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Smart Tourism for Managing Climate Change Effects on Tourism Industry and Tourism Development in African Countries

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Abstract: The tourism sector is among the fastest-growing sectors in the global economy. Despite the significance of this sector in the global economy, the tourism industry is facing several climate change problems, such as wildfires, droughts, changes in water levels, and flooding, which disturb the sector's development. Thus, a lack of advanced solutions to tackle these issues in the tourism industry decreases tourism revenue and biodiversity. This study examines the role of smart tourism in managing climate change effects in the tourism industry and its development in Africa, precisely to document climate change effects in the industry and explore people's perspectives on smart tourism in managing climate change effects. A questionnaire of both closed and open questions was used to capture the views of 100 respondents (99 city residents and one expert from the urban economic development of Kigali City) on how intelligent tourism can assist in handling climate change problems linked with the tourism sector. Results show that digital technology in tourism can manage climate change effects and increase revenues, as mentioned by Kigali City's expert in the urban economic development and 79% of the interviewed city residents. Additionally, the study has revealed that road cameras to monitor tourists' security were distributed in the cities and towns of Rwanda. Also, there is a loss of species in the forests caused by wildland fires. Financial capacity to buy emerging technology-related equipment and qualified personnel to fix it were mentioned by 80% of the respondents as factors that delay smart tourism operations in African countries. Smart tourism must be taken into consideration to boost tourism and manage its climate change effects. This line-up includes early warning systems to alert heavy rain in touristic areas and sensors to detect fires occurring in touristic areas for future climate change related effects management.

***Keywords*:** smart tourism, climate change, tourism industry, development, African countries

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Nomenclature

Term	Description
AI	Artificial intelligence
ANP	Akagera National Park
AU	African Union
BE	Blue Economy
CO_2	Carbon dioxide
COVID-19	Coronavirus disease
DRC	Democratic Republic of the Congo
EU	European Union
FIRMS	Fire Information for Resources Management System
FRW	Rwandan Franc
GDP	Gross domestic product
ICT	Information and communication technology
IOT	Internet of Things
ISCO	Intersec Security Company
IT	Information technology
NASA	National Aeronautics and Space Administration
NNP	Nyungwe National Park
RDB	Rwanda Development Board
SADC	Southern African Development Community
SDGs	Sustainable Development Goals
SME	Small and medium-sized enterprises
UN	United Nations
USD	United States dollar
VNP	Volcanoes National Park
WTO	World Tourism Organization
WTTC	World Travel and Tourism Council

1. Introduction and literature review

The concept of smart tourism is defined by the EU as a destination that facilitates access to tourism and hospitality products, services, spaces, and experiences through ICT-based tools. Climate change comprises changes in temperature and many other weather conditions over a given period of time. Various studies conducted in different places specify that climate change has a major effect on different sectors of the economy, including the tourism industry. Thus, the negative effects of climate change can be both indirect and direct, but all of them require a system of initiatives to be mitigated. Moreover, there are many problems caused by climate change affecting the tourism sector and hotels, including damage to animal habitats, changes in water levels, high temperatures, and planning problems as a result of unreliable forecasts as well as crop loss [1]. Climate change is among the additional factors that are undermining our ecosystem. More than 83% of the world's population lives in countries where the demands of nature exceed what the country's ecosystem can renew. We need the ecological capability of half the planet to meet our current needs. More than 60% of the planet's ecosystem is being ruined or used inappropriately. 1.5 to 2.5 degrees centigrade increases in temperature will result in 30% of all species being at high risk of disappearance [2]. The effect of COVID-19 on universal economies, health, and

social impacts has been extraordinary and has weakened the tourism sector [3].

Tourism is not only to risk from climate change effects, but it is also one the elements that motivates it and is a substantial contributor to emissions growth. By 2030, it is projected there will be 1.8 billion global visitor arrivals, an increase of more than 3% a year from 2010, without mentioning domestic travelers. Tourists are going farther than ever before, and most of the energy used in the tourism industry is fossil fuel-based. Transportation is the major contributor to tourism CO_2 emissions with planes accounting for 40%, cars for 32%, and accommodation for 21%. Therefore, if no action is taken, emissions from travel and tourism will increase by 169% by 2050 [4]. As the 17 SDGs and the corresponding 169 SDG targets give the planet a new orientation, tourism can and must play a crucial role in providing sustainable solutions for people, the world, prosperity, and peace [5].

According to the WTO [3], world tourism has become one of the largest and fastest-growing economic sectors, with global tourist arrivals growing from 983 million in 2011 to an anticipated 1.8 billion by 2030. The tourism sector's contribution to the economies of developing nations is incredibly significant. For instance, in Tanzania, the tourism sector is second after the manufacturing sector in contributing to the national income. In particular, the travel and tourism sector's contribution to GDP in 2019 was 6.6634 billion USD, equivalent to 10.6% of the country's GDP [6].

