Technological Tools before and after COVID-19 in Ecuador

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Abstract

The COVID-19-induced state of emergency in Ecuador necessitated compulsory isolation for most of the people. During this period, there was a rise in the utilization of technical equipment as individuals had to perform their tasks remotely from their homes. This study sought to assess the utilization of technology resources during the period of quarantine, necessitating the creation of a survey. Specific indicators were considered and standardized for processing. The data processing techniques employed were the Hierarchical Analytical Process and Logic Scoring of Preference. The key findings indicate that the indicators "Modes of Use," "Use Preferences," "Daily Usage Frequency," and "Monthly Expenditure" are crucial for measuring the composite indicator "use of technological tools." A survey was created to contribute to the research.

Keywords: Hierarchical Analytical Process; Logic Scoring of Preference; Data Normalization; Composite Indicator; Technological Tools Usage

1. Introduction

The Covid-19 epidemic is a highly significant occurrence in the 21st century. Even in its nascent phases, the influence on tourism is immense. Present estimates suggest that around 75 million employment opportunities in the tourist sector are in urgent jeopardy, and the industry is projected to suffer a loss of over 2.1 trillion US dollars in revenue. Border closures, docking of cruise ships, grounding of entire air fleets, and closure of hotels, restaurants, and tourist destinations have occurred. The coronavirus pandemic is characterized by an indisputable level of complexity, as it is unprecedented in scale and encompasses several types of disasters and crises. The situation is characterized by a combination of a natural disaster, a socio-political crisis, an economic crisis, and a crisis in tourism demand [1].

The President of the Republic of Ecuador declared a "State of Exception" from March 16 to September 11, 2020, due to the various disaster and crisis typologies caused by the pandemic. This declaration included mandatory measures such as a curfew from 21:00 to 05:00, suspension of land, air, and sea transport, suspension of in-person educational activities, and home confinement. Currently, due to the pandemic, traveling internationally, regionally, and locally, as well as engaging in activities such as air transport, cruises, public transport, lodging, cafes and restaurants, conventions, festivals, meetings, or sporting events, has become extremely problematic for anyone involved in the global tourism industry [2].

Given the worldwide restrictions on foreign travel, Ecuador should have actively encouraged domestic tourism while implementing stringent biosecurity precautions. This would have stimulated local, regional, and national tourism, leading to a gradual revival of the tourism industry. In order to

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comprehend the behavior of individuals in relation to the use of technological tools before and after a state of exception, it is crucial to acknowledge that the rapid pace of the current digital era brings about significant changes in social, cultural, and economic dynamics, particularly during a six-month period of home confinement [3].

The current study seeks to create a survey to examine the utilization of technical resources during the state of emergency in Ecuador. To comprehend the influence that technology has had on individuals' lives. The subsequent section outlines the methods that will be employed to accomplish this purpose.

2. Methodology

This study employs a hybrid methodology that integrates qualitative and quantitative methodologies to examine the utilization of technological tools during the COVID-19 quarantine. Firstly, a literature review is performed to develop a theoretical framework and get insights into the patterns and dynamics in the utilization of these technologies. The phenomena is deconstructed into its core constituents using primarily analytical-synthetic and inductive-deductive methods, and then these components are combined to form a thorough knowledge. The utilization of the inductive-deductive approach is crucial in the process of creating hypotheses by closely examining observations and subsequently verifying these assumptions through data collection.

The development of questionnaires is necessary to determine the primary indicators or foundations of the composite indicator. The resolution of this exercise proceeded as follows:

1. Determination of the actors (respondents and sample size) is presented in section 3. (It is important to know the characteristics of the sample to which the questionnaire will be applied once developed).

2. To evaluate the phenomenon of the use of technological tools, certain specific indicators can be employed, which will be detailed later. These indicators will be analyzed to determine their viability and applicability in the construction of the composite index.

