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The Evaluation of Benefits Using WCMS Platforms for SMEs in E-commerce (the Case of Georgia)

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Abstract: The purpose of this paper is to identify the factors in the Georgian market that assist small and medium-sized businesses in beginning e-commerce activities. The paper's research is based on the assumption that for start-ups, small and medium-sized businesses, it is critical to take the first steps in e-commerce with as few mistakes and as few costs as possible. The ease of starting this type of business for small and medium-sized entrepreneurs stems primarily from the fact that they can build the website they want without having to hire expensive programmers or understand complex coding. All of this is provided by web content management system (WCMS) platforms. At the same time, however, the fact that the easier it is to start an e-commerce business through such platforms, the greater the competition in this market, in response to which, in the digital world, we need to constantly keep an eye on the news, trends, technological updates and innovations in this field in order to make the appropriate Implementation of issues in our business. In addition to international WCMS platforms, Georgia has several Georgian companies, about which we will provide a detailed breakdown in terms of positive and negative characteristics in the research section. Before that, it is worth noting that one of the primary benefits of using WCMS platforms from local businesses is quick support/facility (if needed). The used research methods and experience can be useful for other researchers to analyze opportunities for SMEs in any other country.

Keywords: Web content management system; SME; e-commerce.

1. Introduction

E-commerce effectively saves infrastructural investments and costs when compared to traditional commercial activities, and this is one of the reasons for the promotion of the e-commerce market in developed countries. However, it is intriguing to learn about the situation in developing countries in this regard. Although there may be more barriers to the rapid development of e-commerce in developing countries, it is worth noting that it has great potential for individuals and businesses to obtain products or services remotely, quickly, and easily.

A web page is an important tool for e-commerce because it allows the user to purchase a product or service. This type of website can be created in a variety of ways. It can be created by a specific programmer or special agencies on a private order, with your specifications and required functionalities taken into account. It is also possible to build a site using ready-made templates from various Web content management system (WCMS) platforms; this method is much easier and less expensive; however, when deciding on the creation of an e-commerce type of web page, we should first consider the business goals and Tailored to specific needs.

If the templates and functionality provided by the WCMS platforms based on the specifics of the business are sufficient, the website can be created from the mentioned WCMS platforms at the initial stage, saving a lot of resources. However, if the specifics of

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the business are calculated on the specific functionality of the web page and it is necessary to develop an individual design and concept, it is preferable to build the site from start to finish with full software protection.

E-commerce is rapidly growing in Georgia. According to Nationals Statistics Office of Georgia, 23.8% of local internet users were using e-commerce services in 2022 (5.2 percentage point growth between 2016-2022). Additionally, the size of Georgian e-commerce market will be grown by 21.4% according to recent forecasts (Dec 2022) from Statista.

2. Literature Review

F. Kotler and G. According to Armstrong, digital marketing is a type of direct marketing that electronically connects consumers with sellers through interactive technologies such as email, websites, online forums and newsgroups, interactive television, mobile communications, and more [1].

In their study "A Comparative Study of Web Content Management Systems," Jose-Manuel Martinez-Caro et al. demonstrate how a WCMS can be managed and what can be accomplished by using it. As examples, the study uses three of the most popular WCMS platforms: Joomla!, WordPress, and Drupal. The study used a comparative methodology to compare the advantages, disadvantages, difficulties, and security of each platform, with three sites of equal purpose registered separately on each of the three platforms. The research presented in the work is founded on the aforementioned research methodology. As a result, we can conclude that WCMS is a flexible and simple way to create and manage a website [2]. The popularity of such platforms stems primarily from the fact that they are widely available, which means that anyone with no knowledge of software or coding can create a website on their own [3-4].

Yuansheng Wei and Yuxuan Dong investigated the incentives of retailers in marketplace-type businesses to mediate merchants through the online sales channel using an analytical model in their latest 2022 study "Product distribution strategy in response to the platform retailer's marketplace introduction." The study discovered that the main motivation was income from commissions on products sold on the site, as well as products created exclusively for their platforms by retailers, which added additional image and reputation to the platforms [5].

Another research provides several reasons why e-commerce in developing countries lags behind statistical data from developed countries. According to the article, developing countries represent a massive e-commerce market. E-commerce is cited in academic research as a good strategy and an ideal opportunity for developing countries to explore new economic avenues [6].

Mesut Savrula, Ahmet Incekarab and Sefer Senerb in their 2014 paper described how SMEs can benefit the new environment via e-commerce. Their findings show that company size can be also a disadvantage to competing in a global platform of e-commerce [5].

Several recent articles are also discussing the role of entrepreneurship education for E-commerce managers in modern business [8-9].

The research also studied articles that analyze evaluation criterias for WCMS platforms (see methodology part). The UI/UX design principles described in the paper by Hakam W. Alomari, Vijayalakshmi Ramasamy, James D. Kiper, and Geoff Potvin serve as the foundation for the ease-of-use criterion [10]. The research offers guidelines that make it simpler for people to interact with the web page interface based on user experience.

The technical functionality and security criterion are relied upon a study published by Jose-Manuel Martinez-Caro and co-authors which compares the 3 leading WCMS platforms, listing the technical functionalities necessary to build a user-friendly site [2].

Since the site directly reflects the image of the company, its visual side is one of the important factors, so if the user decides to build the site from the WCMS platform, the platform must have many template designs, be diverse and should fit the company's brand. Gabriel Almeida Lucas and others, in their study based on user experience, emphasize the impact of site design on the buying process [11].

The evaluation tools to understand the differences between different WCMS platforms (WordPress VS DRUPAL VS JOOMLA) are also reviewed in an article by Iqbal et. al; 2020 [12].

3. Materials and Methods

The study employs a comparative methodology, which entails the development of three demonstration sites with the same structure. Georgian CMS platforms will be used to build each site. The research will look at the various functionalities and designs of Georgian CMS platforms, as well as payment systems, ease of use, security, and tariffs.

Table 1. Evaluation criteria of WCMS platforms used in the study

Criteria	Method	References
Ease of use	Observing the process of assembling simulated registered sites by the researchers participating in the study and receiving feedback from them.	Alomari et. al; 2020
Technical functions	Determining and evaluating the number of technical functionalities available on the platform.	Martinez-Caro et. al; 2018 Iqbal et. al; 2020
Template design	Determining the number of template designs in the system and analyzing the technical capabilities (how much it is possible to make changes to the template, change the color, text font or image frame size, etc.).	Martinez-Caro et. al; 2018 Iqbal et. al; 2020 Lucas et. al; 2023
Integration of payment systems	Assessment of the possibility of adding payment methods (how many payment methods can be added to the site).	Lucas et. al; 2023
Safety	To determine by what method they ensure the security of transactions.	Martinez-Caro et. al; 2018 Iqbal et. al; 2020
Tariffs	Pricing and comparison	_

source: The table was built by the authors.

Three pre-selected people were tasked with building the site in order to evaluate the ease of use of the web page control panel. People involved in the study were given the basic structure of the site, menu items, product categories, images, text descriptions, and other necessary materials so that they could work in the control panel with the already prepared materials. The personal observation was carried out in parallel with the work process. Respondents were chosen from a personal network of acquaintances who had no prior contact with WCMS. They were tasked with platform registration, template design selection, site visual assembly from the control panel, uploading pre-sent text and photo materials, product input, and simulation integration of payment systems. The site assembly process in the www.b2c.ge system took place on 10.05.2022-12.05.2022, and the site assembly dates in the www.site.namespace.ge system were 13.05.2022-15.05.2022, as for www.desk.ge in this system Assembly took place on 21.05.2022-26.05.2022.

Platform selection criteria:

1. www.site.namespace.ge was selected as the most experienced company that has been operating in the Georgian market since 2014.

2. Selected as having the lowest subscription fee.

3. Based on the statistical data of the international analytical platform as of May 1, 2022, the CMS platform www.b2c.ge (https://trends.builtwith.com/shop/country/Georgia) occupies the second place in the Georgian market, which led to the selection of the mentioned company. and examination.

In addition to direct observation, the participants in the study filled out the following questionnaire:

• Rate the ease of building a site from the WCMS platform on a scale of 1 to 5 points:
o Very difficult
o Moderately difficult
o Neither difficult nor easy
o Moderately easy
o Very simple

• On a scale of 1 to 10, how diverse were the technical functionalities in the control panel?

• Was there a template design in the system?

• How many payment methods were integrated into the control panel?

3. Results

A. Platform www.b2c.ge

The main findings of the researcher on the mentioned platform are:

• The process of registering on the site turned out to be simple;

• The name of the menu items in the control panel and several terminologies turned out to be difficult for the researcher to understand;

• The researcher was unable to upload the product without the help of the video tutorial.

As a result of observation during the researcher's work, we can conclude that a small textual description of the terminology given in the control panel would simplify the user's perception of the term's purpose.

The researcher's observation and final summary of the work process are presented in the form of a table:

Table 2. Summary of findings on www.b2c.ge

Criteria:	Rate
Ease of use	Harder than average
Plenty of technical functionality	4 points out of 10
Template design	12 pieces template design
Integration of payment systems	22 different payment methods
Safety	Secure Sockets Layer (SSL) protocol
Tariffs	Averagely expensive

source: Authors' desk research.

Platform www.desk.ge

The main findings of the researcher on the mentioned platform are:

• The process of registering on the site turned out to be simple;

• The researcher spent a lot of time choosing the template design since there were 64 different designs;

- The control panel of the site has become easy to understand for the researcher;
- The functionality required for the online store was presented, but the system functionality required for embedding plugins for social networks and statistics counters was less available.

As a result of observation during the researcher's work, we can conclude that, despite the control panel and easy site configuration, it is necessary to add system functionalities so that the platform can keep up with modern technological developments.

The researcher's observation and final summary of the work process are presented in the form of a table:

Table 3. Summary of findings on www.desk.ge

Criteria:	Rate
Ease of use	Very simple
Plenty of technical functionality	6 points out of 10
Template design	64 pieces template design
Integration of payment systems	9 different payment methods
Safety	Secure Sockets Layer (SSL) protocol
Tariffs	Cheap

source: Authors' desk research.

Platform www.namespace.ge

The main findings of the researcher on the mentioned platform are:

- The process of registering on the site turned out to be difficult since direct registration is not possible;
- The system does not stand out in terms of the variety of template design, although this cannot be considered a drawback, since the platform is based on WordPress, so it is possible to use many plugins or blocks, which also creates visual variety;
- The control panel of the site was so difficult for the researcher that he could not manage it on his own without help;
- The platform was characterized by functional diversity, as the researcher was able to build several interesting functions tailored to the needs of the business he registered.

The researcher's observation and final summary of the work process are presented in the form of a table:

Table 4. Summary of findings on www.namespace.ge

Criteria:	Rate
Ease of use	Very simple
Plenty of technical functionality	6 points out of 10
Template design	64 pieces template design
Integration of payment systems	9 different payment methods
Safety	Secure Sockets Layer (SSL) protocol
Tariffs	Cheap

source: Authors' desk research.

In addition, the results of all three companies for visibility are given in the form of a table, where the evaluations of all 3 platforms included in the study are given, according to 6 predefined criteria:

Table 5. Summary on findings of all selected WCMS platforms used in the study

	CMS	Number of Functionals	Number of Design	Number of Payment Methods	Safety	Price
B2C	Moderately difficult	4 points out of 10	12	22	SSL	99 Gel
Desk	very simple	8 points out of 10	64	9	SSL	14.99 $
Namespace	very difficult	7 points out of 10	15	according to demand	SLL; IP Address.	99 Gel

source: Authors' desk research.

5. Conclusions and Recommendations

The flexibility and simplicity of WCMS platforms contribute to their popularity and widespread use. Most importantly, it does not necessitate a large sum of money or specialized programming knowledge. The aforementioned factors contributed to their global popularity, though the situation is different in Georgia, where similar platforms are not widely used. Even though the local market is quite small, Georgia has six WCMS platform providers. In this study, three concrete WCMS platforms from the Georgian market are chosen, and the work process is discussed. These platforms are open source, and anyone can register and create their site.

In e-commerce, at the initial stage, the correct selection of the sales channel is of great importance for further development. If we consider scarce resources as one of the main problems for startups, then we can assume that saving money and human resources at the initial stage will play a big role in achieving success step by step. E-commerce sales channels can be a custom-made website, your online store built from WCMS platforms, placing products on large online marketplaces already in the market, or using mobile applications for fast delivery services.

In order to correctly select the platform from which our product or service will be sold at the initial stage, it is better to take practical steps, which means defining the needs. If the business idea is based on functionally loaded needs, for example, authorization through registration, reservation function, generation of specific documents in a personal cabinet or integration of other electronic systems, then it would be better to make a website tailored to the business needs. If the business idea is based on a simple buying and selling concept, perhaps building a personal website created from WCMS platforms available on the market or placing products on existing popular marketplaces is a more practical solution, thus saving human and financial resources. However, the latter does not exclude one or the other, and it is entirely possible to place products on other large marketplaces in parallel with the personal web page.

Creating a personal web page that is tailored to the needs of a specific business necessitates the involvement of people from various professions, such as web developers, UX/UI designers, and web administrators, and the need for people from other professions may increase depending on the specific needs. In this case, the rate for site creation is calculated on an individual basis.

A site registered through WCMS platforms is simple to manage and does not usually necessitate the involvement of a web developer. When selecting a platform, we should be

guided by the needs of the business, what kind of technical functionalities should be on the web page, how the platform ensures the site's security, whether the uploading of the assortment of products is limited, whether the visual diversity of the site is provided, and the other components discussed in the research section.

The role of mobile applications in e-commerce is growing in popularity, as this direction is based on fast delivery service, which in turn provides logistical flexibility. For example, in the local market, there is a Georgian company called "Elvis," as well as international companies called "Glovo" and "Wolt." Similar platforms were primarily aimed at the food sector; however, increased market demand for fast delivery services has led to the development of so-called Q-commerce, which is rapidly expanding into other areas. As a result, for newcomers, this is one of the best channels for increasing sales of their products or services.

To summarize, aspiring entrepreneurs must first define their business needs and then match them with the various sales channels available in the market.

Management systems need to be more loaded with technological functionality, which can be said to be a general recommendation for all 3 WCMS platforms provided in the study. The innovative, technological, and digital improvements that have already been thoroughly tested on the worldwide market should be put into practice right away. In addition, none of them has a clear competitive advantage. It is necessary to promote the field from their side, which may be due to the support of startups and budding entrepreneurs.

Since the worldwide technical sector is expanding and improving quickly, it is essential to incorporate comparable technological advancements on Georgian WCMS platforms as well, so that locals can access high-quality web services based on user experience.

The proper choice of sales channel is crucial for future development in e-commerce in the beginning stage. Saving money and human resources, in the beginning, will likely play a significant part in achieving success step by step if we view a lack of resources as one of the major issues facing startups. A unique website, your online store created on WCMS platforms, listing products on sizable online marketplaces already in existence, or employing mobile applications for quick delivery services are all examples of e-commerce sales channels. The best course of action is to take practical measures, which entails outlining the demands, in order to properly choose the platform from which our product or service will be marketed at the beginning stage.

- It would be preferable to entrust the creation of a website tailored to business needs to a programmer if the business idea is based on functionally loaded needs, such as authorization through registration, reservation functionality, generation of specific documents in a personal cabinet, or integration of other electronic systems.
- If the business idea is based on a simple concept of buying and selling, perhaps creating a personal website using WCMS platforms that are currently on the market or listing things on already-established, well-known marketplaces is a more workable approach, saving both time and money. The latter does not, however, preclude either option, and it is completely feasible to list products on other significant marketplaces concurrently with the own website.

The majority of the time, a website registered through WCMS platforms does not need the assistance of a web developer and it is easy to manage. Yet, as I already stated, the requirements of the business should continually serve as a guide when selecting a platform.

The importance of mobile applications in e-commerce is growing as this industry's focus is on quick delivery, which in turn allows for flexible logistics. For instance, there are international "Glovo" and "Volt" as well as a Georgian company called "Elvis" on the local market. Such platforms were primarily targeted at the food industry, but as the market's desire for speedy delivery services expanded, the so-called Q-commerce emerged and is now expanding to embrace more and more industries. Because of this, one of the best ways for newcomers to enhance the sales of their goods or services is in this route.

In summary, it can be said that new entrepreneurs should first define their business need and match it with the various sales channels available in the market.

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Application of Natural Language Processing to Extract Consumer Behaviors from Product Reviews

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Abstract: Understanding consumer behavior is essential for effective marketing strategies. Market research often employs conventional qualitative analysis to uncover the motivations driving consumer purchases. However, a small sample size limits the ability to draw population-level conclusions, while analyzing large-scale data can be time-consuming. Moreover, qualitative research is prone to human error, subjectivity, and bias, leading to potentially misleading results. To tackle these issues, Natural Language Processing (NLP) is utilized to extract consumer behavior from large-scale product review datasets. The study focuses on product reviews for luxury cars, smart TVs, bread, and soaps to examine complex, dissonance-reducing, habitual, and variety-seeking purchasing behavior, respectively. The results, categorized using the Perceived Value Scale and sorted based on cluster size and ranking indicate that consumer purchase intentions are influenced by perceived economic (#3), emotional (#1), social (#4), and quality (#2) value, respectively in complex purchasing behavior. Dissonance-reducing behavior was found to be primarily driven by perceived quality value (#1), while habitual purchasing behavior was observed to be influenced by perceived economic (#3), emotional (#1), and quality (#2) value, respectively. Lastly, variety-seeking behavior was found to be guided by perceived emotional (#2) and quality (#1) value in purchase decisions, respectively. Therefore, NLP demonstrated an efficient, cost-effective, and unbiased approach to extracting consumer behaviors from large-scale product reviews.

Keywords: marketing research, consumer behavior, consumer perceived value, perceived value scale, purchase intention, qualitative analysis, artificial intelligence, natural language processing, topic modeling, Latent Dirichlet Allocation

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1. Introduction

1.1 Background

Marketing is a field that heavily relies on understanding consumer behaviors. Consumer behavior knowledge helps marketers understand the needs and wants of their target audience, enabling them to offer appropriate products to their customers [17]. Consumer behavior knowledge also helps marketers market and position their products successfully [9]. Recent research in this area has focused on understanding consumer purchase intention toward products. Previous studies have proposed four value dimensions that can influence consumer purchase intention, including perceived economic, emotional, social, and quality value [12,21].

Qualitative research is often used by marketers to understand why consumers behave and purchase products in certain ways. This type of research typically involves non-

numerical, contextualized, and unstructured data such as open-ended questionnaires. However, conventional qualitative research is criticized for its subjectivity, which can be partially attributed to the human analysis of data [1,2]. This method can also be time and cost-consuming, particularly when dealing with large-scale data. In addition, the poor quality of qualitative research can lead to inaccurate findings. Qualitative research with a small sample size may also be insufficient for population-level summaries. Additionally, there are limitations to qualitative research, including potential human error, self-selection bias, and poor questions or designs from researchers [1,2].