Tourism in Morocco has a long history and is the key source of the country's economic wealth. Morocco has various significant advantages that allow it to compete well on an international level. It makes the largest contribution to the country's GDP, almost 8% of the GDP, and employs about 500,000 people. On the world list, Morocco is ranked fifth. Morocco is a stable tourist destination and was not much affected by the Arab Spring revolutions [7]. Morocco saw an increase in the inflow of international tourist arrivals from developed countries, specifically the EU [8].

Mauritius is a small island developing state with a land area of 2,040 km². It is located in the middle of the Indian Ocean. The country has seen an improvement in its GDP from 4.869 billion USD in 2000 to 13.34 billion USD in 2017, with the tourism sector contributing 23.8% of Mauritius's total GDP for 2017. Thus, this contribution is anticipated to reach 26.1% by 2028. This development in tourism has also been complemented by a noticeable growth and visual change in the landscape and architecture discipline and policies of the government of Mauritius [9].

In South Africa, there has been an emerging concern and increasing recognition that climate change must be a component of reframing local government and local development futures [10]. Therefore, technologies make touristic consumers more active, presenting higher opportunities in terms of experience at destinations or specific touristic attractions. Both attractions and tourism destinations have to solve this challenge by implementing technologies and smart infrastructure in their offerings to tourists and designing outstanding tourism experiences [11]. According to AU [12], the major motivating sector of the BE is tourism, both in terms of jobs created and in terms of value added. The oil, gas and mineral sectors have a strong influence on the value added but have low involvement in the job creation process. The fishery sector will stay stable, with a great number of people hired, while aquaculture will keep growing in the next few decades. Shipping and ports will rise at a constant rate.

In Rwanda, the tourism industry is one of the sectors that contributes to the country's economy while generating income from tourism and other related activities. In 2019, the sector contributed approximately 13% of Rwanda's GDP. Rwanda is making the most of nature-based tourism, which has developed quickly and created important foreign exchange and income. Based on statistics available in RDB, the number of visitors to the country's three national parks, including NNP, ANP, and VNP, rose from 43,083 in 2008 to 107,976 in 2022. In the same period, revenues from these national parks increased approximately from 8.20 million USD to 27.3 million USD. During 2019, these accounted for 46% of all the nature-based activities done in all three parks. This is followed by gorilla trekking and golden monkey visits in VNP, which account for 16% and 8%, respectively, of all nature-based happenings. It was in 2019 that gorilla tourism generated 107.3 million USD, almost 21.5% of total tourism income [13].

2. Methods, techniques, studied material, and area descriptions

2.1 *An overview of the study area*

Globally, Africa is the second-largest and second-most populated continent, with a population of 1.2 billion people and an area of around 30 million km². The African continent has 54 nations fully known to the UN [14]. There is something particularly new and different about the economic setting in Sub-Saharan Africa. After decaying for much of

the past 45 years, the economic performance of Africa is currently improving. In the last few years, for instance, GDP growth in Sub-Saharan Africa has accelerated to its strongest point at around 6% per year, while inflation has recorded below a two-digit level. Thus, considerable improvements in performance are confirmed by numerous assessments [15]. During the 20th century, Africa experienced significant economic activity. The first important change happened under colonial rules throughout the first half of the century. Wage labor was introduced, communications and transportation were enhanced, and resources were extensively developed in the colonial territories. However, there have been exports of two or three of the most important agricultural products or minerals, such as petroleum, peanuts, and copper, which have provided foreign earnings for nearly all African countries [16]. In 2019, the tourism industry contributed 7.1% of the total GDP to Africa's economy, compared to Europe's tourism whose contribution to the GDP was 9.1%, and Southeast Asia's 12.2% of the GDP [17]. Figure 1 shows a map of Africa and its countries.

