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Business model for the development of sustainable urban energy for Guayaquil

Modelo de negocio para el desarrollo de energía urbana sostenible para guayaquil

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ABSTRACT
The urban areas with the highest urban and population growth, such as the city of Guayaquil, are the main consumers of energy, therefore, they demand a greater consumption of fossil fuels for the generation of electricity. In some countries, large-scale progress is being made in the energy transition from fossil fuels to sustainable energy sources, however, this requires the construction of new infrastructure. In this scenario, electricity generation through renewable energy sources is the most viable option for the energy sustainability of cities, even being the best alternative until local governments invest in the construction of the necessary infrastructure. Through the bibliometric analysis of journals with the greatest influence of the SCImago indicator, a business model for the development of sustainable urban energies in the city of Guayaquil is proposed; reaching the conclusion that the proposed business model is oriented towards a freemiun service with aggregates in the final product.
Keywords: energy consumption; urban energy; business model.

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Introduction

In 2015, the UN General Assembly adopted the 2030 Agenda for Sustainable Development; This agenda is made up of 17 goals that aim to create "an action plan in favor of people, the planet and prosperity [1], among the countries committed to the 2030 agenda is Ecuador. The achievement of goal 7 regarding the use of energy is to guarantee access to affordable, reliable, sustainable and modern energy [1]. The

largest consumers of energy are large cities [2], which contribute to climate change, accounting for 60% of all greenhouse gas emissions [1], leading to a global environmental crisis, but also creating an opportunity for the improvement and innovation of energy sectors and responsible energy consumption [3].

Talking about innovation is aimed at generating energy within cities through sustainable urban energy systems. The structural model of inefficient energy transition based on fossil fuels is opposed to an efficient decentralized model based on sustainable energies [4]; there is a constant increase in different sources of renewable energy (micro-hydro, solar photovoltaic, wind, biomass, among others) close to consumers called on-site or distributed generation [5] which take advantage of the power lines of local distribution networks to reach users [6]. An example is the city in California where the use of distributed generation with renewable energy sources connected to the electricity supply grid shows its ability to reduce energy consumption costs [7], in addition to being a clean, safe and efficient technology [8].

In order to replicate the use of sustainable energy sources through on-site generation in other cities, it is necessary to propose business models that make these technologies viable and commercialize, giving benefits to the end consumer and contributing to the environment, however, operating in this way and making it economically viable is a prerequisite for sustainable energy communities [9]. To this end, business models have the potential to bring sustainability to companies through innovative approaches [10]. On the other hand, they attract the most attention from academics, companies and even politicians, because they define the logic of the organization to do business with social, environmental and economic value [11]; Added to this is the adoption of sustainable [12] and emerging energy technologies.

In Ecuador, Guayaquil is one of the main cities with the highest trade rate in the country, but also with the highest consumption of electricity from non-renewable sources; according to data from the Corporación Nacional de Electricidad (Cnel EP), the average electricity consumption in the city of Guayaquil varies between 503 and 1080 MW/h; In addition, Ecuador, according to data from the national government through the Secretariat of Risk Management, is facing droughts throughout the territory this year [13], which has implied cuts and rationing of electricity service in several cities, including Guayaquil [14]. According to statements from the Guayaquil Chamber of Commerce, the economic losses due to power cuts due to rationing are incalculable, but they would be in millions of dollars [15]. So, how to contribute to the development of sustainable urban energy for the city of Guayaquil through a business model? According to data from the National Institute of Statistics and Census (INEC), the largest number of companies in our country are located or have service offices in the city of Guayaquil, due to its geographical location and port location, which facilitates the export and commercialization of environmentally friendly technology.

The objective of this research is to propose a business model for the development of sustainable urban energies in the city of Guayaquil; as an additional fact in Ecuadorian legislation, renewable energies have regulatory frameworks that would guarantee local and international investment.

Methods

This research study is descriptive, using the analysis and selection of literature and bibliographic data, taking into account authors, affiliation, study variable, and year of publication [16], the selected information comes from publications of scientific journals, to which bibliometric analysis has been carried out [17, 18], in order to obtain the results that would provide us with a trend towards which proposal for a sustainable energy business model is applicable for the city of Guayaquil.

Digital tools

The search for scientific journals and their relationship with the object of study was carried out on the SCImago indicator platform, which assesses the quality and impact of journals [19]. In its database, the SCImago indicator has a large number of journals and scientific articles, a large number of which are open access, which facilitates the analysis of each document. Through the similarity analyzers, maps of bibliometric networks were created with the words of greatest relevance and importance and their influence on each other; the bibliometric network will show us which are the topics with the greatest transcendence and trend among the scientific literature investigated, in addition, statistical graphs were developed using graph manager tools, based on the lists of journals with the largest number of documents published in relation to the study variables, number of citations, affiliation, among others.

Topic, abstract and keywords

For the search process of the two study variables, a 5-year temporality criterion [20] has been considered in which abstracts of articles, keywords, topics that address research related to business models and sustainable urban energies were systematically reviewed. The keywords facilitate the search and linkage with the study variables, while the abstracts of the articles show scientific interest [21,22].

Results

The results are organized based on the analysis of the two study variables: business models and sustainable urban energies, which will achieve the objective of this research. It should be noted that there is a close relationship between business models and energy, the common thread of the research shows that commercial development is a key factor for energy development.

The selected business model must have three important aspects: generating profitability, creating value and job opportunity [23], in addition to reducing the carbon footprint and covering energy needs.

Business models

Each business model has a strategy that helps you promote your product or service; Decision-making on business models will greatly influence the inputs and outputs of value in the company, even becoming less competitive [24] if good decisions are not made.

It is not only a matter of identifying who their customers are, but also of carrying out an appropriate strategic management process [25]. In senior management, ambidextrous learning is important in decision-making [26] and the sustainable

potential of stakeholders [27]. The impact of the selected business model will help the company to achieve sustainability [11], that shows why the business strategy is as important as the selected business model [28].

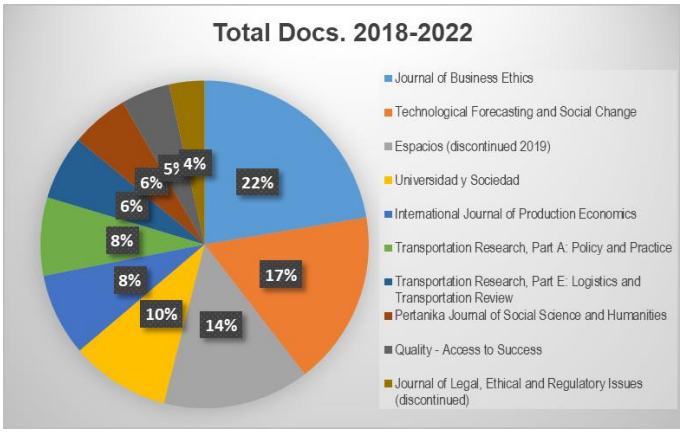

Fig. 1- Total number of documents published in journals according to SCIMago.