Natural language processing (NLP) is a subfield of Artificial Intelligence (AI) [18,20] that focuses on endowing computers with the ability to comprehend human language. This technology utilizes computational linguistics, statistical analysis, and machine learning algorithms to enable computers to process textual data and understand its meaning, intent, and sentiment. In recent years, NLP has been applied to various types of data sources, including open-ended feedback from customer satisfaction surveys and notes in electronic medical records (EMR) [1,2,8,11]. These studies have demonstrated the potential of NLP to capture the overall themes and analyze the content of large-scale unstructured data. Furthermore, NLP can significantly reduce the time and cost involved in analytical processes.

Thus, NLP has the potential to enhance conventional qualitative marketing research, as suggested by previous studies[2,6,10,16]. The current study collected large-scale product reviews for luxury cars [16], smart TVs, bread, and soaps from commercial websites in the U.S. These products were selected because they are associated with complex, dissonance-reducing, habitual, and variety-seeking purchasing behaviors, respectively. Applying NLP, consumer behavior-related terms were extracted from these large-scale datasets. Finally, these terms are categorized based on Perceived Value (PERVAL) and evaluated.

2. Literature review

2.1 NLP-enhanced Qualitative Research

Abram conducted a qualitative research study in 2018, employing a conventional method to unravel the significance of registered nurses' professional role in substance use disorder treatment [1]. The research shed light on the multifaceted responsibilities and contributions of these nurses in addressing substance abuse issues, revealing valuable insights into their crucial role in patient care. In a subsequent study conducted in 2020, Abram, et al. further explored the integration of Natural Language Processing (NLP) using the Latent Dirichlet Allocation (LDA) algorithm into the previous research [1,2]. The incorporation of NLP demonstrated notable advantages, including time and cost savings, highlighting the potential of this technology in enhancing qualitative research processes and analysis [2].

Furthermore, in 2019, Koleck, et al. utilized NLP techniques to process and analyze symptom information extracted from Electronic Health Records (EHR) [11]. The research showcased the potential of NLP in extracting valuable insights from unstructured clinical data, offering a promising approach to improving healthcare decision-making and patient outcomes. In 2022, Hagg, et al. conducted a study that investigated the growing utilization of LDA in the field of psychological science [8]. The research explored the applications of LDA in analyzing psychological data and its potential for advancing research in the field, providing valuable insights into human behavior and cognition.

The Latent Dirichlet Allocation (LDA) algorithm, proposed by Blei, et al. in 2003, is widely used for topic modeling of qualitative data [3]. This algorithm enables the extraction of topics from large-scale datasets, facilitating comprehensive analysis and understanding of textual information. Additionally, in 2014, Sievert, et al. introduced a method called "LDAvis" aimed at enhancing the visualization, interpretability, and comprehensibility of results obtained from LDA topic modeling [19]. The research focused on improving the effectiveness of visualizations, enabling researchers to gain deeper insights from

the extracted topics and better understand the underlying patterns and structures in their data.

2.2 PERVAL Model

On the other hand, Sweeney et al. developed the Perceived Value (PERVAL) model, which aims to evaluate customers' perceptions of the value of consumer durable goods at a brand level [22]. The term "consumer perceived value" refers to consumers' overall assessment of a product's utility based on their perceptions. The PERVAL model encompasses four dimensions: (1) emotional value, (2) social value, (3) economic value, and (4) quality/performance value [22]. Figure 1 presents the adopted PERVAL model in this study, which serves as a framework to evaluate the outcomes derived from NLP analysis.

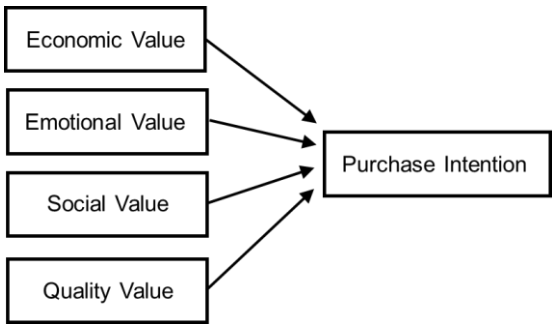

Figure 1. PERVAL Model for this Study

2.3 Research Gap

The rapid adoption of NLP and LDA topic modeling in various fields has indicated its potential application to business-related issues. Within the realm of marketing research, primary data, specifically product reviews obtained directly from customers, play a crucial role in understanding consumer purchasing behaviors. However, traditional qualitative research methods often prove to be time-consuming, particularly when dealing with large-scale datasets. Previous studies have demonstrated the cost-efficacy of Natural Language Processing (NLP) in extracting valuable information from textual data across various domains [2,8,11]. Hence, the current study aims to investigate the potential of NLP and LDA topic modeling in improving the efficiency and effectiveness of qualitative analysis in marketing research, specifically focusing on the extraction of meaningful insights from product reviews and understanding consumer behavior more comprehensively.

3. Research Methodology

3.1 Data Collection

This study involves the collection of large-scale raw data sets from product reviews. Four products are selected based on their distinct association with a specific consumer purchasing behavior [17], rather than their individual attributes or industry, as outlined below. Data sets are available at: https://github.com/pnetsiri/JEBI.

3.1.1 Complex Purchasing Behavior

For this purchasing behavior, product reviews of luxury cars were chosen as they are associated with complex purchasing behavior. Luxury car consumers tend to be highly

involved in the purchasing process and conduct extensive research before committing to a purchase. The data set was obtained from 809 product reviews of a Mercedes-Benz luxury car, collected from the website of CarMax, Inc. (www.carmax.com/reviews/mercedes-benz) in 2003. CarMax, Inc. is currently the largest retailer of pre-owned vehicles in the U.S., and its website offers large-scale product reviews of cars sorted by brand. The number of product reviews collected (809 records) is sufficient to make a population-level summary for this study, and the data set is appropriate as it represents the luxury car segment of the car market. A sample of the product and product review is shown in the previous publication [16].

3.1.2 Dissonance-reducing Purchasing Behavior

For the purpose of studying dissonance-reducing purchasing behavior, product reviews for smart TVs were chosen due to the high level of involvement consumers have in the purchase process, coupled with the difficulty in selecting a brand. The dataset used in this study consists of 1,937 product reviews of a Samsung AU8000 smart TV, collected from the Amazon.com Inc. website in 2023 (www.amazon.com/SAMSUNG-55-Inch-Crystal-AU8000-Built/dp/B08Z21BBWK/). As the current largest e-commerce company in the U.S., Amazon provides a vast array of product reviews of smart TV grouped by brand and model to the public. The large number of records (1,937 records) collected from this source is sufficient for a population-level summary of the study. Moreover, this dataset is relevant for this study because smart TV consumption could represent a segment of the TV market.

3.1.3 Habitual Purchasing Behavior

For extracting habitual purchasing behavior, product reviews for bread were selected because consumers of bread typically have minimal involvement with the brand and purchase their preferred bread. A raw data set consisting of 1,188 product reviews of Sola Sweet and Buttery Bread was collected from Amazon.com Inc.'s website in 2023 (www.amazon.com/Sola-Keto-Bread-Sweet-Buttery/dp/B082G8Z5JN/). Amazon.com Inc. is currently the largest e-commerce company in the U.S., offering large-scale product reviews of bread grouped by brand to the public. A large number of product reviews (1,188 records) obtained from this website is sufficient for making a population-level summary in this study. Moreover, this data set is relevant for the study because bread consumption could represent a segment of the bread market.

3.1.4 Variety-seeking Purchasing Behavior

The aim of this study was to extract variety-seeking purchasing behavior from product reviews of soaps, as consumers often buy new soaps not because they were dissatisfied with the previous one, but because they wanted to try something new such as a new scent. The raw data set included 904 product reviews of Dove Beauty Bar Skin Cleanser, collected from Amazon.com Inc. (www.amazon.com/Dove-Beauty-Bar-Shea-Butter/dp/B002TSA93Y/) in 2023, the current largest e-commerce company in the U.S. Their website provides large-scale product reviews of soaps grouped by brand to the public. The number of reviews (904 records) is considered sufficient to make a population-level summary for this study, and the data set is appropriate as soap consumption represents a segment of the soap market.

3.2 Pre and Post-processing

This study followed two stages of research methodology: (1) pre-processing, which involved preparing the data for analysis through standardization and formatting, and (2) post-processing, which entailed analyzing and visualizing the data [2,16]. The original data was collected in Excel format and then converted to JSON format. The study made

use of several primary packages and modules including NumPy (numpy.org) for scientific computing, Gensim library (pypi.org/project/gensim/) for topic modeling, NLTK library (www.nltk.org) for NLP, pyLDAvis library (pypi.org/project/pyLDAvis/) for interactive topic model visualization, and Jupyter Notebook (jupyter.org) for web-based interactive development. The Python program (Python.org) used in the study is available at: https://github.com/pnetsiri/JEBI.

During the first stage, standard data pre-processing methods were employed to prepare the data for NLP. This involved (1) standardizing text case to lower case, (2) removing stop words (such as "and", "or", "but", and "the"), and punctuation, and (3) stemming words (removing word endings to focus on the word root). Excluding bad data and words that do not contribute to the identification of relevant themes is also a standard process in many qualitative research approaches. A sample of the data after preprocessing is shown in the previous publication [16].

During the post-processing stage, the topic modeling [2,15,23] was performed using Latent Dirichlet Allocation (LDA) [2,3,5,13] from the Gensim library. The LDA output was used to develop topic themes and an overall theme for the data to conduct a qualitative assessment. Additionally, the pyLDAvis library was utilized to visualize the topics estimated by LDA [16,19]. This visualization tool provides both a global view of the topics and the top 10 terms associated with each topic [2,16]. The first topic (Topic 1), depicted as the largest red bubble, was selected for further analysis due to its largest size, suggesting its most significant influence from product reviews. The larger the bubble is, the more frequently the topic is found in the documents [19]. These top 10 terms from Topic 1 are categorized based on the PERVAL model. Since these terms might have multiple meanings, their categorization was manually determined by examing the entire context of the corresponding sample review. For example, if the context indicates an emotion, the term is categorized as an emotional value. Finally, each PERVAL value is sorted based on the cluster size and ranking of terms within each category. The cluster size refers to the number of terms within a category.

4. Results

4.1 Complex Purchasing Behavior

This section focuses on examining the purchasing behavior of consumers by analyzing product reviews of luxury cars. For interpretation, Topic 1 in Figure 2 was selected (38.6% of tokens). The top 10 relevant terms associated with this topic were identified and ranked as: "car" (noun), "great" (adjective), "love" (noun), "good" (adjective), "ride" (verb), "smooth" (adjective), "comfortable" (adjective), "gas" (noun), "mercedes" (noun/brand), and "mileage" (noun). These terms indicate the underlying concept of consumer behavior in this context. Table 1 provides a summary of the terms, sample reviews, and sentiments related to this complex purchasing behavior, with all sample reviews expressing positive sentiments. Lastly, Table 2 provides a summary of the terms, and ranks (#) grouped by their value category. The category and sentiment for each term were manually identified by examing the entire context of the corresponding sample review in Table 1.

Table 1. Terms, Sample Reviews, and Sentiments Related to Complex Purchasing Behavior

Rank (#)	Term	Sample Review	Sentiment
1	car	This **car** is an amazing driving machine.	positive
2	great	It is a **great** car all around.	positive
3	love	I **love** this car and all of its features.	positive
4	good	This is a great car to drive and has enough power to make it feel **good**	positive
5	ride	It's a beautiful car, handling is great, **ride** is smooth and acceleration like no other.	positive
6	smooth	I found this beautiful car to be one of the **smooth**est most conservative machines on the road.	positive
7	comfortable	This is a very **comfortable** and great looking car.	positive
8	gas	Great **gas** mileage and you will just look good driving in comfort.	positive
9	mercedes	The **Mercedes** C300 is an affordable and classy automobile.	positive
10	mileage	Solid performance and good gas **mileage**	positive

Table 2. Categories, Terms, and Ranks Related to Complex Purchasing Behavior

Category and Rank (#)	Term and Rank (#)
Economic value (#3)	mercedes (#9), mileage (#10)
Emotional value (#1)	**car (#1), love (#3), good (#4), ride (#5), smooth (#6), comfortable (#7)**
Social value (#4)	mercedes (#9)
Quality value (#2)	great (#2), excellent (#6), gas (#8), mileage (#10)

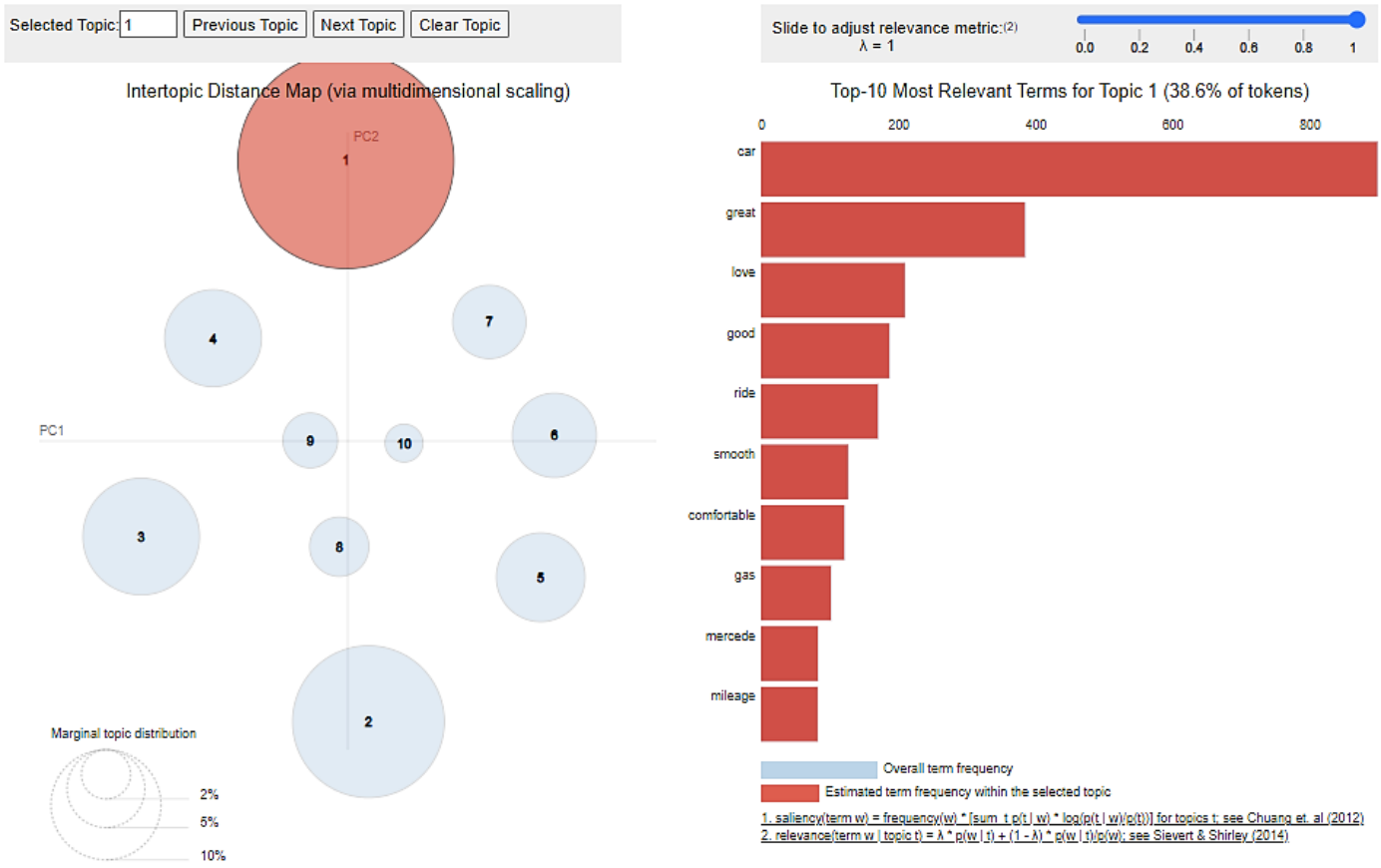

Figure 2. Topic 1 and Top 10 Terms Related to Complex Purchasing Behavior

4.2 Dissonance-reducing Purchasing Behavior

This section focuses on examining the purchasing behavior of consumers by analyzing product reviews of Smart TVs. For the purpose of interpretation, Topic 1 in Figure 3 was selected (37% of tokens). The top 10 relevant terms associated with this topic were identified and ranked as: "picture" (noun), "remote" (noun), "great" (adjective), "sound" (noun), "samsung" (noun), "quality" (adjective), "good" (adjective), "feature" (noun), "smart" (adjective), and "app" (noun). These terms indicate the underlying concept of consumer behavior in this context. Table 3 provides a summary of the terms, sample reviews, and sentiments related to this dissonance-reducing purchasing behavior. One sample review, marked by ** in Table 3 exhibited dissonance-reducing purchasing behavior of comparing brands. Two sample reviews show negative sentiment, and one shows neutral sentiment associated with poor product quality, while the rest express positive sentiment. Lastly, Table 4 provides a summary of the terms, and ranks (#) grouped by their value category. The category and sentiment for each term were manually identified by examing the entire context of the corresponding sample review in Table 3.