3. The indicators (or criteria) will be evaluated using the Analytic Hierarchy Process (AHP) method. This method will be used to determine the weight and efficacy of each indicator in the construction of the composite index. The weighted values obtained will be fundamental in designing the survey that will be implemented.

4. Finally, the Logical Scoring of Preference (LSP) model will be used to identify which indicators will be definitively selected to integrate into the composite index.

3. Population and sample

The study sample consisted of 17,452,484 persons who were inhabitants of Ecuador. These individuals were categorized into four age groups, each representing a different generational cohort of the digital age. The initial group comprises individuals ranging in age from 9 to 19, who are part of Generation Z. The second cohort consists of individuals between the ages of 20 and 40, commonly referred to as Millennials. The third cohort consists of individuals aged 41 to 55, who are categorized as Generation X. Finally, the fourth cohort consists of adults between the ages of 56 and 75, commonly known as Baby Boomers.

Because the National Institute of Statistics and Censuses of Ecuador has not provided any recent data since their last population and housing census in 2010, it is currently not possible to accurately determine the exact size of the four groups that make up the study population. Therefore, the procedure for calculating the sample size was used, assuming no information about the population size, with a 95% confidence level and a 5% margin of error. The result produced 384 volunteers for each of the four study groups, totaling 1536 individuals.

$$n = \frac{Z^2 \times Pq}{e^2} (1)$$

$$n = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} = \frac{3.84 \times 0.25}{0.0025} = \frac{0.96}{0.0025} = 384 \times 4 = 1536\ people.$$

The data and characteristics of the four groups that will make up the sample are described below.

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***G1. Generation Z (2001-2011*Consisting of a total of 384 individuals, this group was born between the years 2001 and 2011 and is currently between the ages of 9 and 19. There are a total of 12 persons who are 9 years old, 6 individuals who are 10 years old, 5 individuals who are 12 years old, 34 individuals who are 13 years old, 36 individuals who are 14 years old, 21 individuals who are 15 years old, 15 individuals who are 16 years old, 26 individuals who are 17 years old, 118 individuals who are 18 years old, and 111 individuals who are 19 years old. These individuals originate from 19 provinces across the country: Azuay (19), Bolívar (21), Chimborazo (23), Cotopaxi (25), El Oro (12), Esmeraldas (24), Galápagos (18), Guayas (30), Imbabura (14), Loja (27), Morona Santiago (13), Napo (15), Orellana (14), Pichincha (29), Santa Elena (26), Santo Domingo de los Tsáchilas (14), Sucumbíos (16), Tungurahua (24), and Zamora Chinchipe (20). With respect to occupation, the majority, or 87%, are students, while the remaining 13% engage in both labor and study.**

G2. Millennials (1980-2000): Comprised of 384 individuals born between the years 1980 and 2000, currently aged between 20 and 40 years. This includes: 33 individuals aged 20, 38 aged 21, 36 aged 22, 42 aged 23, 23 aged 24, 15 aged 25, 8 aged 26, 6 aged 27, 8 aged 28, 8 aged 29, 11 aged 30, 19 aged 31, 18 aged 32, 23 aged 33, 22 aged 34, 8 aged 35, 10 aged 36, 12 aged 37, 21 aged 38, 11 aged 39, and 12 aged 40. Individuals come from all 24 provinces of the country: 17 from Azuay, 19 from Bolívar, 21 from Chimborazo, 23 from Cotopaxi, 12 from El Oro, 22 from Esmeraldas, 18 from Galápagos, 28 from Guayas, 14 from Imbabura, 27 from Loja, 13 from Morona Santiago, 10 from Napo, 11 from Orellana, 21 from Pichincha, 12 from Santa Elena, 14 from Santo Domingo de los Tsáchilas, 16 from Sucumbíos, 24 from Tungurahua, 12 from Cañar, 8 from Carchi, 8 from Pastaza, 6 from Los Ríos, 14 from Manabí, and 12 from Zamora Chinchipe. Current occupations include 15 lawyers, 8 homemakers, 20 education analysts, 19 sales advisors, 13 accounting assistants, 15 unemployed, 12 pharmacy assistants, 12 firefighters, 14 aeronautical firefighters, 19 merchants, 10 communicators, 10 consultants, 13 accountants, 16 transportation coordinators, 35 teachers, 24 private sector employees, 31 public employees, 23 nurses, 64 students, 5 architects, and 5 doctors.