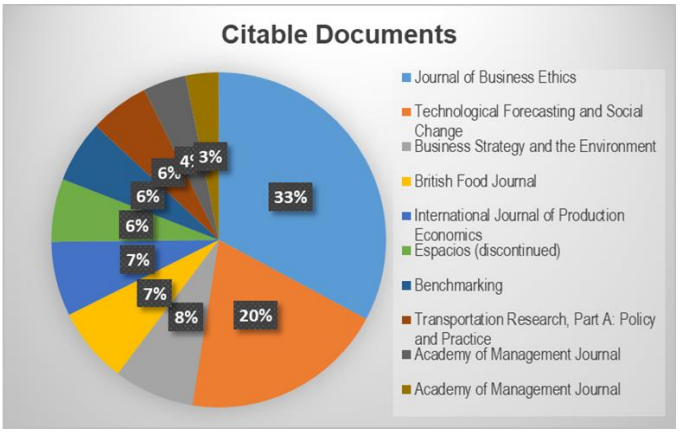

Fig. 2- Journals with the highest number of citations according to the study variable.

Business models are related to the way the business is conducted, while the strategy helps it to have the expected success [29].

In the following paragraphs, an extract is made of some concepts and strategies of the business models found in the database analyzed and applicable to urban areas, which have been studied in different scientific articles that are part of the bibliometric analysis. Information from several scientific journals was reviewed and analyzed, and among the most researched business models we can find 5 types, some of which are mentioned in table 1.

Table 1 - Types of business models.

Business models	Authors	Year

Digital 2.0	Hu, Zhou, & Zhang. Ning & Xiong. Marques, Silva, Thakur, Uturbey, & Thakur.	2022 2024 2023
Strategic alliances	Meygoonpoury, Ghadim, & Ziabakhsh-Ganji. Lin & Xie. Chemmanur, Shen & Xie. Calderon-Monge. Pastor-Sanz, & Sendra-García. Bretas & Alon.	2024 2023 2023 2021 2021 2021
Freemium	Shang, Jiang, Zhang, Zhang, & Liu. Jiang, Yang, Kiang, & Cameron. Seufert.	2024 2021 2014
Retailers	Phan & Vogel. Cao, Navare, & Jin. Karami & Madlener.	2010 2018 2021
Aggregator	Okur, Heijnen, & Lukszo. Wong & Hensher	2021 2021

Business Model Selection

These five business models in table 1 have been studied in other countries and their analysis to include them in this study responds to the feasibility of replicating them or creating a new business model for the development of sustainable urban energy, among their main characteristics is innovation and the use of digital technology [30]. According to studies carried out by Foss and Saebi, research can relate innovation in business models with organizational change processes [31] and these studies make emphasis on three qualities: capacity, leadership and business learning mechanisms, for which a reorganization of the company is necessary in order to be sustainable [32]. Learning from the team and the managers helps sustainability [26], while innovation helps to gain competitiveness and grow in the market [33].

Considering the city where the business model will be proposed, according to data from the National Economic Census of INEC, the economic profile of Guayaquil indicates that the city in 2011 had 88,913 economic establishments, generating sales income of USD 35,507,000 and around 441,976 people employed. The main commercial and service economic activities are the sale of food, beverages and tobacco, and other retail activities in non-specialized trade, restaurant activities and mobile food service and telecommunications. Commerce and service represent the

highest percentage, while manufacturing represents a lower percentage [34], showing that Guayaquil energizes its economy between commerce and service, with a high percentage of online commerce.

On the subject of entrepreneurship, census data profile Guayaquil as one of the cities in Ecuador with the highest demand for research or market studies; annual income from the provision of services totaled USD 88,553,438.00 [34], based on this, the proposed business model has to be based on a service (whether consulting, installation, among others) type Freemium which will create job opportunities and improve profitability, in addition, the final product must have its Aggregate that will give it the necessary value for its commercialization in order to sustain demand.

A concept of a renewable energy business model based on urban sustainability with a freemium service and aggregator of the final product would operate as a small and/or medium-sized enterprise, and its organizational structure would be composed of: roles of personnel, the activities that are carried out and their application [35,36], for the present case the urban area. Interested persons, customers, users, even sponsors or key partners, would have the option of designing the renewable system themselves with the advice of specialists through tools on the company's website [37], such as a shopping cart to which an object or service is added and the price is verified according to the budget.

Freemium Business Model

In general, this business model is used in digital platforms for training, social, work, provides a free service [38], the motto is "try before you buy" [39], but it can also be appropriately focused on online stores that provide the product through free professional services such as assistance, consulting and installation. The success of freemium business models is awareness, monetization, and optimization [40]. Many professionals offer their products through free services on platforms aimed at business use [41,42].

Aggregator Business Model

Unifying the different teams or services to transform them into a single one because each company has a specific good or service (resource) is the business model of aggregators. This business model brings together all the necessary resources, helping to make customer demand more flexible [43], provides benefits and its results are guaranteed [44]. An example is the sale of electricity through energy aggregators.

Sustainable urban energies

The second variable of study is sustainable urban energies, a dependence on renewable energy sources in urban areas is a necessary "energy imperative" [3] however, renewable energies in cities are not usable to their maximum capacity due to multiple factors such as the technology of the sources [45] and availability of resources for their generation [46]. Despite these drawbacks, the production of electricity for cities depends on large thermal generation plants powered by fuels that pollute the environment [6], in the face of which it is possible to create smaller-scale projects that use renewable energy sources [4]. This research focuses on sustainable urban energies for electricity generation.

Sustainable urban cities

The disproportionate increase in population development has led cities to environmental deterioration, without organizational [45] and structural planning that help the adoption of new sources of energy. Cities that have structures that can be integrated into smart grids make it possible to incorporate renewable energies [46] in their environment, and this continues to be the main problem in those cities that do not have these structures [47].

The accelerated growth of cities leads to the research and implementation of environmentally friendly technologies that use the renewable resources available for energy generation, which lowers their environmental impact [46]. In cities such as Nottingham, case studies are carried out on the potential of hybrid systems such as solar and wind for the urban area [48]. In the Niger Delta in Nigeria, specifically in the city of Port Harcourt, the integration of renewable energies for access to the community is being studied [49]. Wrocław in Poland research has demonstrated the potential of rooftop solar systems for electricity self-sufficiency [50]. The above are examples of cities that are researching how to take advantage of their renewable resources.