Table 3. Terms, Sample Reviews, and Sentiments Related to Dissonance-reducing Purchasing Behavior

Rank (#)	Term	Sample Review	Sentiment
1	picture	Great **picture** quality, great sound without sound bar.	positive
2	remote	But the **remote** is not user friendly at all.	**negative**
3	great	**Great** colors and clarity for the picture.	
4	sound	I'm assuming the **sound** quality is just average due to fact that this tv is so thin.	**neutral**
5	samsung	I like the TV. I went from a Sony Bravia to this **Samsung**. I made a great choice.**	positive
6	quality	Good **quality** TV for the price, picture looks nice and sharp	positive
7	good	**Good** TV for the price.	positive
8	feature	First smart TV I have owned and love the **features**.	positive
9	smart	Crystal clear picture, perfect "**smart**" features.	positive
10	app	TV was slow and **app** integration was really poor.	**negative**

****Exhibition of dissonance-reducing purchasing behavior**

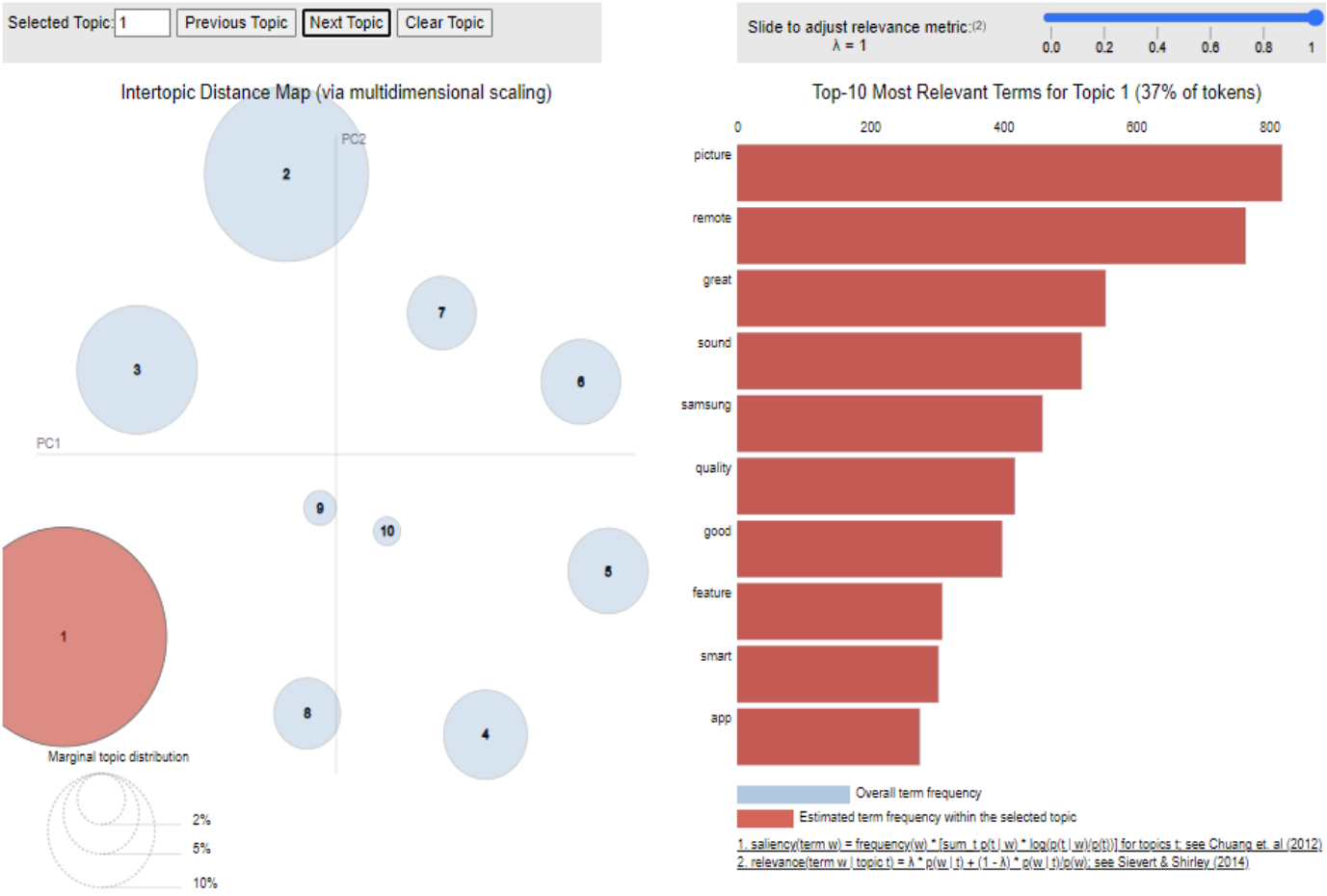

Figure 3. Topic 1 and Top 10 Terms Related to Dissonance-reducing Purchasing Behavior

Table 4. Categories, Terms, and Ranks Related to Dissonance-reducing Purchasing Behavior

Category and Rank (#)	Term and Rank (#)
Economic value	
Emotional value	
Social value	
Quality value (#1)	**picture (#1), remote (#2), great (#3), sound (#4), samsung (#5), quality (#6), good (#7), feature (#8), smart (#9), app (#10)**

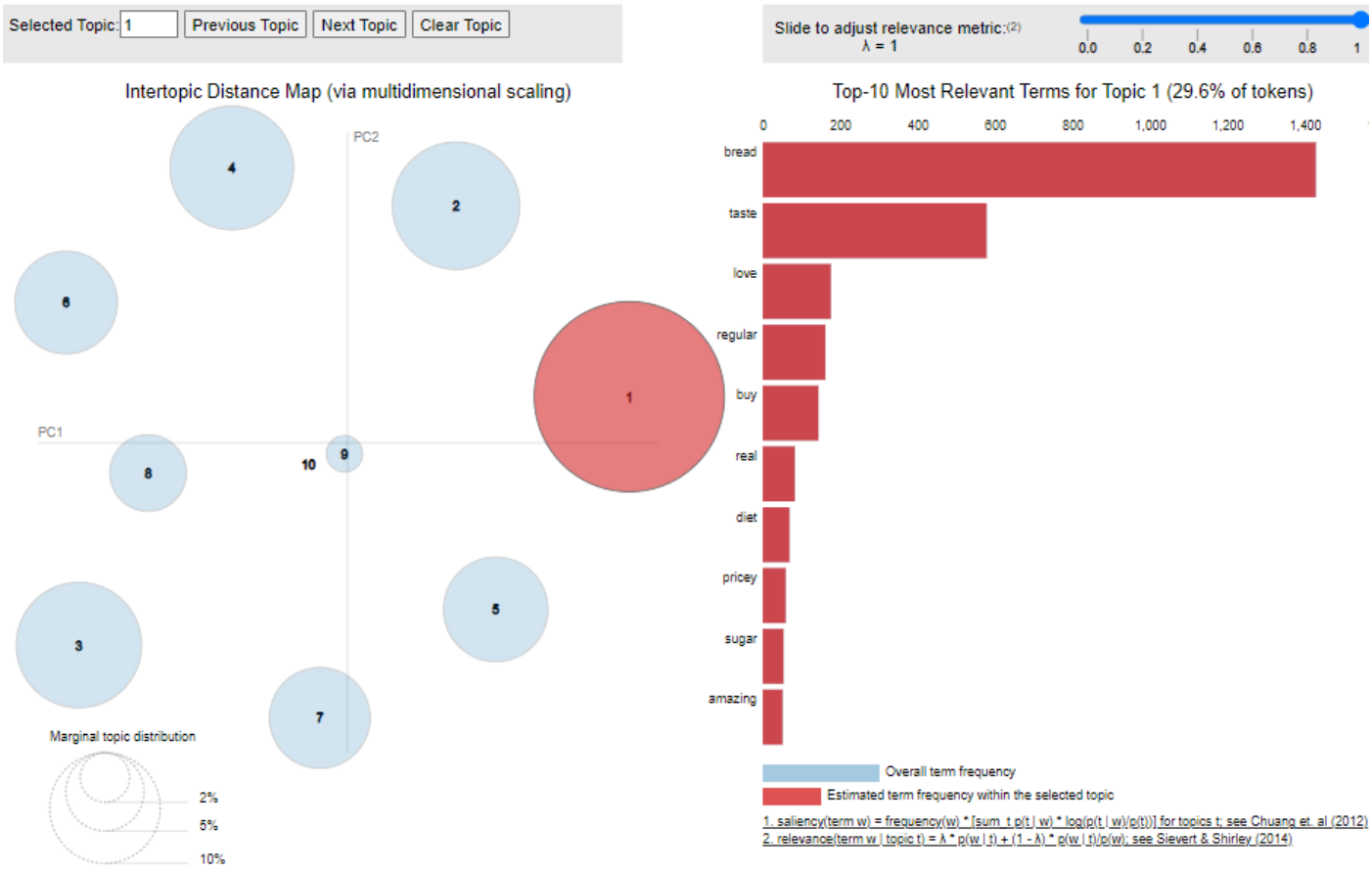

Figure 4. Topic 1 and Top 10 Terms Related to Habitual Purchasing Behavior

4.3 Habitual Purchasing Behavior

This section focuses on examining the purchasing behavior of consumers by analyzing product reviews of bread. For interpretation, Topic 1 in Figure 4 was selected (29.6% of tokens). The top 10 relevant terms associated with this topic were identified and ranked as: "bread" (noun), "taste" (noun), "love" (verb), "regular" (adjective), "buy" (verb), "real" (adjective), "diet" (noun), "pricey" (adjective), "sugar" (noun), and "amazing" (adjective). These terms indicate the underlying concept of consumer behavior in this context. Table 5 provides a summary of the terms, sample reviews, and sentiments related to this habitual purchasing behavior. Two sample reviews, marked by *** in Table 5 exhibited the habitual behavior of re-purchasing. One sample review expresses a negative sentiment associated with the high price of the product, while the remaining reviews show positive sentiment.

Lastly, Table 6 provides a summary of the terms, and their ranks (#) grouped by their value category. The category and sentiment for each term were manually identified by examing the entire context of the corresponding sample review in Table 5.

Table 5. Terms, Sample Reviews, and Sentiments Related to Habitual Purchasing Behavior

Rank (#)	Term	Sample Review	Sentiment
1	bread	This is the best low carb **bread** out there	positive
2	taste	It has a surprisingly good **taste**.	positive
3	love	**Love** this low carb bread!	positive
4	regular	This is the closest bread that I have found that tastes like **regular** bread	positive
5	buy	Will continue to **rebuy** this again.***	positive
6	real	Will buy again fresh and good taste like **real** bread.***	positive
7	diet	Excellent flavor and excellent for my **diet**!	positive
8	pricey	It's a little **pricey**, but I've found anything Low Carb costs more.	**negative**
9	sugar	This is a great bread for the keto diet and for diabetes since it has no **sugar**.	positive
10	amazing	**Amazing** flavor, wonderful texture.	positive

***** Exhibition of habitual purchasing behavior**

Table 6. Categories, Terms, and Ranks Related to Habitual Purchasing Behavior

Category and Rank (#)	Term and Rank (#)
Economic value (#3)	pricey (#8)
Emotional value (#1)	**taste (#2), love (#3), regular (#4), buy (#5), real (#6), amazing (#10)**
Social value	
Quality value (#2)	bread (#1), diet (#7), sugar (#9)

4.4 Variety-seeking Purchasing Behavior

This section focuses on examining the purchasing behavior of consumers by analyzing product reviews of soaps. For interpretation, Topic 1 in Figure 5 was selected (47.2% of tokens). The top 10 relevant terms associated with this topic were identified and ranked as: "soap" (noun), "skin" (noun), "dove" (noun/brand), "bar" (noun), "smell" (noun), "great" (adjective), "butter" (noun), "buy" (verb), "scent" (noun), and "sensitive" (adjective). These terms indicate the underlying concept of consumer behavior in this context. Table 7 provides a summary of the terms, sample reviews, and sentiments related to this variety-seeking purchasing behavior, with all sample reviews expressing positive sentiments.

Table 7. Terms, Sample Reviews, and Sentiments Related to Variety-seeking Purchasing Behavior

Rank (#)	Term	Sample Review	Sentiment
1	soap	I really like using the **soap**.	positive
2	skin	This soap works the best for my **skin**, and for shaving	positive
3	dove	**Dove** leaves my face clean and feeling soft.	positive
4	bar	Does exactly what I would hope a **bar** of soap to do.	positive
5	smell	Good cleansing, pleasant **smell**, & long lasting.	positive
6	great	**Great** moisturizer for sensitive skin.	positive
7	butter	Love the Shea **butter** scent.	positive
8	buy	I'm a first-time **buy**er of Dove Shea Butter. I am impressed and really loving it.****	positive
9	scent	Leaves my skin soft, pleasant **scent**!	positive
10	sensitive	I have **sensitive** skin and this stuff doesn't bother at all... give it a shot!****	positive

****** Exhibition of variety-seeking purchasing behavior**

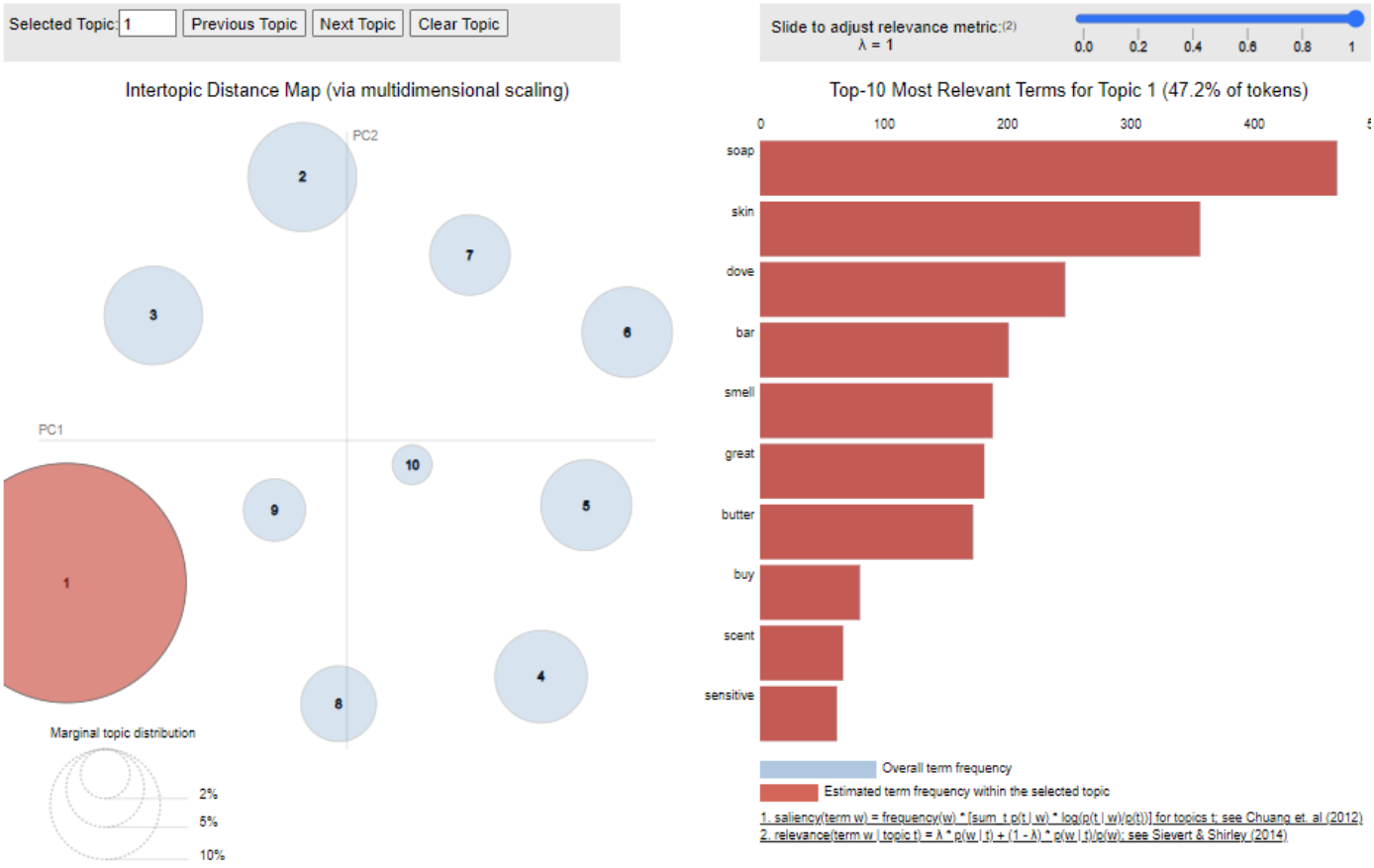

Figure 5. Topic 1 and Top 10 Terms Related to Variety-seeking Purchasing Behavior

Table 8. Categories, Terms, and Ranks Related to Variety-seeking Purchasing Behavior

Category and Rank (#)	Term and Rank (#)
Economic value	
Emotional value (#2)	dove (#3), smell (#5), butter (#7), buy (#8), scent (#9)
Social value	
Quality value (#1)	**soap (#1), skin (#2), bar (#4), great (#6), sensitive (#10)**

Two sample reviews, marked by **** in Table 7 exhibited variety-seeking purchasing behavior of trying something new. All sample reviews express positive sentiments. Lastly, Table 8 provides a summary of the terms, and their ranks (#) grouped by their value category. The category and sentiment were manually identified for each term by examing the entire context of the corresponding sample review in Table 7.

5. Discussion

In this study, the focus was on the analysis of the top 10 terms of the first topic extracted using NLP. These terms were categorized and explored to understand their potential influences within the PERVAL model for economic, emotional, social, and quality values. The additional analysis included ranking (#) these values based on the total cluster size and the rank of terms within each category.

5.1 Complex Purchasing Behavior

5.1.1 Economic Value (#3)

The ranking of this category in Table 2 suggests that economic value holds the third strongest influence on purchase intention. The influence was found positive, as suggested by its sentiments. Terms such as "mercedes" and "mileage" express the economic value associated with the luxury car, respectively. The third strongest influence suggested that the luxury car market is well-established and the price is no longer the primary driver for consumers when purchasing luxury cars. These results align with a previous study conducted by another research group [12].

5.1.2 Emotional Value (#1)

Drawing from the first ranking of this category in Table 2, it can be inferred that emotional value exerts the strongest influence on purchase intention. The influence was found positive, as suggested by its sentiments. Therefore, perceived emotional value strongly affects consumers' intentions to buy luxury cars. This result aligns with a previous study [12], which suggests that luxury car usage brings joy to consumers. Experiencing joy and pleasure plays a crucial role in driving a specific behavior. Terms such as "love", "good", "smooth", and "comfortable" reflect consumers' positive experiences with their luxury cars. Thus, a perceived emotional value significantly influences consumers' intentions to purchase luxury cars.

5.1.3 Social Value (#4)

Based on the fourth ranking of this category in Table 2, it is indicated that social value has the weakest influence on purchase intention. The influence could be positive, as suggested by its sentiment. Hence, consumers may partially believe that owning luxury cars can showcase their social status, supporting previous studies [12]. This finding weakly reinforces the understanding that individuals are concerned about their social identities and tend to choose luxury products to create and maintain a desirable self-image for the public. The term "mercedes" can signify consumers' social status associated with owning

these luxury cars. Consequently, perceived social value shows weakly influence on consumers' intentions to purchase luxury cars.

5.1.4 Quality Value (#2)

According to the second ranking of this category in Table 2, the quality value was identified as the second strongest influence on purchase intention. The influence can be positive, as suggested by its sentiments. Luxury products are often associated with symbolic meanings such as exclusivity, high quality, aesthetics, prestige, and craftsmanship. This finding aligns with previous studies [12]. Terms such as "great", "excellent", "gas", and "mileage" convey the quality value of luxury cars. Therefore, the perceived quality value is found to influence consumers' intentions to purchase luxury cars.

In conclusion, for the complex purchasing behavior observed, consumers' perceived emotional, quality, economic, and social values can influence their purchase intentions regarding luxury cars, respectively. The influence was found positive, suggested by the sentiments. Furthermore, examining the attributes associated with each term can provide additional insights into their corresponding perceived value. Term "smooth", "love", and "comfortable" elicit specific feelings associated with the product. According to the findings, emotional value emerges as the most influential factor in purchase intentions toward luxury cars. Thus, it is observed that providing the highest quality product is not the most crucial aspect of marketing luxury cars. Instead, the development of positive emotions associated with luxury cars is observed to be of utmost importance. Additionally, the positive economic value is found to be of lesser importance while a positive social status linked to luxury cars is found to be of the least importance.