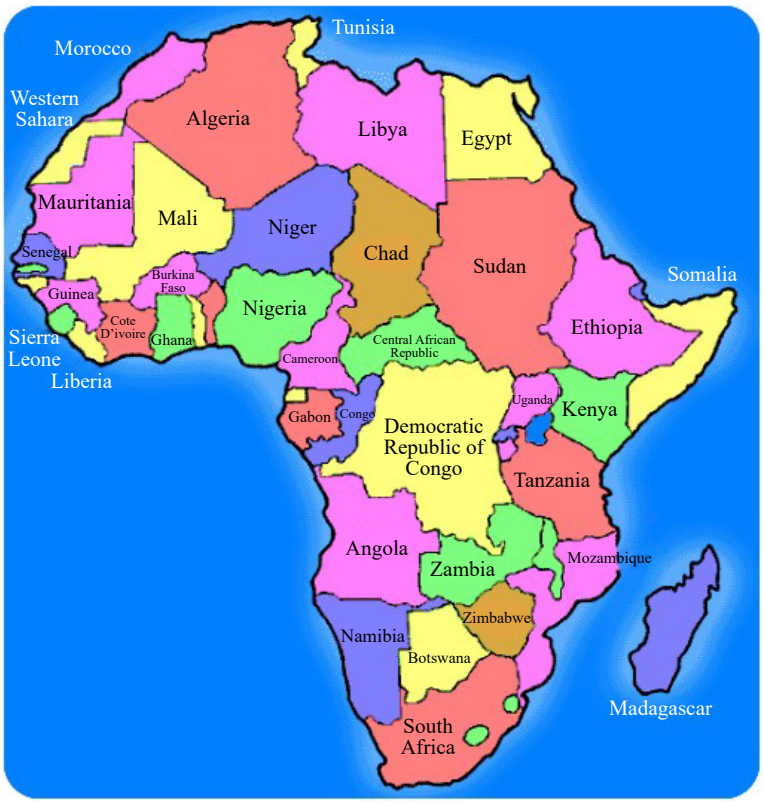

Figure 1. Map of Africa and its countries [18]

2.2 *Data collection procedures and analysis*

This study examined the role of smart tourism in managing climate change effects in the tourism industry and tourism development in African countries, using Kigali, Rwanda, as a specific case simply to capture the opinions of residents in African countries, as the authors didn't travel and ask all African communities about smart tourism and its contribution to climate effects management. Thus, Kigali City represented African residents in responding to questions formulated by the authors on smart tourism in managing climate effects as well as boosting tourism development. In addition to this, Kigali City residents may point out some of the countries facing climate change effects that may delay tourism development, such as Rwanda, Kenya, Angola, the DRC, Somalia, Burkina Faso, etc., to make the study comprehensible to readers and future researchers. The author used field assistants to help with the data collection. The data collection was conducted manually with answer sheets on the field, where 99 Kigali City residents had to respond to structured key questions concerning "Smart Tourism in Managing Climate Change Effects in Tourism Industry

and Tourism Development in African Countries". For authors to capture the views of the community on the subject under study. The responses collected were analyzed with the help of Microsoft Excel and Microsoft Word to produce the report. Data collection procedures began on June 20, 2022, and continued until the end of December 2022 during the day, working days for official interviews, weekends when interviewing city residents, and depending on weather conditions if the sky is clear with no rain, which can impede data collection work by taking the official's availability for data collection purposes. Furthermore, some data were collected from March 18, 2023, up to March 25, 2023, after receiving reviewers' comments, which strengthen the study. Data were collected through mixed methods, which involved interviews with professionals at the city level, specifically specialists in investment and business promotion from the city's urban economic development department. Interviews were also held with 99 Kigali City residents to get a full understanding of smart tourism's role in managing climate change-associated problems. According to this research, a sample of 100 respondents from Kigali City was targeted and selected using the Yamane formula. Out of these, 99 were Kigali City residents, and one specialist in investment and business promotion was selected to represent the professional experts in the urban economic development department at Kigali City. Direct observation was also used to capture information on the existing situation of smart tourism as well as the best practices of existing tourism in Rwanda. The collected data were analyzed both qualitatively and quantitatively through the thematic building as well as descriptive statistics.

3. Results

3.1 *Socio-demographic characteristics of the respondents*

The city of Kigali's livelihood activities include agriculture, livestock keeping, and commercial activities. The findings show that out of the 100 respondents interviewed, 60% were female and 40% were male. This composition of respondents reflects the so-called "gender inclusive" approach to urban planning and management of social development projects. On the researcher's side, this idea of involving both males and females in planning aspects as well as climate change-related effects management in the tourism industry is to avoid gender discrimination that might occur during data collection. Age-wise, 42% of the respondents were 38 to 48 years old, 23% were over 48 years old, and the remaining 35% were below 38 years old.

Regarding their education levels, 47% had attended secondary education, 17% had a university education, and 36% studied until primary education. Knowing the education level of the respondents will not only contribute to answering questions during interviews, but it can also influence the use of smart tourism in managing climate change effects in the tourism industry as well as its development. Figure 2 shows the socio-demographic characteristics of the respondent during fieldwork.