Selection of sustainable urban energies

With the help of the VOSviewer digital tool, the data of the second study variable were processed. The bibliographic network in Figure 2 shows the relevant and important words of greatest importance and correlation with each other: renewable energy, solar energy, biomass, sustainability, photovoltaics, energy efficiency, among others, this shows that interest in renewable energies has not stopped [51]. In several countries, projects have been developed to diversify the generation of renewable energies [52], with solar energy having the greatest potential [35, 53] due to its unlimited, sustainable and ecological resource [54]. Hybrid systems such as solar-wind have also been studied and proposed [48, 49, 55] mostly with the use of microturbines and solar panels.

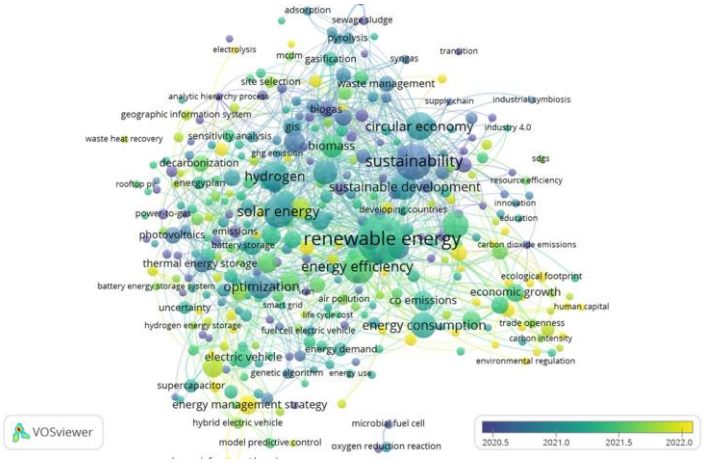

Fig. 3- Bibliometric network with the keywords that have the greatest relevance in the scientific articles searched.

As a statistical fact, in Figure 3 according to the SCImago indicator, it can be seen that China is the country with the largest number of scientific articles published on the subject of renewable energy, Ecuador has a total of 970 scientific articles published, which represents 0.67% of the number of articles published by China. The largest publications correspond to solar energy systems, which have greater economic benefits when used as self-consumers [56]. The scientific journal with the highest number of citations has a total of 720 articles published and correspond to research on solar systems that analyze and study performance [57], technology [58], type of storage [59], optimization [60], among other factors for their implementation.

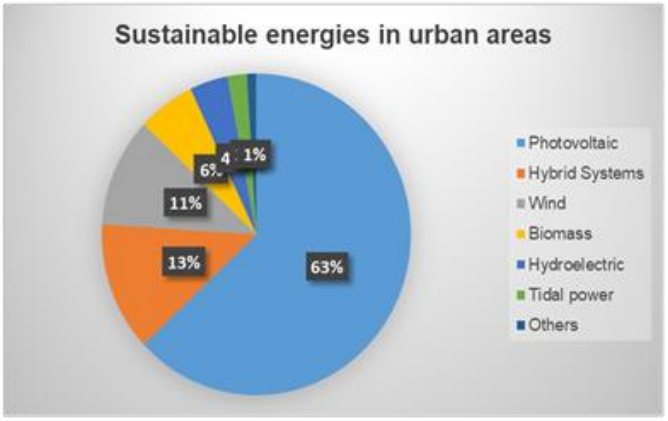

Fig. 4 - Sustainable energy applied in urban areas.

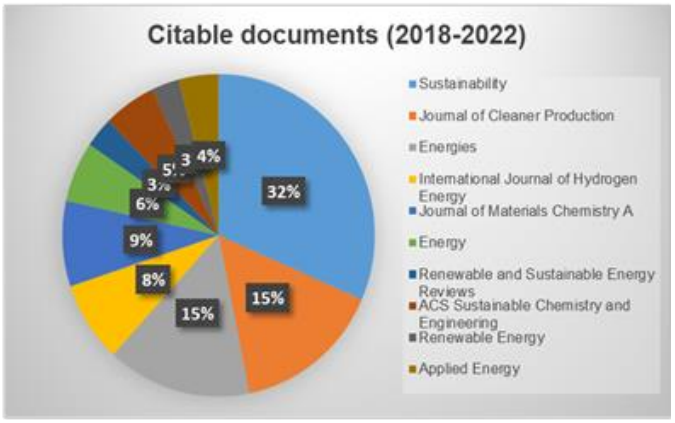

Fig. 5 - Percentage of citations of scientific journals according to study variable.

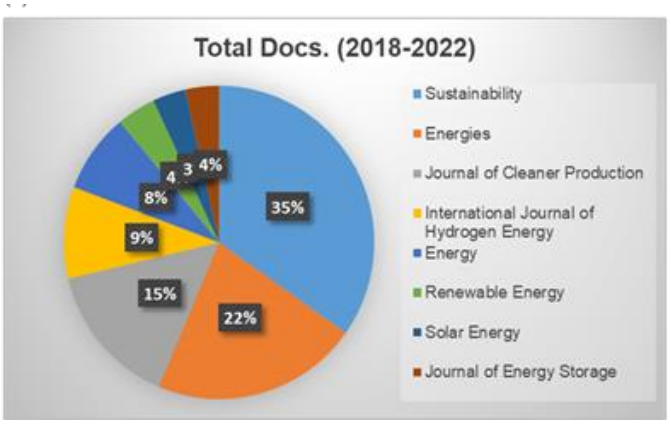

Fig. 6 - Total publications of scientific journals according to study variable.

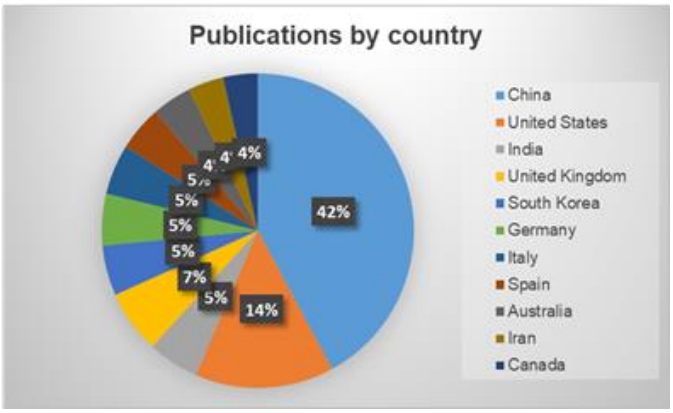

Fig. 7 - Percentage of countries with the highest number of publications according to study variable.