5.2 Dissonance-reducing Purchasing Behavior

5.2.1 Economic Value

No terms in this topic were found to associate with economic value. Consequently, the perceived economic value was observed to have no influence on consumers' purchase intentions regarding smart TVs.

5.2.2 Emotional Value

No terms in this topic were found to relate to emotional value. Therefore, the perceived emotional value was found to not influence consumers' purchase intentions toward smart TVs.

5.2.3 Social Value

No terms in this topic were found to pertain to social value. Hence, the perceived social value was found to not affect consumers' purchase intentions regarding smart TVs.

5.2.4 Quality Value (#1)

As the terms are exclusively found within this category in Table 4, it strongly suggests that quality value is the sole factor influencing purchase intention. Terms such as "picture", "remote", "great", "sound", "samsung", "quality", "good", "feature", "smart", and "app" represent the quality value of smart TVs, respectively. Therefore, perceived quality value is the sole factor that can influence consumers' intentions to purchase smart TVs. This finding aligns with a previous study [7], which highlights the significance of quality and features in attracting customers to TV brands. Furthermore, the influences were found positive, neutral, or negative, as suggested by their sentiments.

In conclusion, for the dissonance-reducing purchasing behavior observed, consumers' perceived quality value is the only factor that can influence their purchase intentions toward smart TVs. Furthermore, examining the attributes associated with each term can

provide additional insights into their corresponding perceived value. Terms such as "picture", "remote", "great", "sound", "samsung", "quality", "good", "feature", "smart", and "app" represent specific qualities associated with the product, respectively. According to the findings, quality value emerges as the primary influencer of purchase intentions toward smart TVs. Therefore, providing the best quality product is found to be the most important aspect of marketing them.

5.3 Habitual Purchasing Behavior

5.3.1 Economic Value (#3)

According to the third ranking of this category in Table 6, economic value exhibited the weakest influence on purchase intention. Therefore, perceived economic value only weakly affects consumers' intentions to purchase bread. The term "pricey" represents the economic value of the bread. Furthermore, the influence is found negative, as suggested by its sentiment.

5.3.2 Emotional Value (#1)

Based on the first ranking of this category in Table 6, it is indicated that emotional value holds the strongest influence on purchase intention. The influence was found positive, as suggested by its sentiments. Therefore, perceived emotional value strongly influences consumers' intentions to purchase bread. Terms such as "taste", "love", "regular", "buy", "real", and "amazing" express the emotional value associated with the bread, respectively. This finding aligns with a previous study that highlights issues such as staling and bad taste as significant factors contributing to bread wastage [4].

5.3.3 Social Value

No terms in this topic were found to relate to social value. Consequently, the perceived social value was found to have no influence on consumers' purchase intentions regarding bread.

5.3.4 Quality Value (#2)

According to the second ranking of this category in Table 6, the quality value was observed to have the second strongest influence on purchase intention. The influence was found positive, as suggested by its sentiments. Terms such as "bread", "diet", and "sugar" represent the quality value of the bread, respectively. Therefore, perceived quality value influences consumers' intentions to purchase bread. This result is consistent with a previous study [4], which emphasizes that quality is a primary consideration for consumers when choosing bread. Bread producers should prioritize product quality.

In conclusion, for the habitual purchasing behavior observed, consumers' perceived emotional, quality, and economic values can influence their purchase intentions regarding bread. Furthermore, examining the attributes associated with each term can provide additional insights into their corresponding perceived value. Terms such as "taste", "love", "regular", "buy", "real", and "amazing" evoke specific emotions associated with the product. According to the findings, emotional value emerges as the primary influencer of purchase intentions toward bread. Therefore, it is found that providing the best quality product may not be the most crucial aspect of marketing bread. Instead, developing positive emotions associated with bread is found to be of utmost importance. Furthermore, developing a positive economic value associated with bread is found to be of lesser importance.

5.4 Variety-seeking Purchasing Behavior

5.4.1 Economic Value

No terms in this topic were found to relate to economic value. Consequently, the perceived economic value was found to have no influence on consumers' purchase intentions regarding soaps.

5.4.2 Emotional Value (#2)

Based on the second ranking of this category in Table 8, it is suggested that emotional value holds the second strongest influence on purchase intention. The influence was found positive, as suggested by its sentiments. Terms such as "dove", "smell", "butter", "buy", and "scent" express the emotional value associated with soaps, respectively. Therefore, perceived emotional value influences consumers' intentions to purchase soaps. This finding aligns with a previous study [14], which highlights the strong relationship between soap brands and purchasing decisions.

5.4.3 Social Value

No terms in this topic were found to relate to social value. Consequently, the perceived social value was found to have no influence on consumers' purchase intentions regarding soaps.

5.4.4 Quality Value (#1)

Based on the first ranking of this category in Table 8, the quality value is found to exert the strongest influence on purchase intention. The influence was found positive, as suggested by its sentiments. Terms such as "soap", "skin", "bar", "great", and "sensitive" represent the quality value of the soap. Thus, perceived quality value strongly influences intentions to purchase soaps. This finding is consistent with a previous study [14].

In conclusion, for the variety-seeking purchasing behavior observed, consumers' perceived emotional and quality values can influence their purchase intentions regarding soaps. Additionally, examining the attributes associated with each term provided further insights into their corresponding perceived value. Terms such as "dove", "smell", "butter", "buy", and "scent" evoke specific emotions associated with the product, respectively. Similarly, terms such as "soap", "skin", "bar", "great", and "sensitive" represent specific qualities of the soap. According to the findings, quality value emerges as the primary influencer of purchase intentions toward soaps. Therefore, providing the best quality product is found to be the most important aspect of marketing them. Furthermore, developing a positive emotional value associated with soap is observed to be of secondary importance.

Data interpretation in the conventional method is typically based on the initial design of the study, whereas the NLP method relies on the topics selected by the researcher [2,8,11]. One notable advantage of the NLP method is the absence of subjectivity, bias, and errors introduced by humans. Additionally, the conventional method is time-consuming and expensive as it relies on manual data processing by humans. In contrast, the NLP method offers faster and more cost-effective analysis since it automates various tasks. Overall, qualitative analysis utilizing NLP provides several advantages in comparison to conventional methods. These advantages include increased efficiency and cost-effectiveness, along with the elimination of bias, error, and subjectivity. However, it's important to note that the NLP method requires careful preprocessing, setup, and adjustments to ensure accurate and meaningful results.

5.5 Future Research

Netsiri et al. [16] have identified several potential applications arising from their study. One such application is in the field of marketing, where the identified terms could be used to guide the creation of strategies. Product designers could also leverage these

terms, rankings, and categories to optimize their designs to attract customers. Manufacturers, on the other hand, could use this information to improve the quality and economic value of their products.

Further research should explore the possibility of using this method to extract various other types of information that may be useful in marketing and related fields. For instance, by analyzing customer feedback, topic modeling could help identify significant terms and provide insights into topics that could positively influence the customers.

6. Conclusions

The purchasing decisions of consumers are intricate and have multiple dimensions. In this study, NLP was applied to extract different consumer-perceived values related to purchasing intentions toward luxury cars, smart TVs, bread, and soaps, respectively. These products represent different consumer behaviors including complex, dissonance-reducing, habitual, and variety-seeking purchasing, respectively. The data was collected from product reviews posted on commercial websites and analyzed using NLP and LDA topic modeling.

The study found that for complex purchasing behavior, consumers' perceived emotional, quality, economic, and social value were found to influence their intentions to purchase, respectively. For dissonance-reducing purchasing behavior, the solely perceived quality value was found to influence purchase intentions. For habitual purchasing behavior, the perceived economic, emotional, and quality value was found to influence purchase intentions, respectively. Finally, for variety-seeking purchasing behavior, the perceived emotional and quality value was observed to influence purchase intentions, respectively.

The terms identified in the study not only indicate perceived values toward purchase intention but also provide insights into their corresponding perceived values [16]. For example, the word "smooth" can indicate a joyful and pleasant feeling associated with driving a luxury car. The rank and cluster size associated with each value category could also assist marketers to prioritize and optimize their marketing strategy. Thus, NLP presents a promising technique to perform qualitative analysis for efficient, cost-effective, and unbiased extraction of meaningful information for marketing research.

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Conflicts of Interest: The authors declare no conflict of interest.

Data Availability Statement: Data sets and Python code are available to download at: https://github.com/pnetsiri/JEBI.

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Efficiency Assessment of Mozambican Banks: A Slacks-Based Measure of Efficiency Approach

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Abstract: This study aims at assessing the efficiency of the banking sector in Mozambique. Data Envelopment Analysis (DEA) models were applied for that purpose. Concretely, the non-radial output-oriented Slacks-Based Measure (SBM-O) model under the assumption of variable returns to scale was applied to assess the technical efficiency of banks. This study can be considered one of the first to apply the SBM model to assess the efficiency of banks in Mozambique. Data for the fiscal year 2020 of 16 commercial banks operating in Mozambique were collected. Three input variables were considered: total assets, operating costs, and deposits; and two outputs: net interest income and loans. According to the results, the average efficiency of the Mozambican banking sector was 72.4%, which reveals a low performance of the sector. The SBM-O model found eight efficient banks, which was considered as a reference set for inefficient banks. The results gained can help bank managers in decision-making, especially for those banks classified as inefficient.

Keywords: Banks, Efficiency, DEA, SBM model.

1. Introduction

The existence of an efficient financial system is a fundamental condition for Mozambique's sustainable economic and social development. A financial sector that allocates resources efficiently is the engine that drives economic growth in any country (Kamau, 2011). On the other hand, a strong financial system encourages investment through financing productive businesses, mobilizing savings, and facilitating commercial activities, and the financial sector as a whole plays a key role in the allocation of financial resources in the economy (Kizito, 2012). Evaluating the performance of banks is important because if financial institutions work more efficiently, they will have more profit and increase the liquidity of the economy. Without efficient financial institutions, it is very difficult to sustain the country's economic growth (Nguyen, 2007).

The strength of a banking sector is directly affected by various variables (internal and external) with an impact on economic growth and the welfare of a stable and efficient banking system, especially for emerging economies (Güneş and Yıldırım, 2016; Fernandes, Stasinakis, and Bardarova, 2018). Therefore, banks try to maintain their asset's quality, efficiency, and profitability, vital requirements for survival and development (Zimková, 2014). Also, efficient use of labour, better use of time, cheaper costs, and economies of scale, among others, can contribute to achieving these goals.

An efficient banking system plays a major role in the progressive economic growth of any country (Kumar and Singh, 2014). The efficiency of the banking sector on a country basis is an important issue as the success of the entire monetary system in the financial

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system and the stability of the banking sector are affected by this activity. Although assessment of bank efficiency is common in the United States (US), Europe, and Asia, few studies are available in the African banking sector (Wanke, Maredza, and Gupta, 2017) and the same is true for Mozambique, indicating a gap in the literature.

Many studies have been developed in different areas using different techniques to evaluate the efficiency or performance of companies, as a way of responding to the financial limitations of the organizations, demonstrating that it is possible to improve prices, the offer of services, increase transparency, and accountability of governments and improving the information used to support the strategic decisions (Worthington and Dollery, 2000).

For this purpose, new methodologies have been proposed to measure the efficiency of the most diverse entities. Among these methodologies is the Data Envelopment Analysis (DEA), a non-parametric method based on mathematical programming (linear programming), which allows the evaluation of the efficiency of a set of independent and homogeneous entities usually called Decision Making Units (DMUs) that use multiple inputs to produce multiple outputs.

Within DEA, the models proposed by Charnes, Cooper, and Rhodes in 1978 (CCR) and Banker, Charnes, and Cooper (BCC) in 1984 are the main models widely applied to measure efficiency. These two models are radial, that is, models in which the inputs are reduced in the same proportion while the outputs remain constant, in the case of input-oriented models, or in which the outputs are increased in the same proportion while the inputs remain constant, in the case of output-oriented models. Such models ignore the existence of an excess of inputs or a shortfall of outputs, normally called slack.

One of the problems associated to the efficiency value obtained through the CCR and BCC models is exactly that of not accounting for inefficiencies due to slack in inputs and/or outputs, which can lead to the DMU being classified as efficient, when really it is not. Several measures and models have been proposed in the literature to circumvent this problem, such as the SBM of Tone (2001).

The article is organized into six chapters. Following the introductory chapter, there is the second chapter, the literature review, which deals essentially with efficiency analysis studies carried out in the banking sector using DEA. The third chapter presents the Data Envelopment Analysis (DEA) and describes the Slacks-Based measure (SBM) in DEA. The fourth chapter presentsthe data and variables selected for the study. The fifth chapter is dedicated to the results and their respective discussion. The sixth chapter presents a summary of the main conclusions and some recommendations for future studies.

2. Literature Review

Data Envelopment Analysis (DEA) is seen as the most widely used non-parametric technique for efficiency measurement, especially in banking (Berger and Humphrey, 1997; Ali and Seiford, 1993). A bank's efficiency means that the bank can deliver its service with the minimum possible resources or produce the maximum possible products and services using a limited amount of input. The efficiency of the banking system is the most important issue in the financial market, as it affects the stability of the banking sector and then the efficiency of the country's monetary policy. There are many studies evaluating the efficiency of commercial banks using the DEA method; Reviews of these various studies are presented as follows:

In the international literature, the work of Sherman and Gold (1985) is considered by many authors to be a pioneer in the application of DEA methodology to analyze efficiency at the banking sector (Daraio and Simar, 2007; Liu et al., 2013; Forsund and Sarafoglou, 2002; 2005). In this pioneering study, the authors explored the use of DEA as a novel approach that can help to improve bank branch efficiency by providing efficiency information that goes beyond what accounting data provides. In other words, the study of Sherman and Gold (1985) provided the basis and inspiration for other studies applying the DEA methodology to be developed in the banking sector.

A range of studies evaluates efficiency in the financial sector using DEA, especially radial and non-radial models. It can be highlighted, for example, some studies involving radial models such as those made by Ataullah et al., (2004), Casu and Molyneux (2003), Favero and Papi (1995), and McAllister and McManus (1993). Radial models represented by CCR and BCC models are those in which the inputs are reduced in the same proportion while maintaining the outputs (input-oriented), or the outputs are increased in the same proportion keeping the level of inputs (output-oriented). Conversely, non-radial models, represented by the Additive and SBM models, do not assume the same proportionality relationship. This implies that an increase or decrease in the input does not necessarily imply a proportional change in output.

Pastor, Perez, and Quesada (1997) compared the efficiency, productivity, and differences in technologies of different European and US banks in 1992. In their study, 168 banks in the USA, 67 in France, 59 in Spain, 44 in Austria, 31 in Italy, 22 in Germany, 18 in the UK, and 17 in Belgium were selected and they used the DEA approach to investigate the efficiency levels of banks. They chose two inputs non-interest expenses and personal expenses, and three outputs loans, other productive assets, and deposits. According to his findings on cross-country efficiency scores, banks in Spain, Denmark, and Portugal were the most technically efficient banks. Banks from France and Italy were found to be less efficient. They also found that banks in the USA, Austria, and Germany were scale-inefficient.

The study conducted by Baidya and Mitra (2012) aimed at measuring and evaluating the technical efficiency of 26 Indian public sector banks for the 2009–2010 fiscal year. CCR and Andersen and Petersen's super efficiency model were used as DEA models. The results reveal that the average technical efficiency of the entire sample was 86.5% and only seven banks (23%) were fully efficient. Thus, 19 public sector banks in India have an efficiency improvement scope. The study found that banks that use more workforce to deliver their services are relatively inefficient.

Yıldırım (1999) conducted research on the efficiency of the Turkish banking sector by using the DEA method between 1988-1996. Guney and Tektas (2006) analyzed the efficiency of the Turkish banking sector during the crisis period using DEA, between 1990-2001. Şakar (2006) applied DEA Malmquist Index to study the efficiency and productivity of banks in Turkey between 2002 and 2005. Budak (2011) applied DEA to evaluate the efficiency of banks in Turkey in 2008, 2009, and 2010. In this study, the basic DEA models (CCR and BCC) were applied.

Raphael (2012) investigated the efficiency of commercial banks in Tanzania using a DEA from 2008 to 2011. The study used three input variables (deposit, interest, and operating expenses) and four output variables (credit, investment, interest income, and non-interest income). The analysis showed that most of the commercial banks in Tanzania are technically inefficient. Large banks outperformed smaller banks in terms of size. According to the study, commercial banks should minimize the use of input resources while maintaining the same level of output to increase technical efficiency. Gizaw (2019) in his study used DEA, to assess the technical and scale efficiency of private commercial banks in Ethiopia.

One of the first studies that used the SBM model, proposed by Tone (2001), was the application carried out in 24 commercial banks in Taiwan to evaluate and predict the performance of these banks (Liu, 2009).

In another study, Avkiran (2011) evaluated the efficiency of Chinese banks after economic liberation, marked by China's entry into the World Trade Organization in 2001, and presents the usefulness of DEA as a reference standard for investors, regulators, and society in general. The study was carried out with the financial information of 21 Chinese commercial banks to evaluate the profitability approach, using financial and non-financial expenses and income variables. In this case, the SBM model was appointed as the appropriate technique to assess efficiency. The author also states that financial indicators, normally used by the market, are not capable of discriminating against the efficiency of banks

(Avkiran, 2011). In this study, the author compared the results obtained by nine DEA models and the research concluded the SBM model is the most adequate, even when compared to the CCR and BCC models, stating that the SBM model is capable of presenting more discrimination between the DMUs (Avkiran, 2011).

The SBM model was applied to evaluate the efficiency of 130 banks in Indonesia between 2003 and 2007 (Hadad et al., 2012). One can also refer to a study carried out in Canada that used the SBM model to evaluate the efficiency of 1000 bank branches in that country. The study showed that even though belonging to the same bank, each branch carries out its stats and demands different management capabilities (Paradi, Zhu, and Edelstein, 2012).

Zinková (2014) analyzed the technical efficiency and super efficiency of a representative sample of commercial banking institutions in Slovakia. In this study, the CCR model, the SBM model by Tone (2001), and the super-efficient model by Tone (2002) were applied. According to the results, Komerční bank, a foreign bank branch, was found to be a super-efficient banking institution operating under variable returns to scale in 2012 in the Slovak Republic.

Chiu and Chen (2009) suggest that the SBM model provides a good representation of banking operations in real situations since banks are given a certain degree of control on both the input and output sides.

Kasim et al., (2019) applied the super-efficiency model based on SBM (SuperSBM) to assess the efficiency of nine commercial banks in Malaysia between 2004 and 2013. In this study, the selected banks were able to be ranked according to their efficiency scores.

Shah et al.(2022) analyzed the impact of non-performing loans on the operational efficiency of commercial banks in Pakistan. In this study, Super-SBM model with the undesirable output for the efficiency evaluation of commercial banks was used.

Nabilah and Al Arif (2022) applied DEA to analyze the efficiency of Islamic banks. In this study, in addition to determining the level of efficiency of the banks, the authors sought, through a regression model, difference-in-difference (DID), to understand the impact of the spin-off policy and other factors that affect the level of efficiency of the banks.