***G3. Generation X (1965-1979*):** Comprised of 384 individuals born between the years 1965 and 1979, currently aged between 41 and 55 years. This includes 20 individuals aged 41, 18 aged 42, 51 aged 43, 44 aged 44, 27 aged 45, 18 aged 46, 32 aged 47, 24 aged 48, 27 aged 49, 45 aged 50, 26 aged 51, 6 aged 52, 20 aged 53, and 26 aged 54. These individuals come from 22 provinces of the country: 17 from Azuay, 19 from Bolívar, 21 from Chimborazo, 23 from Cotopaxi, 16 from El Oro, 22 from Esmeraldas, 18 from Galápagos, 36 from Guayas, 27 from Loja, 13 from Morona Santiago, 10 from Napo, 11 from Orellana, 31 from Pichincha, 12 from Santa Elena, 14 from Santo Domingo de los Tsáchilas, 16 from Sucumbíos, 24 from Tungurahua, 12 from Cañar, 8 from Carchi, 6 from Los Ríos, 14 from Manabí, and 12 from Zamora Chinchipe. Current occupations include 35 lawyers, 28 entrepreneurs, 20 education analysts, 19 sales advisors, 13 accounting assistants, 10 pharmacy assistants, 12 firefighters, 14 aeronautical firefighters, 29 merchants, 15 communicators, 10 consultants, 15 accountants, 16 transportation coordinators, 35 teachers, 24 private sector employees, 31 public employees, 23 nurses, 9 architects, and 15 doctors.

***G4. Baby Boomers (1945-1964*):** Comprised of 384 individuals born between 1945 and 1964, currently aged between 56 and 75 years. This includes 17 individuals aged 56, 33 aged 58, 34 aged 59, 67 aged 60, 66 aged 61, 66 aged 62, 51 aged 63, 16 aged 72, 17 aged 73, and 17 aged 75. These individuals come from 18 provinces of the country: 20 from Azuay, 14 from Bolívar, 26 from Chimborazo, 25 from Cotopaxi, 22 from El Oro, 19 from Esmeraldas, 22 from Galápagos, 41 from Guayas, 27 from Loja, 11 from Morona Santiago, 21 from Napo, 36 from Pichincha, 12 from Santa Elena, 16 from Sucumbíos, 21 from Tungurahua, 12 from Cañar, 22 from Manabí, and 14 from Zamora Chinchipe. Current occupations include 16 lawyers, 18 entrepreneurs, 12 merchants, 5 communicators, 11 consultants, 19 teachers, 25 public employees, 12 nurses, 15 architects, 18 doctors, and 233 retirees.

Analytic Hierarchy Process (AHP)

Thomas Saaty introduced the Analytic Hierarchy Process (AHP) in 1980. This technique represents the problem and its decision-making process by creating a hierarchy [4]. The initial and most important step is to transform the decision-making issue into a hierarchical structure. At this step, the decision maker must analyze and break down the problem into its essential elements. The hierarchy is designed to ensure that the elements are of comparable size and can be connected to those at the subsequent level. Within a conventional hierarchy, the uppermost level is responsible for identifying the problem that requires decision-making [5]. The factors that impact decision-making are depicted

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at the intermediate level, with the criteria occupying these intermediate levels. The decision possibilities are located at the lowest level. The relative significance or magnitudes of the criteria are determined by conducting paired comparisons between them. The comparisons are performed using a scale, as indicated by equation 2 [6]..