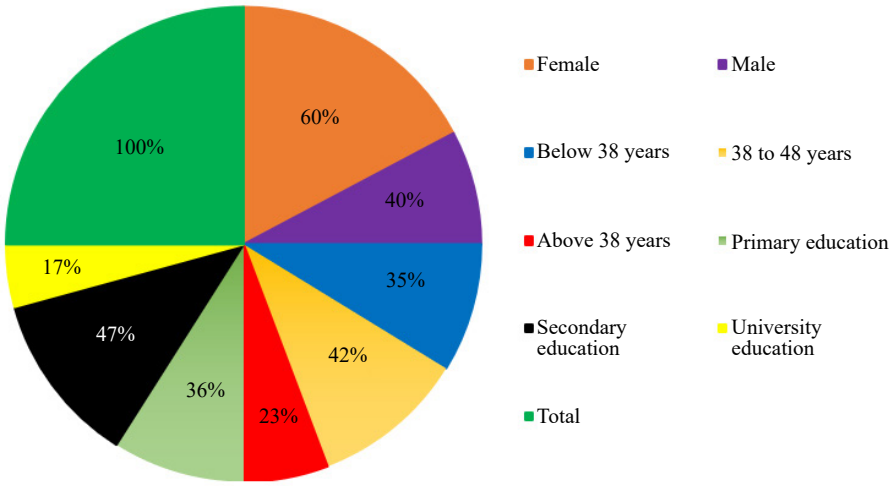

Figure 2. Socio-demographic characteristics of the respondents

3.2 *The effect of climate change (flood and fire) on tourism industry in African countries*

3.2.1 *Flooding*

In Rwanda, there are several areas for tourism activities, such as ANP, located two and a half hours away from Kigali City; VNP in the north of the country; Lake Kivu in the northern province of Rwanda; and many more touristic areas. Thus, a discussion with Kigali City residents during the interview on climate change effects revealed that flooding can hinder tourism activities. 97% of the respondents emphasized this, saying that once flooding occurs within the city, visitors and travelers will stop walking through the area and entering it. Meanwhile, 3% of the respondents said it was possible to travel in a flooded area. According to 85% of the respondents, flooding can also damage infrastructure in tourism areas, including electricity connections, as some African countries still use timber electric poles or electric cables under the ground. According to the city residents, flooding may also cause electricity to be cut off for five days to one week in countries that are behind in development and do not update their electrical supply systems. According to the respondents, during flooding, people evacuate to other locations and leave their homes, and this is also true for national parks and zoos. When these areas flood, tourists lack access and a way to move with cars or walk when they want to climb mountains or walk in the forest or roads. Figure 3 shows flooding along the streets and how it can affect tourist projects if measures at these destinations are not taken to protect tourist areas. Additionally, in Rwanda, drainage systems were provided on major roads and secondary roads to evacuate rainwater from roads to appropriate locations. Rwanda Meteorology Agency generates and scales climate information to the community, and then people become aware of coming rain and related predictions. This climate-related information helps tourists know where and when the rain is coming so that they can plan without interference. As said by 74% of the respondents, flooding events influence technological systems not to function well as most of them are connected to electric cables, and during flooding times most of the electricity is cut off to avoid accidents that may come around and cause death in communities or other touristic activities.

Figure 3. Climate change effect in African countries (flooding) [19]

3.2.2 *Fire*

The study revealed that climate change effects had caused the sun and heat to be more intense than before, where both forest and other farmland became vulnerable to the point that if fire was nearby, it would automatically burn them or even result in fire accidents, which is difficult to manage. 76% of respondents mentioned this effect, while the remaining 24% didn't respond to the question. Figure 4 shows the fire that happened at Mount Kenya Forest. Climate change might be to blame for all of these events. When it comes to fire, it can be seen that tourism-related activities are no longer possible, and animals can no longer exist in areas where fires are burning; instead, they tend to flee the heat produced by the fire. According to SADC [20], 8% of forest areas in Africa are annually damaged by fire. As a result, tourism development diminishes, as tourism is often associated with forest-related projects.

Figure 4. Climate change consequences at Mount Kenya Forest (fire) [21]

Figure 5 illustrates world fire locations (African, Asian, and European countries) recorded by satellite in seven days (May 27 and June 2, 2020) produced by NASA's FIRMS. The figure shows how fire is almost covering the entire world, which is bad for humans and biodiversity in general. Therefore, decision-makers and policymakers need to work urgently on this as well as the major causes of climate change before the whole earth is covered in fire. 85% of the respondents in Rwanda said that wildfires in Rwanda are not a big issue compared to other African countries such as Angola and the DRC. The majority of the forest areas in Rwanda are under the control of the authorities, who prevent people from harming them through fire or by cutting down trees without permission. As a result, there are very few fire attacks on natural resources in Rwanda. As a result, many African countries are working on this by increasing measures and strategies for combating fire outbreaks in their countries, such as daily monitoring of the forest to see what is happening and what might cause fire accidents, and then being present to respond in time.