Some authors have investigated different renewable energy generation systems, the most researched being solar systems using photovoltaic equipment as shown in figure 4, this is due to the ease that these systems show in their installation, availability of resources in areas with high solar irradiation, little maintenance, direct electricity generation, energy self-sufficiency, among other factors.

In Table 2 has been selected and identified some examples of scientific publications in different countries using solar systems using photovoltaic equipment and hybrid systems (solar-wind; hydro-wind-solar; solar-tidal; Bio-wind-solar) that have been the subject of case studies for their application in urban areas. For this research we will focus on solar systems due to the geographical location and the renewable resource present in the city of Guayaquil.

Table 2 - Example of publications on photovoltaics and hybrid systems in urban areas

Publications	Filiation	Power source

Floating photovoltaic systems [52]	Mexico DF, Mexico	Solar
Hybrid photovoltaic/thermal collector system [54]	Duhok, Irak	Solar
Potential of the energy generated by solar cell systems [61]	Merida, Mexico	Solar
Self-sufficiency of photovoltaic systems [50]	Wrocław, Polonia	Solar
Photovoltaic systems potential in buildings [62]	China	Solar
Cost-effectiveness of photovoltaic systems in urban areas [56]	Valencia, Spain	Solar
Optimization of PV systems in urban areas [63]	New York, United States	Solar
Modeling and optmization of a hybrid system [64]	Patani, Nigeria	Hydro-wind-solar
Smart hybrid renewable energy systems for urban areas [65]	Berlin, Germany	Wind-solar
Hybrid photovoltaic and wind microturbine renewable energy system [66]	Africa subsariana	Wind-solar
Rural electrification through removable power for urban areas [49]	Port Harcourt, Nigeria	Wind-solar
Renewable hybrid energy system [67]	Kurdistan, Iran	Hydro-wind-solar
Simulation of hybrid renewable energy system in urban areas [68]	Agkistro, Serres, Greece	Bio-wind-solar
Hybrid systems potential in urban areas [48]	Nottingham, England	Wind-solar
Design and optimization of a hydric system in an urban area [69]	Hurawalhi, Maldivas	Solar-tidal

Guayaquil's Renewable Resources

According to the web portal of the municipality of Guayaquil, the city is projected, among other things, as sustainable and entrepreneurial. Geographically, it has the particularity that it is located in the coastal area of continental Ecuador; The renewable resource that can be used in this urban area is the solar system. Guayaquil has other resources that can be renewed, but they are not exploited, such as water and tidal resources because, according to technical studies by the Prefecture of Guayas, the Guayas River near the city contains a large amount of accumulated sediments; which is harmful to the equipment used in the generation of electricity; as for the wind resource in the city of Guayaquil, the winds are considered weak for the use of

electricity generation; The biomass resource is not feasible to take advantage of because the city does not have good solid waste management.

Solar Resource

Using the PVGIS photovoltaic calculation tool, the coordinates of the city of Guayaquil were entered with the NSRDB meteorological database, resulting in the bar plots of graph 4. In the analysis, Guayaquil has a solar irradiation of 1450.35 kW/m2 per year; the minimum monthly average of energy production of a fixed-angle photovoltaic system is in the month of June with
60.35 kW/h and 84.35 kW/m2 of solar irradiation, to perform this calculation the software performed the simulation with panels built in crystalline silicon. Energy production will depend on the number of solar panels installed in the areas.
According to large-scale research and studies, the highlands region has a great solar potential, while the coastal region has an available and exploitable medium potential [70, 71]. In the city of Guayaquil several large-scale pilot projects will be implemented according to the National Electricity Corporation [70], in addition to ongoing research for the implementation of photovoltaic systems in different sectors of the city [72, 73, 74].

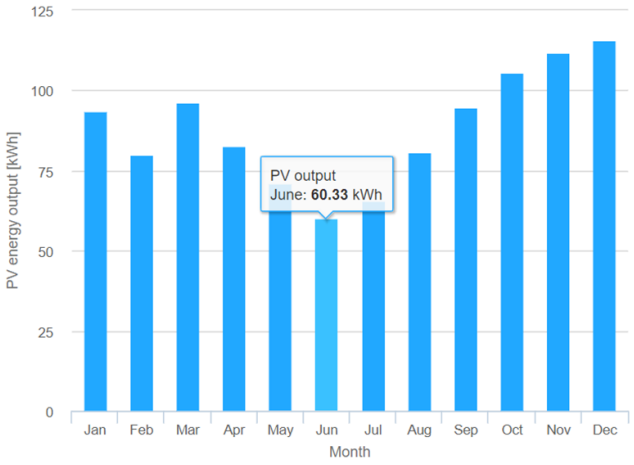

Fig. 8 – Monthly Energy production of Guayaquil.

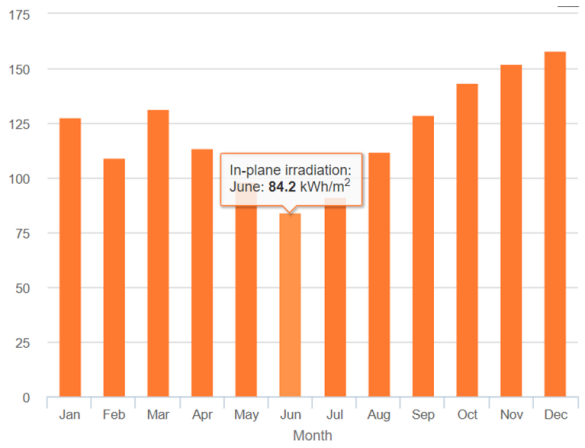

Fig. 9 - Solar irradiation of Guayaquil per month.

Local Research

Works related to the study variables of Ecuadorian researchers published in scientific journals were reviewed; the variable with the most research was business models based on products that include free services or have a final aggregate. Several authors, such as Campos-Sánchez, Cedeño-Palacios, Palma-García, et al., used the bibliographic review of scientific literature as a methodology [75], as did Morales-Sornoza, Mora-Muñoz, Moscoso-Garrido, et al., [76]. Table 3 summarizes other Ecuadorian authors who used bibliographic review to obtain results in their research.

Table 3 - Example of local publications.

Authors	Type of research	Method
Ruiz-Chagna, Terán-Silva [77]	Descriptive	Literature review
Salgado-Monar [78]	Descriptive	Bibliographic review
Muñoz-Chavez, Muñiz-Tumbaco, Parrales-Poveda [79]	Descriptive, documentary and non-experimental	Bibliographic review
Arteaga, Lasio [80]	Probabilistic	Literature review and secondary sources
Borja, Carvajal, Vite [81]	Descriptive	Literature review and secondary sources
Useche-Aguirre, Pereira-Burgos, Barragán-Ramírez [82]	Descriptive	Literature review
Pérez-Siza [83]	Descriptive	Literature review
Pesantez-Cedeño, Moreira-Torres [84]	Descriptive	Literature review

Like the research carried out by Ecuadorian authors, the business model resulting from this research will help to create value for the final product or service and in our case will be delimited by the available and usable renewable resource [45].