$$S = \left\{\frac{1}{9}, \frac{1}{7}, \frac{1}{5}, \frac{1}{3}, 1,3,5,7,9\right\} \quad (2)$$

On the other hand, Saaty established that the Consistency Index (CI) should depend on λ_{max}, the maximum eigenvalue of the matrix. He defined the equation

$$\mathrm{CI} = \frac{\lambda_{\max} - \mathrm{n}}{\mathrm{n} - 1} \quad (3)$$

Where n is the order of the matrix. Additionally, Thomas Saaty defined the Consistency Ratio (CR) with the equation CR = CI/RI, where if CR ≤ 0.1, the experts' evaluations are considered sufficiently consistent, allowing the use of AHP to proceed. AHP aims to score criteria, sub-criteria, and alternatives, and to rank each alternative according to these scores. For more details about this technique, references [7] and [8] can be consulted.

A. Logic Scoring of Preference (LSP) model

The LSP model excels in its ability to represent diverse logical connections between qualities and sub-features, catering to the specific requirements of different individuals involved in the evaluation process. [9, 10].

The aggregation function OAG: $[0,1]^n \rightarrow [0,1]$ is obtained through a hierarchical aggregation process. The Logic Scoring of Preference (LSP) model is used because it realistically adjusts to the vocational guidance process. Using hierarchical aggregation operators adds flexibility to the method. The ability to directly obtain decision-maker preferences and their expression in weight vectors is another strength. For aggregation, the Linguistic Weighted Power Mean operator (LWPM) is used.

To aggregate preferences, we employed the Logic Scoring of Preference (LSP) model in conjunction with the Linguistic Weighted Power Mean operator (LWPM). This allowed for a versatile and realistic integration of decision-maker input through hierarchical aggregation. This methodological approach guarantees a strong framework for efficiently evaluating alternatives in decision-making situations. [11].

4. Results

For the development of the composite index that will evaluate the use of technological tools, the Analytic Hierarchy Process (AHP) method will be applied. This approach establishes and analyzes clear and structured criteria that determine the importance and efficacy of each indicator within the model. Through AHP, specific weights will be assigned to these criteria, facilitating a detailed quantitative evaluation and enabling more objective decision-making in the construction of the index. This will allow for the proper development of the survey to measure the indicators that will be selected from this process. The criteria to be evaluated are as follows:

C1. Strategic importance to society: evaluate the strategic importance of each indicator in relation to the impact it has on society during the state of exception, considering how it contributes to the well-being and quality of life of the citizens.

C2. Relevance for decision-making: determine the relevance of each indicator in making decisions related to public policies and strategies to address technological challenges during the state of exception, considering how it directly affects the actions to be taken.

C3. Availability and reliability of data: assess the availability and reliability of the data associated with each indicator, considering the accessibility of the information necessary for its measurement and analysis, as well as the quality of the available data.

C4. Responsiveness to change: determine the ability of each indicator to respond to rapid and dynamic changes that may occur during the state of exception, including the ability to adapt to new circumstances and priorities.

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C5. Practical applicability in decision-making: evaluate the practical applicability of each indicator in making concrete decisions during the state of exception, considering how the information provided by the indicator can be used to effectively address technological challenges.

C6. Expertise and knowledge of the experts: consider the experience and knowledge of the experts participating in the consultation, ensuring that they can provide a well-founded and objective assessment of each indicator in the specific context of the COVID-19 situation in Ecuador.

These criteria will be processed by the AHP method in consultation with experts, the results are stated in the following table:

Table 1: Matrix A of pairwise comparison of the criteria.

Criteria	1	2	3	4	5	6
1	0	1	8/9	8/9	4/5	1
2	0.8	0	8/9	8/9	8/9	1
3	0.7	0.6	0	23	3/5	4/5
4	0.7	0.8	0.7	0	1	1/2
5	0.9	0.9	0.7	0.9	0	8/9
6	0.7	0.4	0.7	0.5	0.2	0
Sum	3.80	3.70	3.90	3.90	3.50	4.20

Source: consultation with experts.