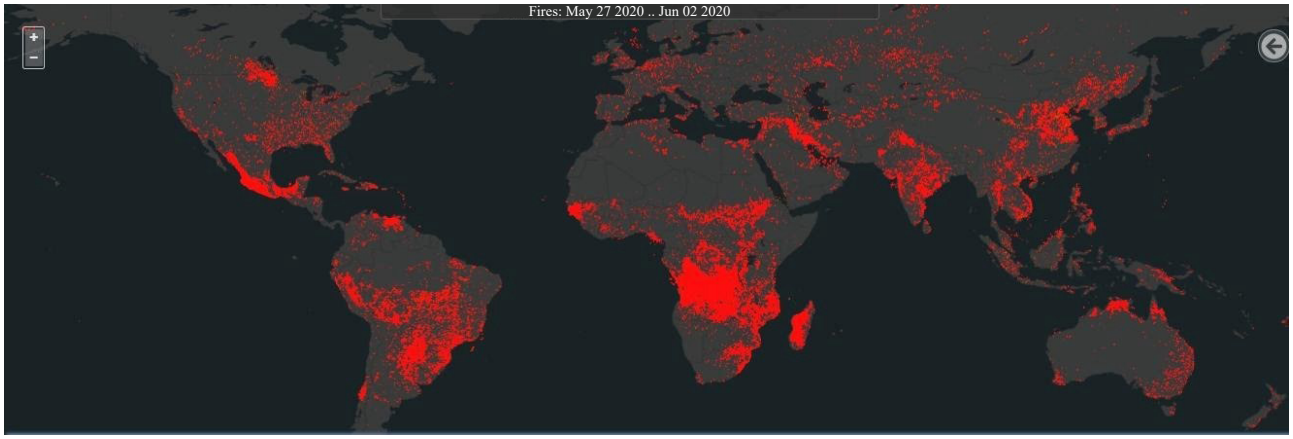

Figure 5. World fire locations recorded by satellite in seven days (May 27 and June 2, 2020) [21]

3.3 *Smart tourism in managing climate change effects in the tourism industry*

3.3.1 *Flooding management using technology in tourism destinations*

3.3.1.1 *Early flooding warning systems*

A large number of African countries do not have appropriate measures to manage flooding. Some of the people decide to escape their houses during heavy rain, while others climb trees as well as dig and construct trenches that will transport rainwater to the neighborhoods. However, due to a lack of good and qualified construction engineers, floodwaters exceed the size of drainage systems, which causes flooding in almost the entire settlement and nearby commodities, as mentioned by most city residents during data collection. As pointed out by 85% of the respondents, early flooding warning systems can be a sustainable flooding solution while informing the community in their neighborhoods once the flooding is coming. It can be noted from Figure 6 that sensors can detect information concerning flood situations and then transmit it through telemetry as well as loudspeakers to make sure that everyone in the village understands that rain is coming at a certain time and will cause flooding, and then people act or respond accordingly by leaving danger zones and weak buildings. Aside from technologies in flood prevention, drainage systems are also another suitable solution that can direct water properly without causing trouble for nearby properties, including cars, houses, and farms.

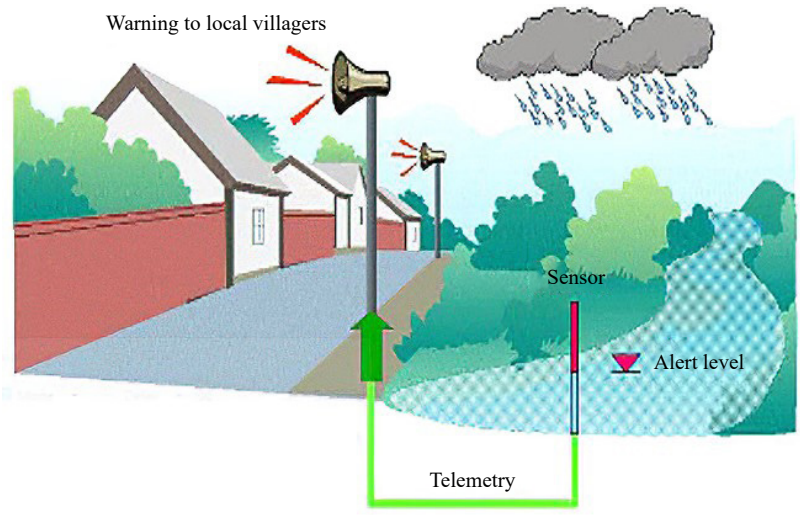

Figure 6. Schematic layout of flood warning system [22]

