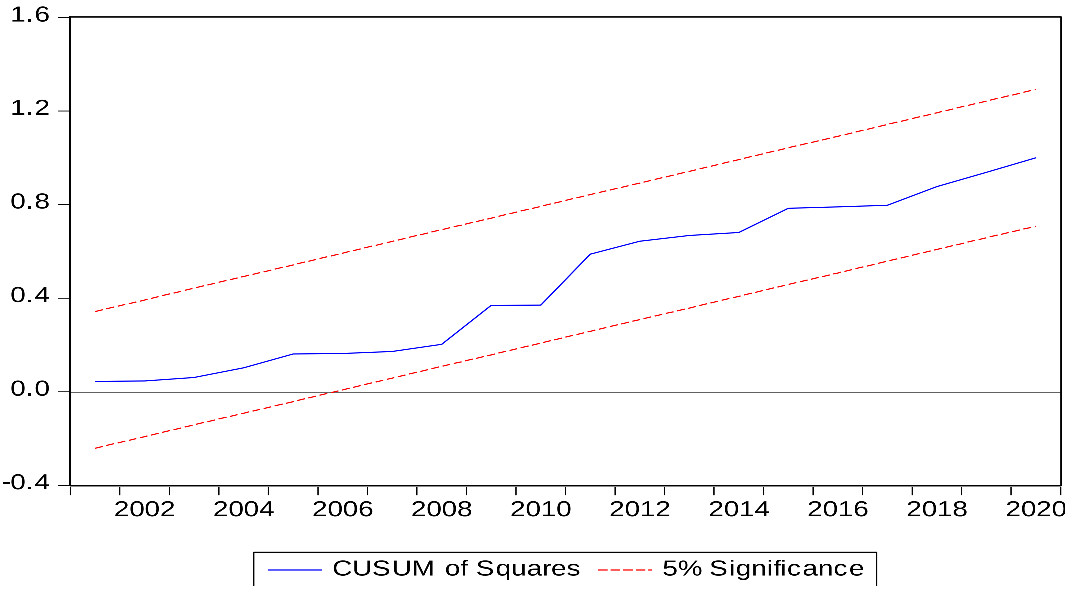

Figure 2 CUSUMsq at 5% significance level

Conclusion and recommendations

This research concludes that interacting technology with tourism has not reduced the problem of urban risk in South Africa, rather it has had a positive but negligible impact on urban risk during the period under study. However, the study observes that the exchange rate, terms of trade, and economic growth positively and significantly promote urban risk in South Africa due to urbanisation. The speed of adjustment in the short-run analysis implies that the economy will adjust back to equilibrium after the initial short-run disturbances. Therefore, concerted efforts, policies, and institutions should be put in place with a major mandate to ameliorate the problems of urban risk in South Africa and to adopt a suitable technological innovation that will assist the process. Also, a data bank on urban risk should be established which will provide access and accurate information on the previous urban risk disasters in the country which will further assist to design a risk-reducing framework to guide against future disasters in South Africa.

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