Discussion

The greatest research related to the study variables: business models and sustainable urban energies has been carried out in recent years, with scientific journals of an environmental and social nature having the most publications, hence the importance and environmental and social impact of the development of this research. Business models are key to the sustainable energy transition (85), they face environmental and social challenges [86] while sustainability is necessary for human beings (87), while urban energy is essential for the sustainable development of cities (46), due to this, it is necessary to specify actions that cause changes in urban energy models (45).
The business models analyzed have strategies that help to give value and sustainability to the final product. Nowadays, it is necessary to use digital tools to innovate [30] to help the market grow; without innovation, competitiveness will be lost [33].
The business model proposed in this research is based on a freemium service with a final aggregate, which could be: in energy (load study, energy quality analysis, among others) or commercial (cost-benefit analysis, tax, among others), which will generate job opportunities, give value to the final product, profitability, it will provide benefits and its results will be guaranteed.
The implementation of the proposed business model for the city of Guayaquil may present challenges such as the incentives for entrepreneurs [88], financing [89], innovation, digital marketing [90], social impact [91], and currently the issue of crime and extortion of entrepreneurs. According to the Ecuadorian Organized Crime Observatory, small and medium-sized companies are the most affected, affecting sectors such as commercial, manufacturing and services, with Guayaquil being the city with the highest rate of complaints [92].
Consequently, an analysis of the potential risks to this research may provide us with a basis for the success of the proposed business model, for this the interested parties must be involved, which are of vital importance, especially those interested parties that are difficult to identify.

Conclusions

Some sustainable urban energy generation systems with the most publications in scientific journals were analyzed for the city of Guayaquil; these renewable energy systems cover energy needs and reduce the carbon footprint; Guayaquil has good solar irradiation indexes during the year, which facilitates the installation, commercialization and marketing of the environment.
and use of solar energy systems, however, other systems such as wind are not recommended due to the average wind speed with respect to the other cities in Ecuador in which wind systems are installed.
The analysis of the results shows that currently hybrid business models such as the one selected strengthen the sustainable growth of the proposed business plan, continuous learning, future contributions and/or contributions to the present research should follow the line of hybrid business models focused on the customer and end user. On the other hand, the research of the public-private business model of renewable energy systems based on distributed generation sponsored by government

entities and aimed at the social sectors with lower economic resources in the city of Guayaquil would create a greater social and environmental impact on the city.
The combination of the results shows that a renewable solar energy business model based on providing freemiun services with aggregates in the final product, is the predominant proposal justified in the research carried out in this study, contributing not only to the development of sustainable energy, but also to the economic development of the city of Guayaquil.

References

1. UN. Sustainable Development Goals. [Online]; 2023. Available at: https://www.un.org/sustainabledevelopment/es/2015/09/la-asamblea-general-adopta-la-agenda-2030-para-el-desarrollo-sostenible/
2. Rosales J, Worrell E. Urban energy systems within the transition to sustainable development. A research agenda for urban metabolism. Resources, Conservation and Recycling. 2018. Available at https://doi.org/10.1016/j.resconrec.2017.08.004
3. Phillips L, Smith P. Sustainable urban energy is the future. Chronicle ONU. 2015; Available at: https://www.un.org/es/chronicle/article/la-energia-urbana-sostenible-es-el-futuro
4. Rodríguez C, Anuzis A. Potencialidad para la implementación de comunidades energéticas sustentables en la provincia de Córdoba, Argentina. Enerlac. 2021; Available at: https://enerlac.olade.org/index.php/ENERLAC/article/view/183
5. IEA. https://www.iea.org/reports/unlocking-the-potential-of-distributed-energy-resources. [Online]; 2023.
6. Paredes L, Serrano B, Molina M. Nuevo paradigma de los sistemas eléctricos: generación distribuida y microrredes eléctricas. Un vínculo de accesibilidad a la electricidad en américa latina y el caribe. Enerlac. 2019; Available at: https://enerlac.olade.org/index.php/ENERLAC/article/view/94
7. Deng J, Rotman R. Does the community choice aggregation approach advance distributed generation development? A case study of municipalities in California. Journal of Cleaner Production. 2023. Available at https://doi.org/10.1016/j.jclepro.2023.137451
8. Bisognin T, Duarte J, Savian F, Mairesse J. Competitiveness of the value chain of distributed generation of photovoltaic energy in Brazil. Energy for Sustainable Development. 2022. Available at https://doi.org/10.1016/j.esd.2022.10.019
9. Kubli M, Puranik S. A typology of business models for energy communities: Current and emerging design options. Renewable and Sustainable Energy Reviews. 2023; p. 2. Available at: https://doi.org/10.1016/j.rser.2023.113165

10. Mukoro V, Sharmina M, Gallego-Schmid A. A framework for environmental evaluation of business models. Sustainable Production and Consumption. 2022. Available at: https://doi.org/10.1016/j.spc.2022.09.007
11. Bhatnagar R, Keskin D, Kirkels A, Romme AGL, Huijben JCCM. Design principles for sustainability assessments in the business model. Journal of Cleaner Production. 2022; 377. Available at: https://doi.org/10.1016/j.jclepro.2022.134313
12. Ebrahimigharehbaghi S, Heijden Hvd, Elsinga M. Sustainable business model of affordable zero energy houses: Upscaling. Journal of Cleaner Production. 2022. Available at: https://doi.org/10.1016/j.jclepro.2022.130956
13. Secretaria de Gestión de Riesgo. Resoluciones COE Nacional. Resolución. Quito: Secretaria de Gestión de Riesgo. Available at: https://www.gestionderiesgos.gob.ec/resoluciones-coe/
14. Ministerio del Ambiente. Plan de sequia nacional. Quito: Ministerio del Ambiente, Agua y Transición. Available at: https://www.ambiente.gob.ec/wp-content/uploads/downloads/2021/05/plan-nacional-de-sequia.pdf
15. Cámara de Comercio de Guayaquil. Certezas que nos iluminan. Comercio. 2024. Available at: https://drive.google.com/file/d/1G7eTwB2TA6e6uadWKe4JWpNGXeyK9dxi/view
16. Rovelli P, Ferasso M, Massis A, Kraus S. Thirty years of research in family business journals: Status quo and. Journal of Family Business Strategy. 2022; 13(3). Available at: https://doi.org/10.1016/j.jfbs.2021.100422
17. Miguel S, Dimitri P. La investigación en Bibliometría en la Argentina: Quiénes son y qué producen los autores argentinos que realizan estudios bibliométricos. Información, cultura y sociedad. 2013;(29): p. 117-138. Available at: https://www.memoria.fahce.unlp.edu.ar/art_revistas/pr.7249/pr.7249.pdf
18. Farsani M, Jamali H, Beikmohammadi M, Daneshvar-Ghorbani B, Soleimani L. Methodological orientations, academic citations, and scientific collaboration in applied linguistics: What do research synthesis and bibliometrics indicate? System. 2021; 100. Available at: https://doi.org/10.1016/j.system.2021.102547
19. Formación universitaria. SCImago. Formación universitaria. 2012; 5(5). Available at: http://dx.doi.org/10.4067/S0718-50062012000500001
20. Zeballos-Ramírez P, Pumacahua-Yucra M. Strategies for searching, selecting and evaluating digital information for reading and writing. Boletín de la Academia Peruana de la Lengua. 2023; 73(73): p. 121-149. Available at: https://doi.org/10.46744/bapl.202301.005
21. Villanueva-López. Keywords, what are they for? Acta ortopédica mexicana. 2014; 28(4): p. 211-211. Available at: http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2306-41022014000400001&lng=es&nrm=iso