Boubaker et al. (2022) applied inverse DEA to evaluate the performance and efficiency of 49 Islamic banks in 10 countries during the period of the COVID-19 pandemic (2019-2020), to assess how these banks can preserve their performance and remain resilient after the pandemic.

Ben Lahouel et al., (2022) applied the combination of the CAMELS rating system and DEA to calculate the financial stability of European banks after the global financial crisis and during the implementation of Basel III liquidity rules.

Amirteimoori et al., (2023) applied DEA to measure scale elasticity in a set of 71 Indian banks over a period of eight years (1998-2005).

Wu et al., (2023), applied DEA and Tobit Regression to analyze the impact of interest rate liberalization on the efficiency of 27 commercial banks in China between 2006 and 2020.

Marlina et al. (2023) applied DEA Window Analysis to measure the level of efficiency of Islamic banks in Indonesia between 2011-2016.

In the case of Mozambique, two studies are highlighted that applied some DEA models to assess the efficiency of banks in that country (Wanke, Barros, and Emrouznejad, 2016; Lemequezane, 2020). Wanke, Barros, and Emrouznejad (2016) applied Fuzzy-DEA and bootstrapping to assess the productive efficiency of banks. In turn, Lemequezane (2020) applied DEA Malmquist Index to assess the productivity of banks. Aside from these studies, none was found that portrays the SBM model to assess the efficiency of the Mozambican banking sector. Thus, the authors see the present study as one of the first to apply the DEA-SBM model in the Mozambican banking sector.

3. Data Envelopment Analysis

Data Envelopment Analysis (DEA) was developed by Charnes, Cooper, and Rhodes (CCR) (Charnes et al., 1978) under the assumption of constant return to scale (CRS) and later modified by Banker, Charnes and Cooper (BCC) under the assumption of variable returns to scale (VRS) in 1984 (Banker et al., 1984). The basic ideas of DEA were developed based on the pioneering work of Farrell (1957). DEA is a non-parametric technique that uses mathematical programming (linear programming) to measure the relative efficiency of homogeneous units that consume multiple inputs to produce multiple outputs. These units, in the DEA literature, are called Decision Making Units (DMUs), in our case banks.

The inputs correspond to the resources used, and the outputs are goods or services obtained as a result of the production process. CCR or CRS model occurs when any variation in the inputs produces an equal proportional variation in the outputs. On the other hand, BCC or VRS model replaces the axiom of proportionality with the axiom of convexity, which means that a variation in the inputs produces a greater or lesser variation than the proportional one in the outputs, allowing DMUs with low values of inputs have increased returns to scale and DMUs with high input values have decreased returns to scale.

Normally, the efficiency value is obtained from two perspectives, input-oriented and output-oriented. There are also non-oriented models. In the input-oriented model, efficiency is achieved by minimizing inputs while maintaining at least the quantity of outputs. In turn, in the output-oriented model, efficiency is achieved by maximizing outputs while maintaining the level of inputs. The choice of orientation for the models varies according to the company's objectives, the control they have over inputs and outputs, and the socio-economic context.

In this study, output-oriented models under the assumption of variable returns to scale (VRS) were chosen. The envelope model used to calculate the efficiency of DMUs under the assumption of variable returns to scale (BCC model or VRS) is represented as follows (Cooper, Seiford, and Zhu, 2004):

$$\phi^* = \max \phi + \varepsilon \left(\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+ \right) \tag{1}$$

Subject to:

$$\sum_{j=1}^{n} x_{ij} \lambda_j + S_i^- = x_{io} \;\; i = 1,2,\ldots,m \tag{2}$$

$$\sum_{j=1}^{n} y_{ij} \lambda_j - S_i^+ = \phi y_{ro} \;\; r = 1,2,\ldots,s \tag{3}$$

$$\sum_{j=1}^{n} \lambda_j = 1 \tag{4}$$

$$\lambda_j \geq 0 \;\; j = 1,2,\ldots,n \tag{5}$$

Where: $\phi^*$is the optimal value; s_i^- represents input excesses; s_i^+ represents output shortfalls, in the literature, they are called slacks; λ_j are the values that allow determining the reference set for the inefficient DMUs; $\varepsilon > 0$ is a very small positive value than any real number (non-Archimedean), generally considered $\varepsilon=10^{-6}$ (Cooper, Seiford and Tone,

2000). For output-oriented CCR and BCC models $\phi^* \geq 1$. A DMUo is said to be efficient if and only if $\phi^* = 1$ and all slacks are zero ($S_i^{-*} = S_r^{+*} = 0$).

3.1. Slacks-based Measure of Efficiency

This study employs the non-parametric SBM in Data Envelopment Analysis under the assumption of VRS to assess the efficiency of commercial banks in Mozambique. The SBM model was proposed by Tone (2001) and deals directly with input and output slack to generate an efficiency index that is invariant to the measurement units for both input and output variables. More generally, this measure is the same when, x_{io} and x_{ij}, are replaced by $k_i x_{io} = \hat{x}_{io}$, $k_i x_{ij} = \hat{x}_{ij}$, respectively, and are replaced by $c_r y_{ro} = \hat{y}_{ro}$, $c_r y_{rj} = \hat{y}_{rj}$, where k_i and c_r $(i = 1,2,\ldots,m;\ j = 1,2,\ldots,s)$ are arbitrary positive constants. This measure has the following important properties:

1. (P1) The measure is invariant withering the measurement of each input and output item. (Units invariant).

2. (P2) The measure is monotone decreasing in each input and output slack. (Monotone).

The production possibility set *P* of SBM model can be defined as follows

$$P = \left\{ (x, y) \mid x \geq \sum_j x_j \lambda_j, y \leq \sum_j y_j \lambda_j, \lambda_j \geq 0 \right\} \tag{6}$$

To estimate the efficiency of a DMU (x_o, y_o) is formulated the index ρ represented through the following fractional program in λ, s^- and s^+:

$$\text{[SBM]} \qquad \min \ \rho = \frac{1 - \frac{1}{m}\sum_{i=1}^{m} s_i^- / x_{io}}{1 + \frac{1}{s}\sum_{r=1}^{s} s_r^+ / y_{ro}} \tag{7}$$

Subject to:

$$x_0 = X\lambda + s^- \tag{8}$$

$$y_0 = Y\lambda - s^+ \tag{9}$$

$$\lambda \geq 0, s^-, s^+ \geq 0 \tag{10}$$

This model assumes that $X \geq 0$. If $x_{io} = 0$, then the term s_i^-/x_{io} in the objective function is eliminated. If $y_{io} \leq 0$, then it is replaced by a very small positive number, so that the term s_r^+/y_{ro} plays a penalty role. It is easy to verify that the value of the objective function, ρ, satisfies property 1 (P1) since the numerator and denominator are measured in the same units for each item in the objective of (1). It is also easy to verify that an increase in any of the slacks (s_i^-, s_r^+), all else remaining constant, will decrease the value of this target, and indeed in a strictly monotonic manner.

This index takes values between 0 and 1, that is,

$$0 \le \rho \le 1 \tag{11}$$

To see that this relationship holds, let us observe that $s_i^- \le x_{io}$ for each i such as $0 \le s_i^-/x_{io} \le 1 (i = 1,2,\dots,m)$ with $s_i^-/x_{io} = 1$ only if the evidence shows that a zero amount of this input was required. It follows that

$$0 \le \frac{\sum_{i=1}^{m} s_i^- / x_{io}}{m} \le 1 \tag{12}$$

This same relation does not hold for outputs because an outputs shortfall represented by non-zero slacks can exceed the corresponding quantity of outputs produced. At any case, there is

$$0 \le \frac{\sum_{r=1}^{s} s_i^+ / y_{ro}}{s} \tag{13}$$

In this way, this represents average ratios of the mixing inefficiencies in inputs and outputs with the upper bound, ρ=1, obtained only in the case where the excesses in all inputs and the shortfalls in all outputs are zero.

The index presented in model (7) can be transformed into the following product

$$\rho = \left(\frac{1}{m} \sum_{i=1}^{m} \frac{x_{io} - s_i^-}{x_{io}} \right) \left(\frac{1}{s} \sum_{r=1}^{s} \frac{y_{ro} + s_r^+}{y_{ro}} \right)^{-1} \tag{14}$$

The ratio $\frac{x_{io}-s_i^-}{x_{io}}$ evaluates the relative reduction rate of input i, and, therefore, the first term corresponds to the mean proportional reduction rate of inputs or input mix inefficiencies. Likewise, in the second term, the ratio $\frac{y_{ro}+s_r^-}{y_{ro}}$ evaluates the relative proportional expansion rate of output r and $(1/s)\sum\left(\frac{y_{ro}+s_r^-}{y_{ro}}\right)/y_{ro}$ is the mean proportional rate of output expansion. Its inverse, the second term, measures *output mix inefficiency*. Consequently, SBM ρ can be interpreted as the ratio of mean input and output mix inefficiencies. Furthermore, If DMUA dominates DMU B so that $x_A \le x_B$ and $y_A \ge y_B$, then $\rho_A^* \ge \rho_B^*$.

Let an optimal solution for [SBM] be (ρ^*, λ^*, s^{-*}, s^{+*}). Based on this optimal the solution, DMU can be defined as being SBM – efficient as follows (Tone, 2001):

Definition 1 (SBM-efficient). A DMU (x_o, y_o) is SBM-efficient if ρ^*=1. This condition is equivalent to s^{-*}=0 and s^{+*}=0, that is, no input excesses
and no output shortfalls in any optimal solution.

For a DMU (x_o, y_o) SBM inefficient, we have the following expressions:

$$x_o = X\lambda^* + s^- \tag{15}$$

$$y_o = Y\lambda^* - s^+ \tag{16}$$

DMU (x_o, y_o) can be improved and become efficient by eliminating the excess inputs and increasing the output shortfalls. This is achieved with the following formulas, called SBM Projection on the efficient frontier:

$$\hat{x}_o \Leftarrow x_o - s^{-*} \tag{17}$$

$$\hat{y}_o \Leftarrow y_o + s^{+*} \tag{18}$$

The SBM projections on the efficient frontier can also be obtained by using the set of indexes ices corresponding to the positive λ^*, the so-called reference set for (x_o, y_o). The reference set is represented by

$$R_o = \{j |\ \lambda_j^* > 0\}\ (j \in \{1, \dots, n\}) \tag{19}$$

Then using R_o we can also express $(\hat{x}_o, \hat{y}_o)$ by

$$\hat{x}_o = \sum_{j \in R_o} x_j \lambda_j \tag{20}$$

$$\hat{y}_o = \sum_{j \in R_o} y_j \lambda_j \tag{21}$$

This means that $(\hat{x}_o, \hat{y}_o)$, a point on the efficient frontier, is expressed as a positive combination of the members of the reference set, R_o, which are also efficient.

The relationship between the CCR efficiency and the SBM efficiency is given by the following theorem: A DMU (x_o, y_o) is CCR-efficient if and only if it is SBM-efficient.

The model discussed above (7) is a non-oriented model. Input-oriented or output-oriented SBM models can be obtained from model (7) by re-evaluating the numerator and denominator of that index. An input-oriented SBM model is obtained by making the denominator equal to 1. In turn, the output-oriented SBM model is obtained by making the numerator equal to 1. This study aims at maximizing the outputs while keeping the level of inputs, the output-oriented SBM model was chosen, whose expression is given by (Tone, 2001; Cooper, Seiford, and Zhu, 2004):

$$\text{[SBM-O]} \qquad \min \rho_O^* = \frac{1}{1 + \frac{1}{s}\sum_{r=1}^{s} s_r^+ / y_{ro}} \tag{22}$$

Subject to:

$$x_0 \geq X\lambda \tag{23}$$

$$y_0 = Y\lambda - s^+ \tag{24}$$

$$\lambda \geq 0, s^+ \geq 0 \tag{25}$$

The optimal values of ρ for the oriented models are always greater than or equal to the value ρ for the non-oriented model, that is, $\rho_I^* \geq \rho^*$ and $\rho_O^* \geq \rho^*$.

4. Data and variables

The population of this study consists of 20 commercial banks operating in Mozambique. Due to the lack of information for some banks, the final sample corresponds to a total of 16 commercial banks. Data were obtained through the financial reports of the banks for the year 2020 and cross-referenced with information from the reports of the Mozambican Banking Association (https://www.amb.co.mz/). Table 1 presents the list of 16 commercial banks selected for this study.

Table 1. List of 16 selected Mozambican commercial banks

No	Banks	Started year	Abbreviation
1	BIM - Banco Internacional de Moçambique, SA	1995	BIM
2	Banco Comercial e de Investimentos, SA	1996	BCI
3	Standard Bank, SA	1967	SB
4	Absa Bank Moçambique, SA	1977	ABSA
5	Banco Nacional de Investimento, SA	2011	BNI
6	FNB Moçambique, SA	2007	FNB
7	First Capital Bank, SA	2013	FCB
8	Moza Banco, SA	2008	MOZA
9	Banco Único, SA	2011	UNICO
10	Banco Mais	2016	MAIS
11	African Banking Corporation(Moçambique),SA	1999	BancABC
12	Banco Letshego, SA	2011	LETSHEGO
13	Ecobank Moçambique, SA	2000	ECOBANK
14	United Bank for Africa Moçambique, SA	2010	UBA
15	Société Générale Moçambique, SA	1999	SGM
16	Socremo Banco de Microfinanças, SA	1998	SOCREMO

Three main approaches are widely used in the literature for measuring efficiency in the banking sector, namely, production, financial intermediation, and value-added approach (Sufian and Kamarudin, 2014; Sealey and Lindley, 1977). The present study opted for the financial intermediation approach, which states that financial institutions normally employ labour, physical capital, and deposits as their inputs to produce earning assets (net interest income and loans). The financial intermediation approach is the most preferred approach among researchers investigating the efficiency of banking sectors in developing countries (Sufian and Kamarudin, 2014; Bader *et al.*,2008).

To fulfil the objectives of this study, three input variables were considered: total assets (TA), operating costs (OC), and deposits (D); and two outputs: net interest income (NII) and loans (L). The variables were chosen to take into account the various studies consulted on the analysis of efficiency in the banking sector (Zinková, 2014; Sufian and Kamarudin, 2014; Arrif and Can, 2008, among others).

Table 2 presents the descriptive statistics of the selected variables, in Metical amounts (MT or MZN), which is the currency unit of the Republic of Mozambique.

Table 2. Descriptive Statistics of the Input and Output Variables (in MZN'000)

Statistics	Total Assets	Deposits	Operating Costs	Net Interest Income	Loans
N	16	16	16	16	16
Mean	45,871.19	35,183.66	2,278.42	2,822.25	15,240.33
Std. Dev.	64,645.37	51,361.67	2,631.84	3,969.11	20,104.86
Min.	1,881.44	995,27	214,96	193,36	298,94
Max.	191,436.46	151,857.03	7,856.04	11,815.26	68,102.65

In applying DEA to measure efficiency, it is necessary to consider several principles, in addition to positive values of input and output variables. First, the "golden rule", is to achieve a reasonable level of discrimination between DMUs, the number n of DMUs must be at least three times the sum of inputs and outputs variables, that is, if m is the number of inputs and s the number of outputs, then n≥max{ms;3(m+s)} (Cooper, Seiford and Tone, 2000).

In the case of this study, this relationship holds. Second, the input variables must be independent from each other, just like the output variables. Third, there must be a positive correlation between input and output variables (Table 3).

Table 3. Correlation between input and output variables

Variables	Total Assets	Deposits	Operating Costs	Net Interest Income	Loans
Total Assets	1.000				
Deposits	0.999**	1.000			
Operating Costs	0.975**	0.974**	1.000		
Net Interest Income	0.992**	0.989**	0.968**	1.000	
Loans	0.969**	0.966**	0.965**	0,954**	1.000

**Correlation is significant at the 0.01 level (2-tailed).

5. Results and Discussion

This chapter presents the main empirical results of our study. Data were processed using the R Studio software and the results are shown in Table 4, which presents information about the CCR-O(θ_0^*), BCC-O (ϕ_O^*), SBM (ρ^*), and SBM-O(ρ_O^*) technical efficiency values. Also, there are illustrated the reference set, the respective weights (λ^*), and the slack values.

Table 4. The results of the SBM model

		CCR	BCC	SBM		Slacks in MZN'000					
No.	**Banks**	θ_O^*	ϕ_O^*	ρ^*	ρ_O^*	**Reference set and weights(λ^*)**	s_1^{-*}[TA]	s_2^{-*}[D]	s_3^{-*}[OC]	s_1^{+*}[NII]	s_2^{+*}[L]
1	BIM	1.5473	1.000	1.000	1.000		0	0	0	0	0
2	BCI	1.4995	1.000	1.000	1.000		0	0	0	0	0
3	SB	1.9733	1.072	0.851	0.888	BIM(0.30), BCI(0.45), LETSHEGO(0.25)	235	0	831	0	9525
4	ABSA	1.7684	1.000	1.000	1.000		0	0	0	0	0
5	BNI	1.000	1.000	1.000	1.000		0	0	0	0	0
6	FNB	3.2663	2.167	0.137	0.292	ABSA(0.27), LETSHEGO(0.73)	10284	15276	1113	1136	9992
7	FCB	2.2732	1.948	0.297	0.398	MAIS(0.58), LETSHEGO(0.42)	1343	3382	0	647	2202
8	MOZA	1.5014	1.000	1.000	1.000		0	0	0	0	0
9	UNICO	2.0574	1.568	0.381	0.613	BCI(0.11), ABSA(0.07), LETSHEGO(0.82)	5212	19688	777	1221	5364
10	MAIS	1.5834	1.000	1.000	1.000		0	0	0	0	0
11	BancABC	2.4138	2.007	0.235	0.440	ABSA(0.14), LETSHEGO(0.86)	5212	10236	643	1236	5252
12	LETSHEGO	1.0000	1.000	1.000	1.000		0	0	0	0	0
13	ECOBANK	2.6586	2.294	0.343	0.376	MAIS(0.38), LETSHEGO (0.17), SOCREMO (0.45)	0	642	0	337	1665
14	UBA	3.7122	2.729	0.189	0.190	MAIS(0.87), LETSHEGO(0.12), SOCREMO(0.01)	0	34	0	335	2039
15	SGM	1.8680	1.806	0.241	0.379	BIM(0.01), LETSHEGO(0.99)	4572	9732	67	1353	4013
16	SOCREMO	1.0000	1.000	1.000	1.000		0	0	0	0	0
	Mean		1.474	0.667	0.724						

From the results obtained, as shown in Table 4, the average efficiency of the Mozambican banking sector, according to the SBM model, is 72.4%. On the other hand, analysing the data, it can be said that the financial intermediation process was successfully achieved by eight commercial banks: BIM, BCI, ABSA, BNI, MOZA, MAIS, LETSHEGO, and SOCREMO. For the fiscal year 2020, these banks are classified as technically efficient, since $\rho_O^* = 1.000$. The remaining eight other banks are classified as inefficient: SB, FNB, FCB, UNICO, BancABC, ECOBANK, UBA, and SGM. From the SBM-O model, inefficient banks obtained efficiency values ranging from 19% (UBA) to 88.8% (SB). For example, UNICO bank obtained an efficiency value equal to 0.613 (61.3%). Because DEA is a benchmarking method, inefficient banks can reach the efficiency frontier if they mirror efficient banks. The eight efficient banks mentioned above constitute the reference cluster for the set of other eight inefficient banks. Therefore, the exercise here is to project inefficient banks, through good practices, to the efficiency frontier. In the table, for each inefficient bank, the reference group and the respective weights (λ^*) are presented, which must be considered, for the projection of target values, so that they can reach the efficiency frontier. For example, it can be seen that the SB bank has the BIM, BCI, and LETSHEGO banks as a reference, with weights of 0.30, 0.45, and 0.25, respectively. These weights are used to determine target values. But on the other hand, we determined the slacks that indicate how inefficient banks must increase their output (output-oriented) to reach efficiency. Thus, for the SB bank, the value s_2^{+*}[L]=9,525,000.00 means that, the achievement of efficiency would require augmenting the loans from their observed value by MZN 9,525,000.00.To achieve efficiency, FNB bank must increase net interest income and loans by MZN 1,136,000.00 and MZN 9,992,000.00, respectively. Another verified aspect, a greater number of foreign

banks, namely, SB, FNB, FCB, BancABC, ECOBANK, UBA, and SGM were classified as inefficient, which means that the financial intermediation process for those banks was not achieved in a satisfactory way. This aspect gives evidence to state that these banks should review their operating profile. One of the ways is to follow good practices, through the reference set for each of the banks. George Assaf, Barros, and Matousek (2011) carried out a study of the efficiency of nine Saudi Arabian banks in 2004. The study used the output-oriented DEA-BCC model as a basis for financial intermediation, resulting from the volume of credit granted and insurance as well as interbank deposits. The finding was that foreign banks would be inefficient technically. According to Cooper, Seiford, and Zhu (2004), the results obtained via the SBM measure reflect not only the weak efficiency values in CCR or BCC, but also the other (slack) inefficiencies as well. Therefore, the results of the SBM model can bring better discrimination between the banks compared to the radial models (CCR and BCC). In general, and taking into account the average efficiency of the sector, banks should outline management policies to increase their efficiency and productivity, especially for banks that were classified as inefficient.