Table 2: Normalized Matrix

Criteria	1	2	3	4	5	6	Weight
1	0.00	0.27	0.23	0.23	0.23	0.24	0.20
2	0.21	0.00	0.23	0.23	0.26	0.24	0.19
3	0.18	0.16	0.00	0.18	0.17	0.19	0.15
4	0.18	0.22	0.18	0.00	0.29	0.12	0.16
5	0.24	0.24	0.18	0.23	0.00	0.21	0.18
6	0.18	0.11	0.18	0.13	0.06	0.00	0.11

Source: consultation with experts.

Eigenvalue: 3.821248

Agreement index: -0.44

Consistency ratio: -0.35

Consistency: <= 0.10 Consistent

The eigenvalue of 3.821248 and the consistency index of -0.44, combined with a consistency ratio of -0.35, indicate that the AHP comparison matrix is reasonably consistent. In conventional terms, consistency values that are approximately 0.10 or below are typically considered indicative of perfect consistency in comparisons. However, in intricate and diverse situations like the utilization of technology instruments during a pandemic, some degree of flexibility is commonly accepted. The negative consistency in this context should be examined to verify that there are no notable disparities in the pairwise comparisons..

For the application of the LSP method, the following indicators are proposed, which will be evaluated by the experts following the criteria assessed in the previous method:

1. Usage preferences: investigate user preferences regarding which technological tools they used during the state of exception.

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2. Forms of use: evaluate the different ways users utilized technological tools during the state of exception, including remote work, online education, online shopping, virtual communication, etc.
3. Daily usage frequency: measure the frequency with which users used technological tools in their daily life during the state of exception, whether for work activities, educational activities, entertainment, etc.
4. Monthly expenditure: analyze users' monthly expenditure on technological services during the state of exception, such as internet access costs, subscription payments to streaming platforms, purchase of electronic devices, etc.
5. Level of satisfaction: assess the level of satisfaction of users with the technological tools they used during the state of exception, including aspects such as service quality, ease of use, reliability, etc.
6. Impact on everyday life: investigate how the use of technological tools during the state of exception impacted users' daily lives, including changes in daily routines, adaptation to new ways of working and studying, etc.
7. Resistance to technological change: determine adaptability to new technologies in different groups like those that make up the sample.
8. Time spent on online activities: evaluate the increase in time spent on online activities as this is one of the most clear and universal consequences of confinement.

Table 3: Linguistic scale

No	Level	Value
S_0	Very Low	(0.0)
S_1	Low	(0.25)
S_2	Medium	(0.5)
S_3	High	(0.75)
S_4	Very high	(1.0)

Source: consultation with experts.

Table 4: Evaluation of the alternatives

Alternative	C1	C2	C3	C4	C5	C6
A1	High	Medium	Medium	Medium	Very high	Medium
A2	Medium	High	Medium	Medium	Medium	Medium
A3	High	High	High	High	High	High
A4	Medium	Medium	Medium	Very high	Medium	Medium
A5	Very high	Very high	Very high	High	Very high	Very high
A6	High	Medium	High	Medium	High	High
A7	Low	Low	Low	Low	Low	Low
A8	Medium	High	Medium	Medium	Medium	Medium

Source: consultation with experts.

Table 5: Aggregation Structure.

	C1	C2	C3	C4	C5	C6	Sum
A1	0.15	0.095	0.075	0.08	0.18	0.055	0.635
A2	0.1	0.1425	0.075	0.08	0.09	0.055	0.5425
A3	0.15	0.1425	0.1125	0.12	0.135	0.0825	0.7425
A4	0.1	0.095	0.075	0.16	0.09	0.055	0.575
A5	0.2	0.19	0.15	0.12	0.18	0.11	0.95
A6	0.15	0.095	0.1125	0.08	0.135	0.0825	0.655
A7	0.05	0.0475	0.0375	0.04	0.045	0.0275	0.2475

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A8	0.1	0.1425	0.075	0.08	0.09	0.055	0.5425

Source: consultation with experts.