22. Martín S. The importance of abstract in a scientific article. Methodo. 2021; 6(2): p. 59-60. Available at: https://doi.org/10.22529/me.2021.6(2)01.
23. García-Puga Y. El Lienzo de modelo de negocio o modelo Canvas: Herramienta para emprendedores. FAECO sapiens. 2023; 6(1): p. 347–363. Available at: https://revistas.up.ac.pa/index.php/faeco_sapiens/article/view/3530
24. Hacklin F, Björkdahl J, Wallin M. Strategies for business model innovation: How firms reel in migrating value. Long Range Planning. 2018; 15(1): p. 82-110. Available at: https://doi.org/10.1016/j.lrp.2017.06.009
25. Afuah A, Tucci C. Internet Business Models and Strategies: Text and Cases USA: McGraw-Hill; 2001.
26. Dhir A, Khan S, Islam N, Ractham P, Meenakshi N. Drivers of sustainable business model innovations. An upper echelon theory perspective. Technological Forecasting & Social Change. 2023; 191. Available at: https://doi.org/10.1016/j.techfore.2023.122409
27. Velter M, Bitzer V, Bocken N. A Boundary Tool for Multi-stakeholder Sustainable Business Model Innovation. Circular Economy and Sustainability. 2022; 2: p. 401–431. Available at: https://doi.org/10.1007/s43615-021-00103-3
28. Drzewiecki J. Strategic management in Polish startups: strategy vs business model approach – research results. Procedia Computer Science. 2023; 225: p. 3163-3172. Available at: https://doi.org/10.1016/j.procs.2023.10.310
29. Palacios M, Duque E. Modelos de negocio propuesta de un marco conceptual para centros de productividad. Administración & Desarrollo. 2011; 39(53): p. 23-34. Available at: https://doi.org/10.22431/25005227.144
30. Haftor D, Climent R. Five dimensions of business model innovation: A multi-case exploration of. Journal of Business Research. 2023; 154. Available at: https://doi.org/10.1016/j.jbusres.2022.113352
31. Foss N, Saebi T. Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go? Journal of Management. 2017; 43(1). Available at: https://doi.org/10.1177/0149206316675927
32. Coffay M, Bocken N. Sustainable by design: An organizational design tool for sustainable business model innovation. Journal of Cleaner Production. 2023; 427. Available at: https://doi.org/10.1016/j.jclepro.2023.139294
33. Toniut H. El uso del modelo de negocio para la innovación empresarial: aportes de los principales autores. Palermo Business Review. 2020;: p. 139-156. Available at: https://www.researchgate.net/publication/362713417
34. INEC. Resultados Censo Nacional Económico. Quito.
35. Bankel A, Mignon I. Solar business models from a firm perspective – an empirical study of the Swedish market. Energy Policy. 2022;(166). Available at: https://doi.org/10.1016/j.enpol.2022.113013
36. Heirani H, Moghaddam N, Labbafi S, Sina S. A Business Model for Developing Distributed Photovoltaic Systems in Iran. Sustainability. 2022;(14). Available at: https://doi.org/10.3390/su141811194

37. Shakeel S, Juntunen J, Rajala A. Business models for enhanced solar photovoltaic (PV) adoption: Transforming customer interaction and engagement practices. Solar Energy. 2024;(268). Available at: https://doi.org/10.1016/j.solener.2024.112324
38. Shang Y, Jiang J, Zhang Y, Zhang R, Liu P. When does a freemium business model lead to high performance? — A qualitative comparative analysis based on fuzzy Sets. Heliyon. 2024; 10(3). Available at: https://doi.org/10.1016/j.heliyon.2024.e25149
39. Jiang J, Yang M, Kiang M, Cameron AF. Exploring the freemium business model for online medical consultation services in China. Information Processing & Management. 2021; 58(3). Available at: https://doi.org/10.1016/j.ipm.2021.102515
40. Seufert E. The Freemium Business Model. Freemium Economics. 2014;: p. 1-27. Available at: https://doi.org/10.1016/B978-0-12-416690-5.00001-4
41. Chen W, Hua Z, Zhang Z, Bi W. Analysis of Freemium Business Model Considering Network Externalities and Consumer Uncertainty. Journal of Systems Science and Systems Engineering. 2018; 27: p. 78–105. Available at: https://doi.org/10.1007/s11518-017-5342-8
42. Cziehso G, Schaefers T. The Effects of Interrupted Preview Endings on Purchase Decisions in "Freemium" Business Models: An Abstract. Creating Marketing Magic and Innovative Future Marketing Trends. 2017;: p. 517–518. Available at: https://doi.org/10.1007/978-3-319-45596-9_96
43. Okur Ö, Heijnen P, Lukszo Z. Aggregator's business models in residential and service sectors: A review of operational and financial aspects. Renewable and Sustainable Energy Reviews. 2021; 139. Available at: https://doi.org/10.1016/j.rser.2020.110702
44. Wong Y, Hensher D. Delivering mobility as a service (MaaS) through a broker/aggregator business model. Transportation. 2020; 48: p. 1837–1863. Available at: https://doi.org/10.1007/s11116-020-10113-z
45. Barragán-Escandón E, Zalamea-León E, Terrados-Cepeda J. Las energías renovables a escala urbana. Aspectos determinantes y selección tecnológica. Bitácora Urbano Territorial. 2019; 29(2): p. 39-48. Available at: https://doi.org/10.15446/bitacora.v29n2.65720
46. Ayala M, Medina A. Sostenibilidad, energía y ciudad. CienciAmérica. 2021; 11(2). Available at: https://doi.org/10.33210/ca.v11i2.391
47. Wilberforce T, Olabi A, Sayed E, Mahmoud M, Alami A, Abdelkareem M. The state of renewable energy source envelopes in urban areas. International Journal of Thermofluids. 2024; 21. Available at: https://doi.org/10.1016/j.ijft.2024.100581
48. Naik K, Ianakiev A, Galadanci A, Cucca G, Shubham , Sun M. Evaluating the potential of wind and solar energy in achieving zero energy ratings in residential

homes A Nottingham case study. Smart Energy. 2024; 13. Available at: https://doi.org/10.1016/j.segy.2023.100129