6. Conclusion

The efficiency assessment of banks is of great importance because banks that can achieve efficiency and can serve as a benchmark for competing banks. In this study, the efficiency of 16 commercial banks operating in Mozambique in 2020 is assessed by using Data Envelopment Analysis (DEA) models. Concretely, the non-radial output-oriented SBM model under the assumption of variable returns to scale was applied to assess the technical efficiency of banks. On average, the efficiency of the Mozambican banking sector is 72.4%, which translates to low performance of the sector during the analysed period. Despite the low performance, half of the banks were classified as efficient and can be considered as a reference set for the other eight inefficient banks. Inefficient banks should, through good practices, that is, looking at the reference set, improve their performance to improve the efficiency and productivity of the sector. On the other hand, the results obtained in this study can help bank managers in decision-making. The efficiency analysis through DEA is affected by the number of DMUs and variables, so making comparisons, further studies are needed in the same line, using other variables. Finally, an efficiency assessment of the Mozambican banking sector considering Window Analysis, Additive, and Super-efficiency DEA models can be suggested for future research.

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Monetary Policy Challenges of the Post-Pandemic Period

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Abstract: On November 3, 2021, the Federal Reserve announced that it was ending its quantitative easing program and on December 15 announced that it would double the rate of contraction. For financial market participants and businesses, this decision was a very serious signal for the emergence of expectations of another serious wave of the global economic downturn. At a press conference following the decision to raise the base rate in March this year, Jerome Powell said that the US central bank would do everything to bring annual inflation down to 2%. According to him, the US Federal Reserve is not considering raising the base rate by 75 basis points. However, the opposite has happened: Federal Reserve has raised the federal funds rate by 75 basis points four times in a row, and so far annual inflation of over 7% has been unable to do anything, let alone bring it down to 2-3%. Analysts are asking questions: how strong is the US economy, can it withstand the anti-inflationary drug called "monetary tightening"? According to most economists, tightening monetary policy is very likely to trigger another global recession.

Keywords: Federal Reserve System, quantitative easing, federal funds rate, key rate, global inflation, quantitative tightening, mortgage-backed securities, derivatives, global recession.

1. Introduction

The term "quantitative easing" was coined and put into circulation by the US monetary authorities back in 2008, in the midst of the financial crisis. As explained in textbooks on macroeconomics, central banks must issue money in a way that does not provoke inflation or deflation. That is, the issue should ensure a balance between the commodity and money supply.

During the era of the gold-dollar standard, which lasted a quarter of a century after the end of World War II, the issuance of dollars by the US Federal Reserve was limited to US gold reserves. In other words, the "gold brake" formally acted on the issue of the dollar. In 1971, US President Richard Nixon announced the end of the exchange of dollars for gold. However, it was precisely this commitment that the United States made at the Bretton Woods Conference in 1944.

In 1976, the Jamaican Monetary and Financial Conference finally abolished the gold dollar standard and replaced it with a paper dollar standard. With the removal of the "golden brake" from the "printing press" of the Federal Reserve System, it became possible to create as many "green papers" as the main shareholders of the US Federal Reserve System wished. De facto, "quantitative easing" began back in the 70s of the last century, when the world financial system began to be flooded with a mass of dollars.

The increase in the mass of the dollar was accompanied by a rapid increase in the total US debt. After all, the dollar is credit money that enters circulation through the accumulation of debt on loans issued or through the purchase of bonds and other debt obligations. This could not but create gigantic disproportions in the American economy. The latter manifests itself in inflating giant "financial bubbles" in the stock markets.

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2. Materials and Methods

Over the past half century, the US economy has experienced several crises. The latest of these crises is the 2008-2009 crisis. It was then that the "typewriter" of the US Federal Reserve System was put into action at extremely high speed, to justify which the term "quantitative easing" was coined.

If at the end of 2007 the assets of the Federal Reserve System amounted to a little more than $800 billion, then by October 2014, when the third quantitative easing program ended, they had already reached $4.5 trillion. The expansion of the money supply was carried out mainly through the purchase of Treasury and mortgage-backed securities in the stock markets by the Federal Reserve. It should be noted, that monetary policy should be largely responsible for regulating the business cycle, which means stabilizing inflation rates and interest rates by using inflation "targeting", thus the impact of classical monetary policy channels on the economy is limited because, on the one hand, security markets are underdeveloped in some countries, and on the other hand, interest rate dynamics are more dependent on structural factors than on monetary conditions [10].

In seven years, the money supply created by the Federal Reserve almost quintupled. And this at a time when the mass of goods produced by the US economy has increased by only 20% during this time. According to all the laws of economic science, unbridled inflation should have begun. And this did not happen for the simple reason that almost the entire mass of dollars went to the stock markets, which inflated the “bubbles” of stock indices. The latter periodically exploded, which caused strong fluctuations in the American economy.

"Quantitative easing" entailed another dangerous risk: the astronomical amount of US dollars in the markets of the United States and the world contained the danger that one day the dollar could depreciate sharply and lose its status as a world currency.

Since the end of 2014, the Federal Reserve has been trying to reduce the money supply. It went really bad. By the end of 2019, it was possible to reduce the assets of the US Federal Reserve System to only $3.9 trillion. By March 2020, a "Covid pandemic" was declared. In the same month, the Fed announced the start of a new round of quantitative easing. By November 2021, Federal Reserve assets reached $8.7 trillion. That is, in just two years it has increased by 2.2 times [1].

By the way, many central banks from the very beginning of the “pandemic” act like the Federal Reserve System, i.e. expand the large-scale emission of their own currencies. From the end of 2019 to the end of 2020, the assets of all central banks in the world grew from $30.5 trillion to $41.9 trillion, i.e. by 37% (Norrestad, 2021). By 2021, the combined assets of all central banks have reached $45 trillion.

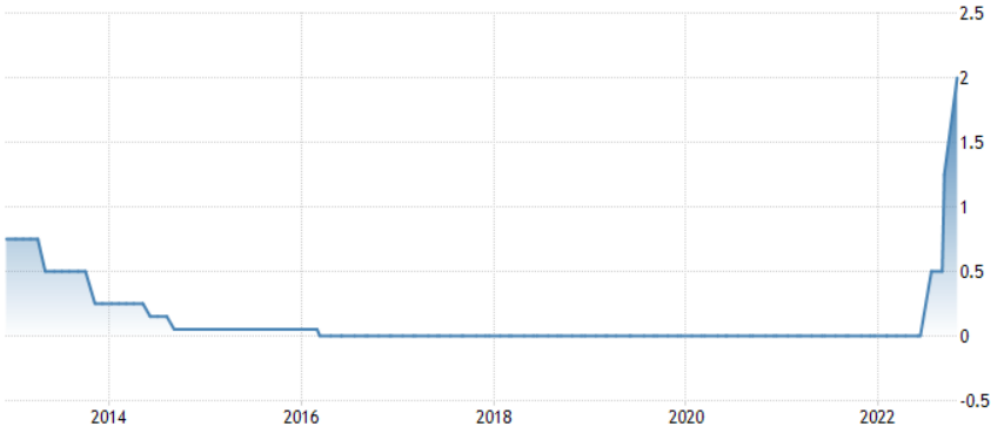
Of course, central banks that issue reserve currencies, such as the European Central Bank, the Bank of Japan, the Bank of England, the People's Bank of China, the Swiss National Bank and others, have shown the greatest issuing activity. For example, the European Central Bank doubled its assets in about two years of the “pandemic”, reaching 8.7 trillion euros in November. The total assets of four central banks - the US Federal Reserve, the European Central Bank, the People's Bank of China and the Bank of Japan - reached about $31 trillion by the end of 2021, while at the beginning of 2020 their volume reached only $20 trillion [1].

Analysts and experts are trying to guess how long the leading central banks will be able to continue such a policy of "quantitative easing". There are several versions of the alternative currency system, which we will not discuss now. We only note that the experts named such options as the revival of the gold standard in one form or another, the replacement of "old" dollars with "new" ones, the creation of a supranational monetary unit, etc.

Let's return to the policy of the central banks of the leading countries of the world. Since March of this year, a sharp tightening of monetary policy has begun, which is caused by the provocation of global inflation.

Source: https://tradingeconomics.com/united-states/interest-rate.

Figure 1. US Federal Funds Rate (2012-2022)



Source: https://tradingeconomics.com/euro-area/interest-rate

Figure 2. Base interest rates of the European Central Bank (2012-2022)

Source: https://tradingeconomics.com/united-kingdom/interest-rate

Figure 3. Base interest rates in the UK (2012-2022)

The US federal funds rate has risen to 4.5% from the current 0-0.25% in early 2022. However, in contrast to the standard BJ rise of 0.25 percentage points, this year there was a multiple increase of 0.75 percentage points, which is unprecedented in the history of the Fed. The European Central Bank has raised its benchmark interest rate from 0% to 2.5%, the Bank of England from 0.1% to 3.5%, and the Bank of Japan has kept its benchmark rate unchanged at an unusually low level of -0.1%.

Source: https://tradingeconomics.com/japan/interest-rate.

Figure 4. Base interest rates of the Bank of Japan (2012-2022)

Despite the tightening of monetary policy by the central banks of the leading countries, inflation is still very far from the target level (2-3% per year) (see Table 1).

Table 1. Annual Inflation Rates In The Leading Countries Of The World (as of October 2022)

Countries	Inflation rate (%)
USA	8,2
United Kingdom	11,1
Germany	10,4
France	6,5
Italy	11,8
Spain	9,5
European Union	11,5
Japan	3,7

Source: https://tradingeconomics.com/country-list/inflation-rate?continent=world

According to experts, these decisions mean that the global economic crisis will break out in the near future. If we take into account the accumulated imbalances in the world economy, first of all, the total world debt, which, according to the International Financial Institute, exceeds $300 trillion, the crisis will be very unusual. In terms of its devastating consequences, it will surpass all post-war crises and will probably surpass the most severe world crisis in the history of capitalism - "The Great Depression" [2].

If an economic crisis begins in America, then no amount of quantitative easing programs will be able to save the economies of other countries from an economic collapse. Crises will spread around the world like wildfire. This was the case in 2008, when the

crisis began with the collapse of the mortgage securities markets in the US, then spread to other sectors of the US economy, and a little later to Europe and the rest of the world.

In addition to the huge debt, derivative financial instruments (derivatives) are the most powerful slow-acting mine, which for some reason are rarely talked about lately. No one even knows exactly what the volume of the derivatives market is, because banks and companies do not reflect them in their balance sheets, these are off-balance sheet positions. But the total amount of derivatives (the nominal amount of derivative contracts) reaches hundreds of trillions of dollars [3].

In the mid-2000s, the total amount of unhedged derivatives, according to the Bank for International Settlements, was $1,400 trillion (1.4 quadrillion) dollars. After the 2008-2009 crisis ended, the Bank for International Settlements reduced this figure to $600 trillion, closing most of the positions, mainly through offsets.

The figures are rather arbitrary, because even the Bank for International Settlements itself does not have a complete picture of the off-balance sheet operations of banks and companies. To date, according to the most conservative estimates, the total value of all derivatives in the world has already exceeded 2 quadrillion dollars.

Recall that during the crisis of 2008-2009, the inability of many banks and companies to fulfill their obligations under derivatives led to their bankruptcy. In 2002, the famous American billionaire Warren Buffett called derivatives "a financial weapon of mass destruction."

Now let's talk more about the decisions of the US Federal Reserve System. The “quantitative easing” program launched by the Federal Reserve in March 2020 involved $120 billion in monthly securities purchases, including $80 billion in Treasury bonds and $40 billion in mortgage-backed securities.

The Federal Reserve's November 3, 2021 decision called for a $15 billion cut in monthly purchases, including $10 billion in Treasury securities and $5 billion in mortgages. The Federal Reserve's decision of December 2021 accelerated the rollback of the "quantitative easing" program by half. That is, the Federal Reserve has pledged to cut monthly purchases of Treasury securities by $20 billion and mortgage purchases by $10 billion. By March 2022, the "quantitative easing" program has officially ended! [4].

At the meeting of the Open Market Committee on December 15, 2021, the Fed released figures reflecting the views of committee members on key rates in the medium term (FOMC, 2021).

According to the average forecast, members of the Federal Open Market Committee predicted three key rate hikes in 2022 and 2023, respectively. At the time, the previous forecast called for only one rate hike in 2022 and two in 2023. If we assume that each increase was to be only one standard step, equal to 0.25 percentage points, then in a year the key rate should have increased to 0.75-1%. However, the global financial, economic and pandemic crisis was added to the global cataclysms caused by the Russian-Ukrainian war, which manifested itself in a sharp decrease in energy supplies to the market. And this provoked global inflation, which became the basis for a jump in key rates of the Fed, the ECB, the Bank of England, the Swiss National Bank and others [5].

To express the current world situation in the words of the famous financial speculator George Soros, "the music is no longer heard, but they are dancing again." “The music stops” in November-December 2021, but many market participants “keep dancing.” This means that they get more cheap money from banks and buy securities in the stock markets.

But stock market players act according to their habits. The largest corporations buy back their own shares in the markets, thereby stimulating the growth of the capitalization of their business. But nine out of ten participants of the dance floor (exchange) are still “dancing”, only one has already stopped dancing.

To take an example, in November 2021, Microsoft announced that it would continue to buy back its own shares. And at that time, its CEO Satya Nadel sold more than 50% of its own shares of Microsoft on the stock exchange in one day. Elon Musk of Tesla sold his

shares for $10 billion, but decided not to scare other market participants by saying that the sale was due to non-market considerations, namely the need to get cash to pay taxes [6].

Already after the meeting in March of this year, when the key rate was raised by one "step", Fed Chairman Jerome Powell began to psychologically prepare market participants for possible radical steps by the Fed. He has repeatedly stated that the American economy is facing two big problems: inflation and recession. Inflation is already rising (8.2%) and a recession (economic downturn) is still possible. Loose monetary policy is needed to fight a recession, and tighter to fight inflation. In the second case, it is necessary to raise the key rate and reduce the money supply. The Federal Reserve understands that it cannot fight on two fronts at once, and chooses to fight inflation. In March, annual inflation in the US for the first time in 40 years (since January 1982) exceeded 8%. "We will take the necessary steps to restore price stability. In particular, if we conclude that it is appropriate to act more aggressively by raising rates by more than 25 basis points at the Open Market Committee meeting, we will do so," said Powell [8].

Meanwhile, most experts believe that a crisis is inevitable in the near future. Among them are such authorities as Wall Street Bank analyst Golgman Sachs, New York University professor Nouriel Rubin, who predicted the 2008 global financial crisis [7].

On June 1, Jamie Dimon, CEO of the largest US bank JP Morgan Chase, speaking at a financial conference in New York, expressed serious concern about the clouds that are gathering over the US economy: "This storm ... is approaching us. . We just don't know yet whether it will be a small storm or a super storm" (Son, 2022).

Elon Musk said the same thing in May: "Will there be a recession in the near future? Rather than not." In early June, Musk said he had a "very bad feeling" about the US economy (Crooks, 2022).

Of all the forecasts for an economic downturn in the United States, Donald Trump's opinion was the most resonant. On June 20, he stated: "This is not something that can happen in two years… We are already in a recession" (Weaver, 2022). Trump's statement is not outrageous at all. The former US president expressed what most Americans feel.

Implications of global anti-inflationary policies

The annual inflation rate in the United States, despite the tightening of monetary policy, has been significantly exceeding the target (2-3%) for several months now. In 2022, the monthly price inflation rate in the US will look like this (see Fig. 5): January - 7.5%; February - 7.9%; March - 8.5%; April - 8.3%; May - 8.6%; June - 9.1% (at the end of June, inflation reached a new high over the past 40 years. This is the highest rate since December 1981); July - 8.5%; August - 8.3%; September - 8.2%; October - 7.7%; November - 7.1%.

Source: https://tradingeconomics.com/united-states/inflation-cpi

Figure 5. Monthly inflation figures in the US (January-November 2022)

To sort out the unpleasant picture, the US Department of Labor started the so-called Core Inflation Calculation. That is, the rise in prices without taking into account such commodity groups as energy and food products. This core inflation was also quite high - 5.9% in June. As for food and energy products, they are not taken into account, they are considered as "distorting factors". For example, US President Joe Biden called inflationary price increases in America a "Putin tax" [7].

President Joe Biden and US Federal Reserve Chairman Jerome Powell believe that the two main economic threats to America are recession and inflation. But while recession still looms dimly on the horizon, inflation is a daily reality for millions of Americans.