3.3.1.2 *Cameras to monitor urban wetland eco-tourism park in Kigali City*

Figure 7 shows the cameras fixed in Nyandungu Urban Wetland Eco-Tourism Park parking lots in Kigali City, Kicukiro District, to check the wetland, for instance, tourists' movements, rainwater control, unofficial entering, and security by the managers in the office. This wetland attracts numerous tourists locally, and parents take children to this place on the weekends, as well as young people. This place is suitable for those who love spending their time walking around, going to restaurants constructed in this wetland, and cycling from Section 1 to 5. The entry fees for locals are equal to 1,500 (FRW) per day. International tourists, including eastern Africans, visit this place more often with their families or friends, walking from one section to another. QA Venue Solutions Rwanda Ltd., a private company that takes entry fees from all visitors, is currently in charge of managing the wetland. The company is in charge of maintaining the wetland's good condition and appointing workers to clean and remove unwanted bushes or other materials brought by rain that might disturb water filtration and move in constructed water channels. ISCO is in charge of wetland security both inside and outside of wetland areas for incidents that may occur within the park or nearby. During field observations, the authors observed that wetland security has been fully implemented as cameras are installed everywhere, not only for wetland management but also for security purposes. The electricity used is from a solar system and is installed on road lamps to give light during the night as well as on offices constructed in the wetland for better management. According to 89% of the respondents, this wetland park collects more money than farms or agriculture activities that were not properly managed due to flooding caused by rainwater. This statement is supported by one staff member at Nyandungu Urban Wetland Eco-Tourism Park. The staff member mentioned that before this wetland, there was flooding everywhere, and people had no option but to cultivate their farms due to flooded areas. It is for that reason that the government decided to turn it into a park and create ponds for rainwater collection as well as filtration. The staff member added that many wetland areas will be created in the city of Kigali to manage flooding water and offer room for tourism attractions and destinations.

Figure 7. Smart tourism in Kigali City (camera)

3.3.2 *Technology in wildland fire management in tourist areas*

3.3.2.1 *IOT*

Until now, many African countries' forests have been destroyed by fire, either as a result of climate change or human activity. According to city professionals, traditional firefighting practices such as mechanical water pumps to extinguish fire areas and phone calls to call firefighters within the areas where fire incidents occurred are still used. The results from the findings show that professionals from urban economic development and 95% of the residents said that smart technology is among the solutions to manage fire occurrences either in the city or in the wild, whereas 5% do not agree with this. Sensors installed in forests and other areas exposed to fire outbreaks send fire accident information to the appropriate technical team of IT, who then respond in time. Figure 8 reveals how IOT is used in forests to inform the fire department in case forests, parks, or zoos are on fire. From the factors distressing smart tourism as a sustainable solution to managing climate change-connected effects, 80% of the Kigali City residents answered that the financial capability to buy smart technology equipment, including sensors and fire detector cameras, as well as the implementation of smart tourism-related projects, is a major factor. Furthermore, 20% replied that knowledge of this diversification of new products in the tourism sector is still a challenge. Most Kigali City residents (89%) mentioned that technologies for fighting fire attacks not only in Rwanda but also in many African countries are still as small as in Rwanda. Firefighting activities belong to the government under National Policy, which is in charge of controlling and stopping fires in the wild or houses on fire. Additionally, they need to increase smart tools for managing fire outbreaks that may come at an expected time at the tourism destination, neighboring settlements, as well as forests and parks in Rwanda, as highlighted by 79% of Kigali City residents interviewed.

Figure 8. IOT in detecting wildfires [23]

3.4 *Smart tourism in developing countries*

3.4.1 *Proposed sample of smart tourism in African countries*

In Rwanda, emerging smart tourism technologies have started as the government installed cameras in many areas in Kigali City to monitor car accidents and security for road users, including tourists. Cashless and e-payment are also now in action, where most of the city's residents are paying using mobile money and Visa cards, which are used for shopping and fuel buying at petrol stations. This allows many visitors who have money in bank accounts to avoid wasting time withdrawing money and moving around with their money, which could lead to theft. African countries are changing their cities into smart cities, and climate change is taking place nowadays. This will continue to happen. Decision-makers and policymakers need to think deeply about the tourism industry as well as how climate change effects can be

reduced and managed so that the industry will continue to be more productive in contributing to the country's economy. Figure 9 shows the proposed sample of smart tourism concepts that can be used in African countries for future climate change effects management. Based on this idea, smart tourism can assist in connecting other sectors and offer a broad solution for tourists' safe arrivals and effective and efficient travel to their destinations. Technology will also help them identify problems at their destination or check touristic areas before arriving there to see what goods and bads are there so that travelers and tourists can choose a suitable destination. Smart technology will also assist them in airport situation analysis during landing and taking off, as well as how the airport is connected with other infrastructure, including neighboring goods and cheap hotel rooms where tourists can stay and even get more service they need. All of the city residents interviewed (100%) concur with the idea of smart tourism, which involves connecting all activities with other city activities as shown in Figure 9 to achieve a high level of tourism attractions and destinations as well as managing tourism-related problems while at the same time increasing tourism development.