49. Ezekwem C, Muthusamy S. Feasibility study of integrating the renewable energy system for increased electricity access A case study of Choba community in Nigeria. Scientific African. 2023; 21. Available at: https://doi.org/10.1016/j.sciaf.2023.e01781
50. Jurasz J, Dabek P, Campana P. Can a city reach energy self-sufficiency by means of rooftop photovoltaics? Case study from Poland. Journal of Cleaner Production. 2020; 245. Available at: https://doi.org/10.1016/j.jclepro.2019.118813
51. Park S, Yoon N, Ullah Z, Kipchirchir-Tarus B, Choi B, Kim HH, et al. Energy storage capability of seawater batteries for intermittent power generation systems: Conceptualization and modeling. Journal of Power Sources. 2023; 580. Available at: https://doi.org/10.1016/j.jpowsour.2023.233322
52. Carrera-Cadena A, Medrano-Pérez O, Méndez-López L. Potencial de generación de la tecnología fotovoltaica flotante en México. Enerlac. 2023; 6(2). Available at: https://enerlac.olade.org/index.php/ENERLAC/article/view/213
53. Cruz-Pérez N, Santamarta J, Rodríguez-Martín J, Beltrán R, García-Gil A. Photovoltaic potential of public buildings in a world Heritage city: The case of San Crist´obal de La Laguna (Canary Islands, Spain). Renewable Energy. 2023; 209: p. 357–364. Available at: https://doi.org/10.1016/j.renene.2023.03.127
54. Ali O. An experimental investigation of energy production with a hybrid photovoltaic/ thermal collector system in Duhok city. Case Studies in Thermal Engineering. 2020; 21. Available at: https://doi.org/10.1016/j.csite.2020.100652
55. Boretti A. Integration of solar thermal and photovoltaic, wind, and battery energy storage through AI in NEOM city. Energy and AI. 2021; 3. Available at: https://doi.org/10.1016/j.egyai.2020.100038
56. Vargas-Salgado C, Aparisi-Cerdá I, Alfonso-Solar D, Gómez-Navarro T. Can photovoltaic systems be profitable in urban areas? Analysis of regulation scenarios for four cases in Valencia city (Spain). Solar Energy. 2022; 233: p. 461-477. Available at: https://doi.org/10.1016/j.solener.2022.01.057
57. Aziz A, Naim-Tajuddin M, Adzman M, Ramli M, Mekhilef S. Energy Management and Optimization of a PV/Diesel/Battery Hybrid Energy System Using a Combined Dispatch Strategy. Sustainability. 2019; 11(3). Available at: https://doi.org/10.3390/su11030683
58. Imam A, Al-Turki Y, Kumar R.. Techno-Economic Feasibility Assessment of Grid-Connected PV Systems for Residential Buildings in Saudi Arabia—A Case Study. Sustainability. 2020; 12(1). Available at: https://doi.org/10.3390/su12010262
59. Iqbal S, Alshammari N, Shouran M, Massoud J. Smart and Sustainable Wireless Electric Vehicle Charging Strategy with Renewable Energy and Internet of Things Integration. Sustainability. 2024; 16(6). Available at: https://doi.org/10.3390/su16062487

60. Xu Y, Hu Z. Source-Grid-Load Cross-Area Coordinated Optimization Model Based on IGDT and Wind-Photovoltaic-Photothermal System. Sustainability. 2024; 16(5). Available at: https://doi.org/10.3390/su16052056
61. Morcillo-Herrera C, Hernández-Sánchez F, Flota-Bañuelos M. Practical method to estimate energy potential generated by photovoltaic cells: practice case at Merida City. Energy Procedia. 2014; 57: p. 245-254. Available at: https://doi.org/10.1016/j.egypro.2014.10.029
62. Feng X, Ma T, Yamaguchi Y, Peng J, Dai Y, Ji D. Potential of residential building integrated photovoltaic systems in different regions of China. Energy for Sustainable Development. 2023. Available at: https://doi.org/10.2139/ssrn.4014218
63. Zhu R, Wong M, Kwan M, Chen M, Santi P, Ratti C. An economically feasible optimization of photovoltaic provision using real electricity demand: A case study in New York city. Sustainable Cities and Society. 2022; 78. Available at: https://doi.org/10.1016/j.scs.2021.103614
64. Nyeche E, Diemuodeke E. Modelling and optimisation of a hybrid PV-wind turbine-pumped hydro storage energy system for mini-grid application in coastline communities. Journal of Cleaner Production. 2020; 250. Available at: https://doi.org/10.1016/j.jclepro.2019.119578
65. Rieck J, Taube L, Behrendt F. Feasibility analysis of a heat pump powered by wind turbines and PV- Applications for detached houses in Germany. Renewable Energy. 2020; 162: p. 1104-1112. Available at: https://doi.org/10.1016/j.renene.2020.07.011
66. Babatunde O, Munda J, Hamam Y. Off-grid hybrid photovoltaic – micro wind turbine renewable energy system with hydrogen and battery storage: Effects of sun tracking technologies. Energy Conversion and Management. 2022; 255. Available at: https://doi.org/10.1016/j.enconman.2022.115335
67. Kazemi K, Ebrahimi M, Lahonian M, Babamiri A. Micro-scale heat and electricity generation by a hybrid solar collector-chimney, thermoelectric, and wind turbine. Sustainable Energy Technologies and Assessments. 2022; 53. Available at: https://doi.org/10.1016/j.seta.2022.102394
68. Żołądek M, Figaj R, Kafetzis A, Panopoulos K. Energy-economic assessment of self-sufficient microgrid based on wind turbine, photovoltaic field, wood gasifier, battery, and hydrogen energy storage. International Journal of Hydrogen Energy. 2024; 52: p. 728-744. Available at: https://doi.org/10.1016/j.ijhydene.2023.04.327
69. Khare V, Khare C, Bhuiyan M. Design, optimization, and data analysis of solar-tidal hybrid renewable energy system for Hurawalhi, Maldives. Cleaner Energy Systems. 2023; 6. Available at: https://doi.org/10.1016/j.cles.2023.100088
70. CELEC EP. Estudio potencial solar fotovoltaico del Ecuador. Institucional. Quito: Corporación Eléctrica del Ecuador. Available at: https://www.celec.gob.ec/wp-