Therefore, Jerome Powell and the Federal Reserve under him chose a course of tightening monetary policy - a tried and true means of combating inflation. So far, with some pauses, the Federal Reserve has been easing monetary policy since 2008. First of all, this was manifested in a gradual decrease in the key interest rate, which was reduced to almost zero. Secondly, the money supply has increased; It was carried out by the American central bank in the financial market through the purchase of Treasury bonds and mortgage-backed securities. As a result of this policy (called quantitative easing), US Fed assets rose from $0.8 trillion at the end of 2007 to $8.9 trillion by early 2022. In a word, there was an 11-fold increase. Therefore, the mass of the dollar increased by almost the same amount.

In the period from the beginning of 2020 to the beginning of 2022, the key rate of the Central Bank of America was at the level of the plinth: it was 0-0.25%. And since February 2022, the US Federal Reserve has sharply perked up. Jerome Powell, always careful in his speeches, suddenly grew bolder. He said without his usual half hints and ambiguity: the Federal Reserve is choosing a course of tightening monetary policy and will carry it out to the extent necessary to eliminate inflation (more precisely, to reduce its level to 2-3 percent).

On March 16, the US Federal Open Market Committee (FOMC) raised its key rate by 0.25 percentage points (25 basis points) to 0.25-0.5%.

The next step was taken on May 4, when the key rate was raised by two standard steps: (i.e. by 50 basis points) to 0.75-1%.

Another step was taken on 16 June. This move caused a great uproar both in the US and abroad. The Fed raised the key rate by three "steps" at once (75 basis points), and it amounted to 1.5-1.75%. The last such three-stage jump was made by the Federal Reserve in 1994. On July 27, the Federal Open Market Committee took another step towards raising the key rate. He once again raised the key rate by three "steps" - 2.25-2.50%. This was followed by an increase in the federal funds rate to 3.25% in September, and on November 11 it was raised to 4%. In other words, for the first time in its 109 years of existence, the Federal Reserve has made four consecutive 75 basis point rate hikes!

An increase in the key rate is accompanied by a movement towards "quantitative tightening". The latter includes the Federal Reserve selling from its own portfolio the same Treasury and mortgage-backed securities it has accumulated over the years. Monthly sales of $30 billion in Treasury bonds and $17.5 billion in mortgage-backed securities took place during the summer. In September, bond sales more than doubled to $60 billion in Treasury bonds and $35 billion in mortgage-backed securities [3].

3. Results

Analysts are asking questions: how strong is the US economy, can it withstand the anti-inflationary drug called "monetary tightening"? Some suggest that even the current dose of the drug has serious consequences. Michael Wilson, chief US equities strategist at Morgan Stanley, said investors shouldn't put their money into equities right now, despite the stock market's rally following the Fed's decision to hike rates by 75 basis points. The US stock market will continue to fall due to the economic downturn, Wilson warns. "The market always goes up as soon as the Fed raises rates, but not until a recession hits." "It is

unlikely that this time there will be a long gap between the end of the Fed's rate hike campaign and a recession," he said (Landsman, 2022).

Some experts believe that the short-term treatment (an increase in the key rate, at most, by two or three more "steps") will be sustained by the body of the American economy. But if the fighting in Ukraine drags on, then energy and food prices on world markets will remain at an unprecedented high level. Even if the US Federal Reserve raises the key rate at the next meeting of the Federal Open Market Committee at the end of December this year, inflation in America will not be eliminated. On the contrary, it will provoke a serious recession. It is extremely difficult to assess the devastating effects of the economic crisis thus provoked by the Federal Reserve.

4. Discussion

The only "plus" of such a crisis can only be that prices will start to fall if the economy enters a depression phase (post-recession stage). Inflation will also be defeated. However, this way of fighting inflation is like "treating" a headache with a guillotine.

Here's what US Department of Commerce macro data for the second quarter of 2022 tells us. The US economy contracted 0.9% year on year in the second quarter. It should be noted that in the first quarter, US GDP fell by 1.6%. Two consecutive quarters of decline in gross domestic product fit the technical definition of a recession. The National Bureau of Economic Research (NBER) also informs us about the onset of a recession, and their definition of a recession is different from the technical one. For NBER, a recession is a significant decline in economic activity throughout the economy that lasts for several months. Private sector fixed investment fell 3.9% in the second quarter, while federal government spending fell 1.9% [9].

5. Conclusions

Thus, the tightening of monetary policy by the central banks of the world's leading countries in 2022 has not yet led to the fact that the actual inflation rate is at least slightly closer to the target, instead, as a result of such a policy, the likelihood of provoking another wave of the global economic crisis is growing.

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Education and Labour Market Outcomes: Empirical Evidence in Romania

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Abstract: Education and vocational training provide the correct skill mix for economic growth in a globalized economy that demands more specialized labour markets, being decisively important among young people and adults, both from the urban and especially the rural environment. Emphasis on education and vocational training can play a strategic role in the process of economic development since it enhances knowledge-based and skills–based instruction. The research objective of this work consists in evaluating the effects of the representative factors that influence education in Romania in close relation to the coordinates of the labour market, infrastructure and personnel in education. Thus, we consider as endogenous variables the number of graduates, but also the degree of participation of the population in the labour force, highlighted through the lens of the employment rate and the unemployment rate, for the period 2000-2020. The research methodology consists in the application of structural equation modelling (SEM). In order to capture the differences between urban and rural areas, two other specific coordinates will be introduced, namely the employment gap and people at risk of poverty or social exclusion according to the degree of urbanization. The results obtained illustrate the importance of human capital (school population and teaching staff), educational infrastructure (school facilities, school laboratories, school workshops) and related endowments with sports equipment and main influencing factors of the number of graduates and drivers of labour market performance. Therefore, proper strategies and measures are needed for improving the quality of education in Romania in accordance with labour market.

Keywords: education; labour market; urban-rural; Romania; poverty.

1. Introduction

Education means the connection between the individual and society, which influences the entire social life. This represents an uninterrupted exchange of information from society to the individual, which is carried out for the proper functioning of the community. Thus, through education, a transfer of values is produced from society to individuals, and what sets it apart from the other phenomena that involve this transfer is the very accentuation of its characteristics. In this sense, education is a very important and decisive factor for the sustainable development of all countries of the world.

Education is not only a human right, but it is also a starting point in the process of achieving sustainable development, and it also represents the fundamental tool for the administration and promotion of democracy. Thus, it can improve people's mentality, developing their ability to create a much better and more prosperous world, thus influencing the quality of life [1, 2].

Romania faces great deficiencies in the field of education, even if it is a necessary criterion for the good development of citizens and society [3]. Over time, several measures have been tried to improve this situation, but the education of the people in Romania has become more and more precarious and, in some situations is even absent. What is worrisome is the fact that in this situation there are more and more young people who come from the countryside, hindering in this way the sustainable development of Romania, in the idea that without a quality education for its citizens, a country cannot aspire to development [4-6].

Education is important both for the present and for the future, providing people with knowledge, skills, and abilities to effectively participate in economic and social life, to develop

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current knowledge, and to activate, integrate or reintegrate successfully into the labour market. The role of education in providing access to the labour market is reflected in the increased employment opportunities for the educated population, people with high levels of education have better chances in the labour market. The correlation between education and the labour force is neither independent of the conditions on the labour market, nor limited only to the level of education of individuals. An educated person has more chances to integrate into the labour market, to find a job according to his level of competence, with greater mobility, higher openness to long-life learning, to professional reorientation or diversification. The relationship between education and the labour market is continuous throughout the entire active life period of people. Therefore, the education system and the labour market must support each other. Moreover, rural education has a number of problems, a number of major difficulties regarding the number of qualified teaching staff, staff turnover due to the high degree of isolation of certain localities, as well as their development, limited access to professional training or continuing education programs, of the rural population, but also of poor investment in physical infrastructure. Thus, the rural environment remains a disadvantaged environment, where the turnover of teaching staff is high, in contradiction with the proportion of qualified staff, which is low. One of the main risk factors regarding children's access to education in rural areas is the poor socio-economic situation of a family. This reduces the educational chances of the children who come from this type of family, and the lack of education, school training, and then professional training, reduces their opportunities to integrate into society, thus increasing the chances that they will still end up in poverty in the future [7].

On this framework, the research objective of this work consists in evaluating the effects of the representative factors that influence general education and vocational training in Romania in close relation to the coordinates of the labour market, infrastructure and personnel in education. Thus, we consider as endogenous variable the number of graduates, but also the degree of participation of the population in the labour force, highlighted by the employment and the unemployment rates, for the period 2000-2020. The research methodology consists of structural equation modelling (SEM), which captures the direct, indirect and aggregate effects of the variables considered in the analysis specific to the educational system and the labour market in Romania. The research hypotheses (that are detailed in the Methodology section) are oriented to assess the synergy among education and labour market, namely in which way: (*i*) the number of graduates is influenced by human capital (school population and teaching staff), educational infrastructure (school units, school laboratories, school workshops, sports equipment and related spaces), labour market and the standard of living, on the one hand; and *(ii)* how the labour market is influenced by the selected dimensions of the educational system and the standard of living, on the other hand.

The novelty of the research lies in the fact that, although it is a topic that is quite addressed in the literature, the analysis through the lens of the education infrastructure and the labour market has been less addressed. In addition, to capture the differences between urban and rural areas, two other specific coordinates will be introduced, namely the employment gap according to the degree of urbanization and people at risk of poverty or social exclusion according to the degree of urbanization.

After a brief introduction regarding the importance of the topic addressed, Section 2 consists of a review of the literature, where various related studies carried out in this field are presented. Section 3 presents the data and the research methodology, consisting of structural equation modelling (SEM) which sought to capture the effects of the variables considered in the analysis specific to the educational system and the labour market in Romania. Then, Section 4 contains the analyses, results and discussions, which illustrate the importance of human capital (school population and teaching staff), educational infrastructure (school units, school laboratories, school workshops) and related endowments with sports equipment and related spaces as factors of the influence of the number of graduates and drivers of the labour market performance, in the perspective of the appropriate professional insertion in the labour market of young people after graduation. Finally, Section 5, respectively the conclusions, draws the benchmarks regarding the improvement of education in Romania, in correlation with the labour market.

2. Literature review

Studies in the literature show a direct link between investment in education and economic, social and human development, with education being an important factor to ensure sustainable development. There are many studies that have focused their research on finding the reasons for the factors that lead to economic growth, one of them representing the level of education [1, 5-10].

Thus, we can say that, thanks to education, the standard of living among young people can increase, especially by gaining entrepreneurial skills, thus education is related to the development of society and labor market [8].

Education for sustainable development tends to increase young people's interest in acquiring the skills and competencies necessary for employment in the labour market, in accordance with its requirements, as well as assuming a way of life supported by a future alongside responsible and competent citizens [5, 9].

In this sense, promoting the principles of sustainable development induces effects on the labor market, by involving many categories of actors. The contribution of educational institutions is particularly important considering their multiple functions in the didactic, research and entrepreneurial fields [10]. Higher education institutions (HEIs) play an important role in providing the right mix of skills tailored to professional profiles and matched to the needs of and opportunities offered by the labour market, particularly in the current globalized digital economy. Entrepreneurship education and training, as „the process of teaching students entrepreneurial, which involves identifying viable business opportunities and turn them into successful commercial ventures"[11], at the university level, enhances students' entrepreneurial intentions, as it encourages the acquisition of advanced knowledge and skills. Therefore, higher education institutions have an essential role in providing advanced knowledge and necessary skills linked to the needs of the labor market, thus increasing students' innovation and their entrepreneurial intentions [12], while also strengthening the economic system/development through the creation of new businesses in knowledge-intensive sectors [13].

Related to Romania, the literature underpinnings [3-6, 14-16] in the field of education, revealed that there are many deficiencies, although it represents one of the most important factors for the good development of society and citizens.

One of these deficiencies is highlighted by the poor financing of education [3]. Thus, due to the low degree of budgetary allocations to the educational system, a poor performance of young people in this sector is evident, which subsequently contributed to the creation of several major discrepancies and inequalities in terms of their employment opportunities. Therefore, we can say that the delay in the modernization of the school infrastructure can lead to affecting the quality of education, and thus it is expected that the school population will decrease considerably.

Another deficiency is represented by regional disparities, especially between rural and urban areas [5, 6], with low performance in terms of rural education and labor market integration.

As regards the standard of living, monetary child poverty has decreased, but there has been no progress on access to services for children in vulnerable situations [14-16]. Thus, children in villages and vulnerable groups have low access to many things, including pre-school education, schooling, proper nutrition, healthcare and housing. The process of deinstitutionalization of children has reached satisfactory progress, with particularly important measures being taken in this regard, especially about the relevant legislative framework. High child poverty rates predict inequality of opportunity in the future. Considering this, the most disadvantaged are children who have parents with a low level of education, but also those from households with a very low work intensity [14].

The decrease in the schooling rate and the increase in the school dropout rate for these groups show a polarization of education that could contribute to a higher rate of poverty among future adults. Poverty reduction is not only related to economic conditions, but is an integrated process that includes, also environmental, social, ethical, legal and other issues depending on the international sphere [15]. Thus, a country that wants to achieve sustainable development can easily strike the right balance and achieve the best results in terms of poverty reduction and other conditions [16].

3. Data and methodology

The data used in the analysis are annually and were extracted for the period 2000-2020, including indicators specific to the educational system in Romania, but also indicators of the labour market (employment rate and unemployment rate), thus configuring the data panel at the level of Romania.

The name of the indicators used in the empirical analysis, along with the acronym of the variables used in the econometric modelling and the source of the data [17, 18], are presented in Table 1.

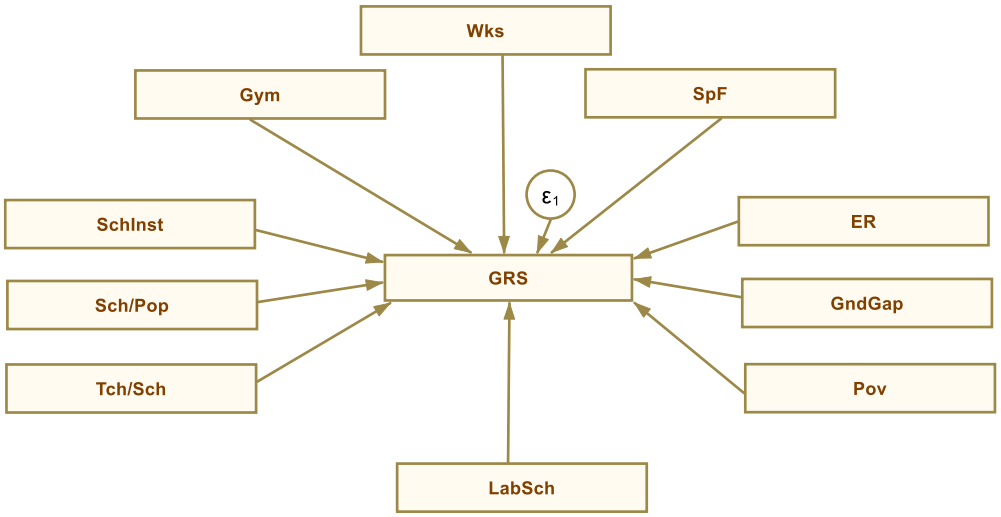
Table 1. List of indicators used in the analysis, period 2000-2020

Indicator (name, unit of measure - UM)	**Acronym**	**Data source**
School units/institutions (UM: number)	*SchInst*	Eurostat, INS
Share of school population/total average residence population (calculated)	*Sch/Pop*	Eurostat, INS
Share of teaching staff/school population (%, calculated)	*Tch/Sch*	Eurostat, INS
School laboratories (UM: number)	*LabSch*	Eurostat, INS
Gym classes (UM: number)	*Gym*	Eurostat, INS
School workshops (UM: number)	*Wks*	Eurostat, INS
Sports fields (UM: number)	*SpF*	Eurostat, INS
Gender employment gap according to the degree of urbanization (UM: percentages)	*GndGap*	Eurostat, INS
People at risk of poverty or social exclusion depending on the degree of urbanization (UM: percentages)	*Pov*	Eurostat, INS
Graduates (UM: number)	*GRS*	Eurostat, INS
Participation of the population in the labour force - Employment rate, 15-64 years (UM: percentage)	*ER*	Eurostat, INS
Population participation in the labour force - Unemployment rate (UM: percentage)	*UR*	Eurostat, INS

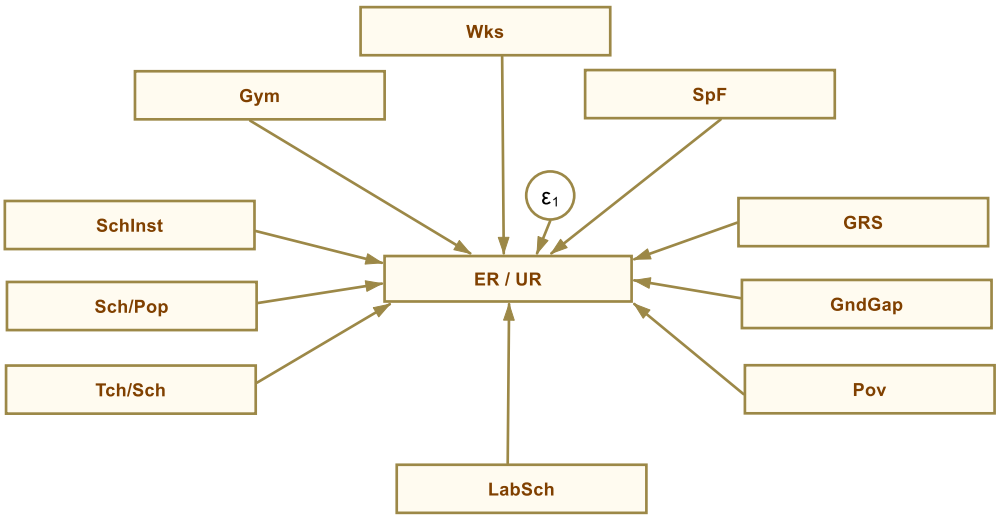
Source: author contribution

To carry out the research, we applied structural equation modelling (SEM) to capture the direct, indirect and total links between the representative factors that influence education in Romania.

The general configuration of the SEM model is shown in Figure 1, which reveals in which way: *(i)* the number of graduates is influenced by the stock of human capital (school population and teaching staff), educational infrastructure (school units, school laboratories, school workshops, sports equipment and related spaces), labour market dimensions (employment rate and the gender employment gap according to the degree of urbanization) and standard of living (poverty), on the one hand (Figure 1(a)); and *(ii)* how the labour market outcomes (employment and unemployment rates) are influenced by the selected dimensions of the educational system and the standard of living, on the other hand (Figure 1(b)).