Figure 9. Proposed sample of smart tourism in African countries [24]

3.5 *Kigali City's professional perception of the concept of smart tourism in African countries*

Through interviews and discussions with experts from Kigali City, specialists in investment and business promotion in the Department of Urban Economic Development, and investors, including young investors in the tourism sector, it is observable how technology can help to manage tourism-based agriculture and people-based tourism projects, where most people may use smart technology to display their products and assist foreign tourists at their headquarters where these activities are done. The specialist added that technology is rapidly changing, and we must adapt as we advertise our tourism industry, sell our services, and attract many tourists from all over the world, which can help the sector grow quickly. Creativity and innovation in the tourism sector were highlighted by the expert to achieve what advanced countries have achieved in the sector. From the challenges that delay the development of the concept in tourism, the specialist said that financial means are the major constraint that limits the use of smart technology in tourism development and tourism-related climate change effects management. People's awareness, the specialist mentioned, is not a big issue as most people nowadays study, and those who didn't study had trainings or attended meetings that opened their minds for them to act well in tourism. Also, infrastructure is needed to achieve sustainable tourism development now and in the future. The specialist recommends tourism that attracts both local and foreign tourists for suitable tourism development in Africa.

4. Discussion

The tourism industry is one of the sectors, both in developed and developing countries, that contributes to a country's economy while generating income from tourists and other related tourism activities. According to AU [12], in 2018, coastal tourism contributed 80 billion USD, or almost 3.4% of the GDP, at an annual increasing ratio of 1.3% over the past decade. In 2018, the contribution to employment was also estimated at 24 million jobs in Africa, at an annual rising ratio of 5.6% compared to the global average of 3.9%. This offers room for potential openings for economic development. Again, tourism in many countries is still done traditionally without the use of technology. However, the time for change is today, when tourism in developing countries needs to change from traditional to smart tourism. This sector should be technologically driven and help tourists arrive at their destinations safely and accurately, with no problem, and effectively and efficiently. Given these factors, as well as the era of pandemics, COVID-19, and climate change effects, the use of smart technology in tourism sector management is the best way to adapt to appropriate tourism achievement as well as the fight against climate change effects, which is a challenge for many countries. This was confirmed by Zhang et al. [25] that tourism destinations become smart through the employment of smart technology to increase competitiveness, and tourists use existing smart technologies for decision-making, for instance, establishing travel plans on their mobile phones, cooperating with other tourists, and sharing their own experiences. Furthermore, Pai et al. [26] said that intelligent technologies support communities to book hotel rooms, airplane tickets, and many other tourism products on mobile phone platform sites and make it easy to receive updated information on destination transportation as well as attractions on their smartphones in case they need it.

Apart from an early warning system, African countries need to think about "sponge cities", which are suitable solutions for countries facing flooding. This solution captures flood waters and appropriately directs them so they don't affect adjacent communities and settlements. The flooding water is managed in different ways, where some go and irrigate farms and make small lakes, and others come back for reuse purposes once the rain is not around again and when water is off in the neighborhoods. Others are also removed in proper drainage channels, but in a way that will not cause any harm to the bordering community. This was highlighted by Rau [27], where, to improve the management of flooding in urban areas, green infrastructure is designed to retain and slow stormwater before it flows into drainage ways. Before the initial flush of stormwater enters rivers, it must be treated in vegetated sedimentation ponds as well as earth filters. Drought is also one of the effects of climate change, which is currently causing diverse related problems, including a lack of forest cover, water bodies, and agricultural products on the land. But through emerging technologies, for example, drone technologies, agronomists and land developers can be able to know the soil water content, fertilizers inside the soil, and if drought is about to affect the land and crops if the quality of the soil is checked daily. Drone experts can monitor soil suitability to avoid drought, which also causes the removal of biodiversity on land. The availability of biodiversity gives room for tourism activities to take place, including animal visits by tourists and swimming activities in lakes and oceans.