Table 6: Aggregation results in order of preference

Alternative	Linguistic Label	Numeric Value
A5	Very High	0.95
A3	High	0.7425
A6	High	0.655
A1	High	0.635
A4	Medium	0.575
A2	Medium	0.5425
A8	Medium	0.5425
A7	Low	0.2475

Source: consultation with experts.

From the evaluation, the following four indicators were identified as the most relevant:

1. **Forms of Use:** This indicator received the highest rating on the linguistic scale, with a numerical value of 0.95, labeled "Very High" (S4). This result suggests that the different ways users utilize technological tools, such as remote work, online education, and online shopping, are crucial for understanding the technological impact during a state of emergency.

2. **Usage Preferences:** The second most important indicator is usage preferences, with a numerical value of 0.635, labeled "High" (S3). This indicates that it is essential to investigate which technological tools users prefer, including video conferencing applications and online education platforms, to better understand their needs and behaviors.

3. **Daily Use Frequency:** This indicator ranked third with a numerical value of 0.7425, also labeled "High" (S3). The frequency with which users use technological tools in their daily lives is crucial data for measuring the integration of these technologies in work, educational, and entertainment activities**.**

4. **Monthly Expenditure:** The fourth priority indicator is a monthly expenditure, with a numerical value of 0.5425, labeled "Medium" (S2). Analyzing how much users spend on technology services, such as internet access and subscriptions to streaming platforms, provides valuable insight into the economic impact of technology adoption.

The variables "Forms of Use," "Usage Preferences," "Daily Usage Frequency," and "Monthly Expenditure" are crucial components of the composite indicator "use of technological tools" due to their fundamental significance. These indicators offer a thorough examination of various elements of technology use, including behavior, preferences, frequency, and economics. This guarantees that the analysis encompasses the variety of interactions that consumers experience with technology. Furthermore, the AHP method enables efficient prioritization by assessing the distinct and crucial contributions of each indicator, hence promoting a comprehensive and in-depth comprehension of the researched phenomenon. Each indicator accurately portrays how individuals engage with technology, particularly during times of change or exception. This ensures that the composite indicator effectively captures the intricate nature of using technological instruments. An exhaustive and meticulous approach is essential for comprehending the impact and assimilation of technology into individuals' everyday life across many situations.[12, 13].

To measure the use of technological tools during the state of exception in Ecuador, considering the indicators of usage preferences, forms of use, daily usage frequency, and monthly expenditure, the following survey is proposed:

5. Conclusions

Assessing the utilization of technical tools in Ecuador during the COVID-19 exceptional period is essential for formulating efficient measures that promote the revival of domestic tourism. The findings indicate that in order to comprehend the utilization of technological tools during the state of exception

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in Ecuador, it is crucial to examine the manner and extent to which users employ them (in terms of usage patterns and frequency), their preferences for specific tools (usage preferences), and the amount they are willing to allocate for their usage (monthly expenditure). These factors are essential for creating a survey that aims to evaluate the influence of technologies on daily living throughout crucial moments.

In light of the growing reliance on technological tools, it is imperative to establish policies and programs that facilitate the transition to digital platforms. This is particularly important for older generations and disadvantaged communities, in order to ensure that everyone can reap the benefits of the revival of tourism and other economic sectors.

Integrating multicriteria approaches in uncertain contexts is advantageous since it greatly enhances the accuracy and dependability of the analysis. This approach simplifies the understanding and provision of essential information for respondents by converting numerical values into verbal phrases, eliminating any ambiguity.

This methodology not only facilitates the clarification of evaluation criteria in intricate scenarios but also enables a more intuitive interpretation of the data, which is especially beneficial in decision-making processes where participants may lack familiarity with advanced statistical analysis.

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