(a)



(b)

Figure 1. General graphical configuration of the structural equation model, considering as endogenous variables the number of graduates (*GRS*) (a) and the dimensions of the labour market (alternatively, employment rate – *ER* and unemployment rate – *UR*) (b) and as exogenous variables the school units/institutions (*SchInst)*, share of school population/total average residence population (*Sch/Pop)*, share of teaching staff/school population (*Tch/Sch)*, school laboratories (*LabSch)*, gym classes (*Gym)*, school workshops (*Wks)*, sports fields (*SpF)*, gender employment gap according to the degree of urbanization (*GndGap)*, people at risk of poverty or social exclusion depending on the degree of urbanization (*Pov)*

Source: author's design in Stata 16

Structural equation modelling has the advantage of allowing the estimation of several relations/hypotheses simultaneously, but also of ensuring the storage and reporting of the direct, indirect and total effects of the exogenous variables considered on the *endogenous* one (graduates - *GRS*, employment rate - *ER*, unemployment rate - *UR*).

The research hypotheses are:

- H1. There is a direct, positive and significant linkage between the number of graduates and the human capital stock (school population and teaching staff);

- H2. There is a direct, positive and significant connection between the number of graduates and the educational infrastructure (school units, school laboratories, school workshops, sports equipment and related spaces);
- H3. The number of graduates is positively influenced by the dimensions of the labour market;
- H4. The number of graduates is positively influenced by the standard of living;
- H5. The dimensions of the labour market are favorably influenced by the human capital credentials (school population and teaching staff);
- H6. The dimensions of the labour market are favorably influenced by the educational infrastructure;
- H7. The dimensions of the labour market are favorably influenced by the standard of living.

4. Results

The descriptive statistics of the indicators used in our research are detailed in Table 2.

Table 2. Descriptive statistics - panel data at the level of Romania, 2000-2020

Variables	N	Mean	Standard deviation (Sd)	Minimum	Maximum
SchInst	20	11058.2	6327.209	7001	24481
Sch/Pop	20	17.9725	1.596802	15.88	20
Tch/Sch	20	6.486	0.1344149	6.28	6.79
LabSch	20	24692.15	2126.912	20620	26923
Gym	20	4729.1	108.6186	4479	4851
Wks	20	6536.3	1625.756	4690	9551
SpF	19	4926.895	412.9989	4068	5577
GndGap	15	15.9	1.938335	12.7	19
Pov	13	39.81539	4.587818	31.2	47
GRS	19	620538.5	98460.33	495128	784958
ER	20	61.3	2.153578	57.8	65.8
UR	20	6.505	1.130661	3.9	8.4
N total	20				

Source: author's processing in Stata 16

Descriptive statistics grasp a better view of the dataset, by reporting the mean values, standard deviation and minimum and maximum values per each indicator/variable, thus highlighting the distinctive features of the Romanian labour market and educational system. There can be noted a significant drawback in terms of the number of school units that have reached a minimum of 7001 compared to 24481, while the educational investments remain relatively constant as reflected by a slight increase in the number of classrooms, school laboratories, gym classes and sports fields, yet with a significant reduction of the school workshop rooms in the latest years. Accordingly, same differences are noted in terms of the number of graduates that has significantly reduced over time ranging between 495128 and 784958, with an average of 620538. Moreover, the Romanian labour market performance has slightly improved, as reflected by a small increase in the employment rate and a slight decrease in the unemployment rate over the analyzed lapse of time.

In applying the models, 20 observations were used for most variables, except for certain variables that had missing values, namely sports fields (19 observations), employment gap (15 observations), people at risk of poverty (13 observations) and graduates (19 observations), so as shown in Table 2.

Reliability of the SEM results was assessed by goodness-of-fit indices for each endogenous variable, respectively graduates *(GRS)* (Appendix, Table A1), employment rate *(ER)* (Appendix, Table A2) and unemployment rate *(UR)* (Appendix, Table A3).

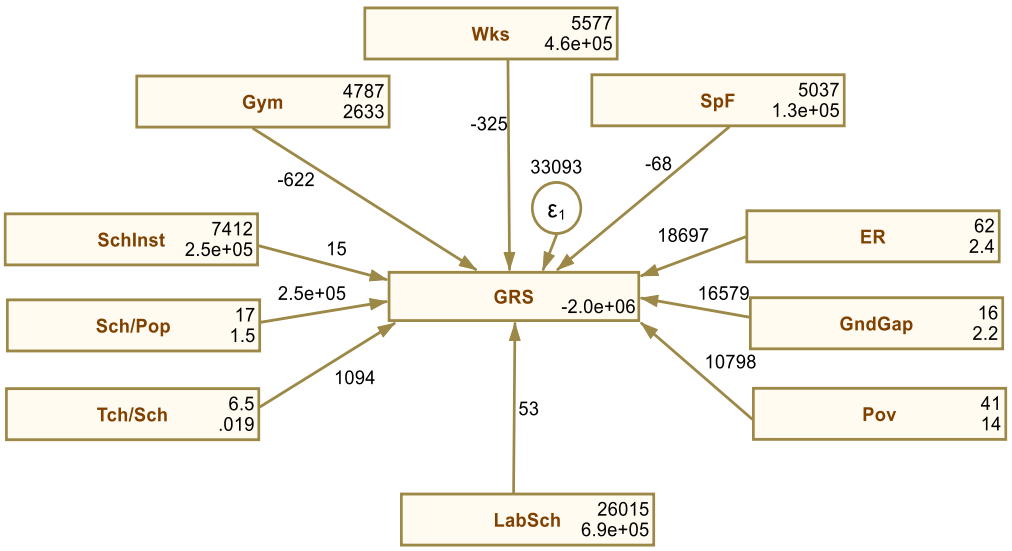
The results obtained by applying SEM are presented in Figure 2 and detailed in Table 3.

A first set of influences (Figure 2(a) and Table 3) revealed favorable effects induced by the number of school units, school laboratories and the share of the school population on the number of graduates (positive and statistically significant coefficients at the 0.1% threshold), on the one hand, and unfavorable impacts induced by the number of gymnasiums, school workshops, sports fields (negative and statistically significant coefficients at the 0.1% threshold), the employment gap as regards urbanization (positive and statistically significant coefficient at the 0.1% threshold) on the number of graduates, on the other hand.

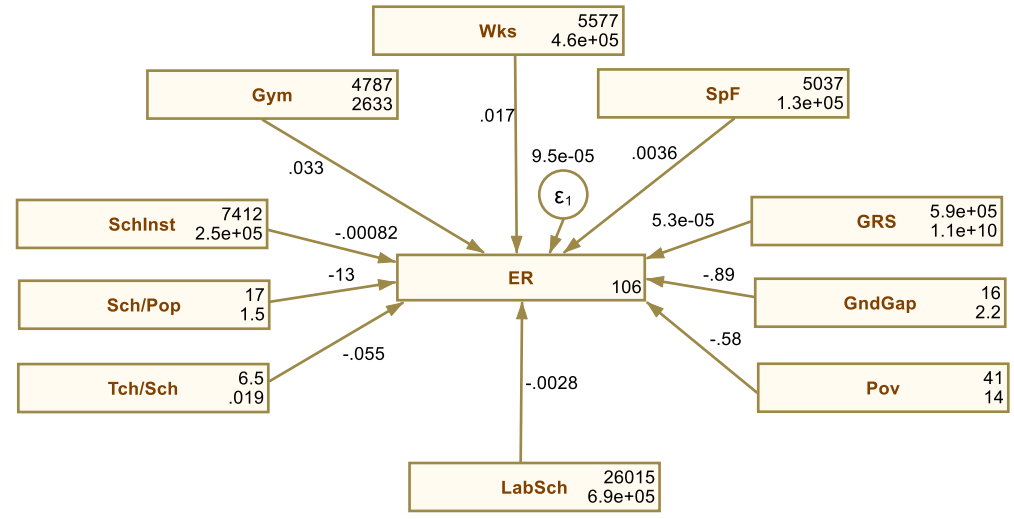
Thus, hypothesis H1 "*There is a direct, positive and significant linkage between the number of graduates and the human capital stock (school population and teaching staff)*" is fulfilled, while hypothesis H2 "*There is a direct, positive and significant connection between the number of graduates and the educational infrastructure (school units, school laboratories, school workshops, sports equipment and related spaces)*" is not fulfilled.

Likewise, adequate professional insertion in the labour market, reflected by an increase in the employment rate, also determines the increase in the number of graduates (the estimator related to this variable is positive and statistically significant at the 0.1% threshold). On the other hand, increasing the number of graduates by increasing the poverty rate would not determine a favorable influence on the educational system and the labour market, considering these interdependencies.

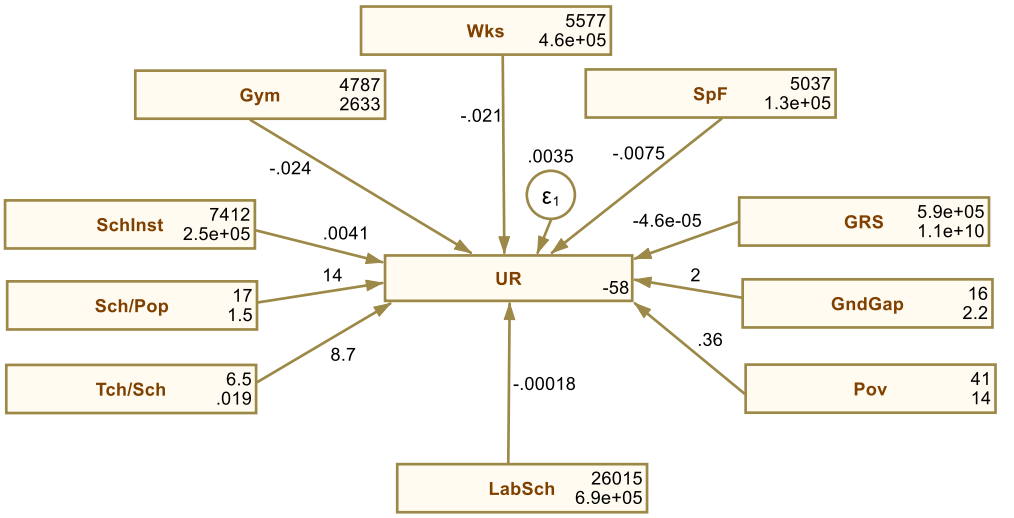
Therefore, hypothesis H3 "*The number of graduates is positively influenced by the dimensions of the labour market*" is fulfilled, while hypothesis H4 "*The number of graduates is positively influenced by the standard of living*" is not fulfilled.



(a)



(b)



(c)

Figure 2. The results of the models with structural equations, considering as endogenous variables the number of graduates *(GRS)* (a), the employment rate *(ER)* (b) and the unemployment rate *(UR)* (c)

Source: author's contribution in Stata 16

The impact of the explanatory variables on the labour market performance indicators (Figure 2(b) and (c) and Table 3) is less significant, with the estimated coefficients having values close to 0. However, a significant negative impact of the schooling population share is observed and of the share of teaching staff in terms of the increase in unemployment (positive and highly statistically significant coefficients at the 0.1% threshold) and the reduction in the employment rate (negative estimated coefficients).

Therefore, hypotheses H5 "*The dimensions of the labour market are favorably influenced by the human capital credentials (school population and teaching staff);*" is not fulfilled.

Positive effects in this regard are induced by improving the school infrastructure by increasing the number of gymnasiums, school workshops and sports fields. Graduates tend to be integrated into the labour market, contributing to its performance by slightly increasing employment (estimated positive coefficient, statistically significant at the 0.1% level) (Figure 2(b) and Table 3) and

reducing unemployment (estimated negative coefficient, statistically significant at the 0.1% level) (Figure 2(c) and Table 3).

Thus, the hypothesis H6 "*The dimensions of the labour market are favorably influenced by the educational infrastructure;*" is fulfilled.

Table 3. Detailed results of SEM models (centralized from Figure 2)

Variables	**(1)**	**(2)**	**(3)**
	Graduates (GRS)	***Employment rate (ER)***	***Unemployment rate (UR)***
main			
SchInst	15.28***	-0.000816***	0.00406***
	(1.229)	(0.0000670)	(0.000405)
Sch/Pop	252366.5***	-13.49***	13.78***
	(1135.6)	(0.105)	(0.634)
Tch/Sch	1094.0	-0.0545	8.721***
	(3224.9)	(0.173)	(1.045)
ER	18697.4***		
	(127.3)		
Gym	-621.6***	0.0332***	-0.0243***
	(3.476)	(0.000205)	(0.00124)
Wks	-324.9***	0.0174***	-0.0213***
	(2.624)	(0.00171)	(0.00104)
SpF	-67.99***	0.00363***	-0.00753***
	(2.090)	(0.000114)	(0.000693)
LabSch	52.87***	-0.00283***	-0.00178
	(1.017)	(0.000508)	(0.00308)
GndGap	16578.5***	-0.886***	1.956***
	(457.1)	(0.0263)	(0.159)
Pov	10797.7***	-0.577***	0.361***
	(81.19)	(0.00245)	(0.0148)
GRS		0.00535***	-0.00462***
		(0.0000364)	(0.000220)
_cons	-1974467.0***	105.6***	-58.34***
	(14198.5)	(0.953)	(5.773)
/			
var(e.GRS)	33092.9*		
	(13510.1)		
var(e.ER)		0.0000946*	
		(0.0000386)	
var(e.UR)			0.00347*
			(0.00142)

Note: Standard errors are shown in parentheses, "*p< 0.05, **p< 0.01, ***p< 0.001"

Source: author's contribution in Stata 16

Regarding the standard of living in Romania, measured by the level of poverty, we observe a reduction in the employment rate (negative estimated coefficients) and an increase in the unemployment rate (positive estimated coefficients) along with the increase in the poverty rate. Thus, hypothesis H7. "*The dimensions of the labour market are favorably influenced by the standard of living*" is not fulfilled.

5. Discussions

The results obtained, related to the research hypotheses illustrate the importance of human capital, reflected by school population and teaching staff, for the number of graduates in Romania, as revealed by hypothesis H1. These results are in line with those obtained by Özen and Ersoy [19], which emphasized the role of the quality of education personnel.

As regards the educational infrastructure (school units, school laboratories, school workshops, sports equipment and related spaces), this does not support the number of graduates (as revealed by hypothesis H2), but acts as a driver of labor market performance, by raising employment rate and decreasing the unemployment rate (as revealed by hypothesis H6), in the perspective of the appropriate professional insertion on the labour market of young people after graduation, all these aspects having a significant impact on the economic growth and long-term development of Romania, as revealed by Cristea et al. [5]. The number of graduates in Romania is attracted by the labour market capacity to integrate them into proper jobs (as shown by hypotheses H3), based on entrepreneurship skills, as Drăgoi et al [7], Trif et al. [12] and Ulman and Dibay [15] have, also, underlined. The results obtained underpin that labour market in Romania is not sustained by human capital - school population and teaching staff (as revealed by hypothesis H5). These results are in line with those obtained by Cristea et al. [5], which assessed, in a comparative approach, the gap between education in rural and urban areas.

As for standard of living in Romania, poverty does not act as main driver for education (hypothesis H4) and labour market capacity for new jobs ((hypothesis H7), with repercussions on Romania's sustainable development, as Panait et al. [10] and Mansi et al. [16] concluded.

6. Conclusions

In full accordance with the main objective of the research undertaken, structural equation modelling (SEM) sought to capture the direct, indirect and aggregate effects of the variables considered in the analysis specific to the educational system in Romania on the number of graduates, but also on the degree of participation of the population in labour force, highlighted through the lens of the employment and the unemployment rates. Thus, we have outlined the connections between education, labour market and standard of living (measured by the poverty level) in Romania.

Education should be one of Romania's priorities, because it is the basis of a prosperous and sustainable society. Emphasis on education and vocational training can play a strategic role in the process of economic development. Vocational education and training are very important among young people and adults, both from the urban environment and, especially, from the rural one.

Based on the results obtained, I propose the following solutions for improving the quality of education in Romania that will also be beneficial for the labour market: the development of improvement or reintegration programs in education and professional training for adults; the development of professional training systems within the workplace; anticipating labour market needs; providing incentives for businesses to hire young people or graduates of vocational schools; insertion bonus for graduates of rural vocational schools; developing the education infrastructure and increasing the quality of education personnel.

The SEM econometric modelling results must be viewed subject to a lower level of statistical significance, taking into account the relatively low number of observations used in the econometric processing, this being a limitation of the empirical research undertaken. Thus, in order to increase the level of robustness of the estimates, but also in order to identify the gaps between the urban and rural environment, the future research approach will be focused on analysing the education pillar for sustainable development of Romania, but also an advanced comparative approach between urban-rural environments, since education in the rural environment encounters many difficulties among school infrastructure, human capital.

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Appendix

Table A1. Results of goodness-of-fit indices for SEM considering as endogenous variable the number of graduates (GRS)

Fit statistic	Value	Description
Likelihood ratio		
chi2_ms(0)	0.000	model vs. saturated
p > chi2	.	
chi2_bs(10)	152.328	baseline vs. saturated
p > chi2	0.000	
Population error		
RMSEA	0.000	Root mean squared error of approximation
90% CI, lower bound	0.000	
upper bound	0.000	
Pclose	0.998	Probability RMSEA <= 0.05
Information criteria		
AIC	929.959	Akaike's information criterion
BIC	935.778	Bayesian information criterion
Baseline comparison		
CFI	0.998	Comparative fit index
TLI	0.998	Tucker-Lewis index
Size of residuals		
SRMR	0.000	Standardized root mean squared residual
CD	0.998	Coefficient of determination

Source: Author's processing in Stata 16

Table A2. Results of goodness-of-fit indices for SEM considering as endogenous variable the employment rate (ER)

Fit statistic	Value	Description
Likelihood ratio		
chi2_ms(0)	.	model vs. saturated
p > chi2	.	
chi2_bs(10)	121.497	baseline vs. saturated
p > chi2	0.000	
Population error		
RMSEA	0.000	Root mean squared error of approximation
90% CI, lower bound	0.000	
upper bound	0.000	
pclose	0.998	Probability RMSEA <= 0.05
Information criteria		
AIC	927.959	Akaike's information criterion
BIC	933.293	Bayesian information criterion
Baseline comparison		
CFI	0.998	Comparative fit index
TLI	.	Tucker-Lewis index
Size of residuals		
SRMR	0.000	Standardized root mean squared residual
CD	0.997	Coefficient of determination

Table A3. Results of goodness-of-fit indices for SEM considering as endogenous variable the unemployment rate (UR)

Fit statistic	Value	Description
Likelihood ratio		
chi2_ms(0)	.	model vs. saturated
p > chi2	.	
chi2_bs(10)	65.473	baseline vs. saturated
p > chi2	0.000	
Population error		
RMSEA	0.000	Root mean squared error of approximation
90% CI, lower bound	0.000	
upper bound	0.000	
pclose	0.998	Probability RMSEA <= 0.05
Information criteria		
AIC	971.180	Akaike's information criterion
BIC	976.514	Bayesian information criterion
Baseline comparison		
CFI	0.997	Comparative fit index
TLI	.	Tucker-Lewis index
Size of residuals		
SRMR	0.000	Standardized root mean squared residual
CD	0.996	Coefficient of determination