At the moment, fire is a climate change-related problem, and if forests are burned by nearby people, tourists, or other people walking through the forest who smoke, the fire spreads and affects the entire forest. On the other hand, heavy wind, which might come with fire from bordering homes, then burns the entire forest or causes a forest fire incident. Climate change effects can be stopped or minimized at a faster rate than before by taking technology into account. Sensors installed in the forest to warn of fires and water pipes at least 5 meters long installed in the forest and linked to sensors in the event of a fire can provide a long-term solution for forest fires while automatically conveying information to firefighter departments and spontaneously opening water taps. Cameras can also provide views and forest monitoring if unauthorized people enter the forest and start a fire. It is recommended that 50 to 100 meters be left between the forest end and the nearby community to observe people living around the forest who may cause fire-related problems. As technology is the answer to several problems in various fields across the globe, researchers argue that the digitalization of information with internet connectivity gives new growth to the digital economy, and smart tourism concepts and development are mostly needed in developed and third-world countries to help and manage tourism for countries' development and investors in this sector. Digital technology will not only facilitate this but also assist in connecting with other different sectors that have connections with the tourism sector, including transportation, business, and many other services tourists might need when finding and traveling to their destination. According to Dabeedooal et al. [9], the availability of different smart devices, systems, and sensors, as well as advanced technologies such as AI, IOT, and big data, permits genuine solutions and activities to various problems in the city.

5. Conclusion and recommendations

5.1 *Conclusion*

This study concludes that smart tourism is needed to manage issues of climate change's effects on the tourism industry and its development in African countries. The proposed sample of smart tourism in African countries that can be adapted to rapidly transform African rural and urban areas is shown in Figure 9. Capital to finance smart technology projects was reported as the major challenge to implementing smart tourism in managing climate change-associated effects.

5.2 *Recommendations*

This part summarizes the recommendations for improving tourism and managing climate change effects in the tourism industry, particularly in African countries and other continents experiencing climate change effects in tourism. Therefore, the following are recommendations that researchers would like to highlight for future climate change-related problems in tourism industry management:

1. Employ or apply appropriate technology, such as IOT, in managing climate change's effects on the tourism industry and tourism development.
2. Early warning systems to inform the public of the problem, including heavy rain in tourism locations, before it stops tourists from traveling to their destinations and walking comfortably in parks.
3. Use of sensors to detect fire once it occurs in the forest or tourism destination.
4. Fund allocation from the government for emerging technologies during smart tourism-related actions

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Conflict of interest

The authors declare no conflict of interest concerning the research, authorship, and/or publication of this article.

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Appendix

Republic of Rwanda
City of Kigali

Ref.n°. 17666/07.01.16/22 Kigali on 17 FEV 2022

Mr. David MIHIGO
Tel: (+25)0788808339
Email: mihigodavid7@gmail.com

Dear Sir,

Re: Your request for research paper/ dissertation data collection in Kigali City

Reference is made to your letter dated on 30th December 2021 requesting for research paper/ dissertation data collection in the City of Kigali on " **Emerging technologies, smart city like smart housing, smart transportation, urban agriculture, urban and regional planning and land management**";

We would like to inform you that your request is hereby granted. However, before starting data collection, you must first introduce you to the department of **Human Resource and Administration** to be guided.

Sincerely,

UMUJYI WA KIGALI

Joseph NIYONGABO
Director General of Corporate Services

Cc:
-City Manager of the City of Kigali
KIGALI

City of Kigali, P.O.Box 3527 Kigali, Hotline 3260, Email: info@kigalicity.gov.rw, Wbsite: www.kigalicity.gov.rw

Figure A. Acceptance letter for data collection

Structured questionnaire for the formal interview

The questionnaire addressed to respondents (Kigali City residents and one specialist in investment and business promotion from the urban economic development department)

Section A: Social demographic characteristics information

1. Questionnaire details
   a) Date: __ June 2022
   b) Interviewer: _____
2. Survey site details
   a) District: Nyarugenge
   b) City: Kigali
   c) Country: Rwanda
3. Age
   □ Below 38 years
   □ 8 to 48 years
   □ Above 48 years
4. Gender
   □ Male
   □ Female
5. Level of education
   □ Primary education
   □ Secondary education
   □ University education

Section B: Questions addressed to Kigali City residents

1. What are the effects of climate change on the tourism industry (Discuss)?
2. What do you think about smart tourism in managing climate change effects in the tourism industry (Discuss)?
3. What is your opinion on the Nyandungu Urban Wetland Eco-Tourism Park constructed in Kigali in the context of smart tourism and the tourism industry?
4. What is your opinion on smart tourism and tourism development in developing countries?
5. What is your recommendation on smart tourism for managing climate change effects in the tourism industry and tourism development in African countries?

Section C: Questions addressed to the specialist in investment and business promotion from the urban economic development department

1. What do you think about smart tourism in managing climate change effects in the tourism industry and tourism development in African countries (your opinion, the concept in the Rwanda context, and your recommendations)?