content/uploads/2024/05/Folleto-PROYECTOS-FOTOVOLTAICOS-ECU-2024-2-26-FEB.pdf

71. Urdiales L, Espinoza J, García M, Vasquez F. Energia solar en el Ecuador. Solar Power. 2015. Available at: https://www.researchgate.net/publication/291356953_Energia_solar_en_el_Ecuador
72. Chiluiza V, Bravo J. Implementation of a photovoltaic system to supply energy to a rural sector of the Gulf of Guayaquil through load analysis and software simulation. Polo del conocimiento. 2023; 8(2): p. 1647-1679. Available at: https://dialnet.unirioja.es/servlet/articulo?codigo=9152067
73. Muñoz-Vizhñay J, Rojas-Moncayo M, Barreto-Calle C. Incentive pertaining to energy the generation distributed in Ecuador. Ingenius. 2017;(19): p. 60-68. Available at: https://doi.org/10.17163/ings.n19.2018.06
74. Orozco J, Coello S. Estudio de caso: Energía Solar como recurso energético para generación de electricidad urbana. Solar Power. 2023. Available at: https://doi.org/10.13140/RG.2.2.16441.13925
75. Campos-Sánchez S, Cedeño-Palacios C, Palma-García Y, Campos-Sánchez V. Los negocios digitales y su importancia en la era actual. Ciencias económicas y empresariales. 2021; 7(1): p. 1029-1043. Available at: http://dx.doi.org/10.23857/dc.v7i1.1755
76. Morales-Sornoza J, Mora-Muñoz L, Moscoso-Garrido K, Cedeño-Merelo G, Molina-Almeida A, Litardo-Aguirre J. Evolución de los modelos de negocios, un análisis en el contexto de la economía circular. South Florida Journal of Development. 2023; 4(8): p. 3012-3026. Available at: https://doi.org/10.46932/sfjdv4n8-006
77. Ruiz-Chagna C, Terán-Silva C. Emprendimiento, promotor de las economías locales en desarrollo, experiencia del cantón Ibarra- Imbabura Ecuador. Ecociencia. 2018; 5: p. 1–22. Available at: https://doi.org/10.21855/ecociencia.50.155
78. Salgado-Monar J. El Emprendimiento en el Ecuador. Latam. 2023; 4(2): p. 4609-4634. Available at: https://doi.org/10.56712/latam.v4i2.923
79. Muñoz-Chávez R, Muñiz-Tumbaco L, Parrales-Poveda M. Plataformas virtuales: las Apps como estrategia en el emprendimiento no tradicional. Publicando. 2021; 8(31): p. 207-224. Available at: https://doi.org/10.51528/rp.vol8.id2245
80. Arteaga M, Lasio V. Empresas dinámicas en Ecuador: factores de éxito y competencias de sus fundadores. Latinoamericana de Administración. 2009; 42: p. 49-67. Available at: https://www.researchgate.net/publication/41805459_Empresas_dinamicas_en_Ecuador_factores_de_exito_y_competencias_de_sus_fundadores
81. Borja A, Carvajal H, Vite H. Modelo de emprendimiento y análisis de los factores determinantes para su sostenibilidad. Espacios. 2020; 41(24). Available at: https://www.revistaespacios.com/a20v41n24/a20v41n24p15.pdf

82. Useche-Aguirre M, Pereira-Burgos M, Barragán-Ramírez C. Retos y desafíos del emprendimiento ecuatoriano, trascendiendo a la pospandemia. Retos. 2021; 11(22): p. 271-286. Available at: https://doi.org/10.17163/ret.n22.2021.05
83. Pérez-Sisa F. Análisis bibliométrico de la competitividad en el sector manufacturero del Ecuador. Eruditos. 2023; 4(3). https://doi.org/10.35290/re.v4n3.2023.1060
84. Pesantez-Cedeño Z, Moreira-Torres E. Análisis de la tendencia de negocios digitales (e-business) en la zona de planificación 8 del Ecuador. UTA Ecuador. 2020;: p. 36-42. Available at: https://revistas.uta.edu.ec/erevista/index.php/bcoyu/article/view/1017
85. Hall S, Workman M, Hardy J, Mazur C, Anable J. Doing business model innovation for sustainability transitions — Bringing in strategic foresight and human centred design. Energy Research & Social Science. 2022; 90. Available at: https://doi.org/10.1016/j.erss.2022.102685
86. Pietrulla F, Frankenberger K. A research model for circular business models–Antecedents, moderators, and outcomes. Sustainable Futures. 2022; 4: p. 2666-1888. Available at: https://doi.org/10.1016/j.sftr.2022.100084
87. Konietzko J, Das A, Bocken N. Towards regenerative business models: A necessary shift? Sustainable Production and Consumption. 2023; 38. Available at: https://doi.org/10.1016/j.spc.2023.04.014
88. Useche-Aguirre M, Pereira-Burgos M, Barragán-Ramírez C. Retos y desafíos del emprendimiento ecuatoriano, trascendiendo a la pospandemia. Retos. 2021; 11(22): p. 271-286. Available at: https://doi.org/10.17163/ret.n22.2021.05
89. Revista Líderes. Los desafíos para el emprendedor en el Ecuador. Guayaquil. Available at: https://www.espol.edu.ec/sites/default/files/docs_escribe/Los%20desaf%C3%ADos%20para%20el%20emprendedor%20en%20el%20Ecuador.pdf
90. Salgado-Monar J. Entrepreneurship in Ecuador. Latam. 2023; 4(2). Available at: https://doi.org/10.56712/latam.v4i2.923
91. Vizueta-Tomalá V. Facts that currently affect entrepreneurship in Ecuador. Innova. 2020; 5(3.2): p. 122-133. Available at: https://doi.org/10.33890/innova.v5.n3.2.2020.1563
92. OECO. Tipologías y resultados de la Encuesta Nacional de Victimización de Casos de Extorsión Empresarial. Quito. Available at: https://oeco.padf.org/wp-content/uploads/2024/05/Radiografia-de-la-extorsion-en-Ecuador-OECO-compress.pdf

Conflicto de intereses

Los autores declaran que no hay conflicto de intereses.

Contribución de cada autor:

William Russell Pine Tobar: Participó como gestor de la idea, proceso de investigación, control de las variables de estudio y escritura preliminar.

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