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Autonomous and Sustainable Service Economies: Data-Driven Optimization of Design and Operations through Discovery of Multi-Perspective Parameters

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Abstract: The rise in the service economy has been fueled by breakthroughs in technology, globalization, and evolving consumer patterns. However, this sector faces various challenges, such as issues related to service quality, innovation, efficiency, and sustainability, as well as macro-level challenges such as globalization, geopolitical risks, failures of financial institutions, technological disruptions, climate change, demographic shifts, and regulatory changes. The impacts of these challenges on society and the economy can be both significant and unpredictable, potentially endangering sustainability. Therefore, it is crucial to comprehensively study services and service economies at both holistic and local levels. To this end, the objective of this study is to develop and validate an artificial-intelligence-based methodology to gain a comprehensive understanding of the service sector by identifying key parameters from the academic literature and public opinion. This methodology aims to provide in-depth insights into the creation of smarter, more sustainable services and economies, ultimately contributing to the development of sustainable future societies. A software tool is developed that employs a data-driven approach involving the use of word embeddings, dimensionality reduction, clustering, and word importance. A large dataset comprising 175 K research articles was created from the Scopus database, and after analysis, 29 distinct parameters related to the service sector were identified and grouped into 6 macro-parameters: smart society and infrastructure, digital transformation, service lifecycle management, and others. The analysis of over 112 K tweets collected from Saudi Arabia identified 11 parameters categorized into 2 macro-parameters: private sector services and government services. The software tool was used to generate a knowledge structure, taxonomy, and framework for the service sector, in addition to a detailed literature review based on over 300 research articles. The conclusions highlight the significant theoretical and practical implications of the presented study for autonomous capabilities in systems, which can contribute to the development of sustainable, responsible, and smarter economies and societies.

Keywords: service economy; smart society; autonomous services; smart services; sustainable services; deep learning; big data analytics; Natural language Processing (NLP); internet of things (IoT)

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1. Introduction

The rise in the service economy, driven by technological advancements, globalization, and changes in consumer behavior, has transformed our way of life, our occupations, and social interactions [1,2]. Services such as banking, education, healthcare, tourism, and entertainment have become the main drivers of economic growth, replacing traditional industries such as manufacturing and agriculture [3–5]. This shift towards a service-based economy has created employment opportunities, increased standards of living, and brought about greater innovation and personalization in service provision [6–9].

1.1. Macro and Micro Challenges Facing Service Economies

The services sector has become a crucial part of many modern economies, accounting for approximately 71% of global GDP in 2020, up from 60% in 1990 [10,11]. This growth has been linked to increases in innovation, productivity, and job creation, particularly in the digital age enabled through technologies such as big data, the internet of things (IoT), artificial intelligence (AI), and others [3,12–14]. Service exports have also become an important source of revenue for many countries, with recent studies highlighting their positive impact on economic growth and development [15]. Moreover, the International Labor Organization reports that the services sector is the largest employer in the world, providing jobs to approximately 50% of the global workforce [16,17].

While the service sector has brought unprecedented advancements and comfort to our lives, service economies face a range of challenges, both at the macro and micro levels. At the macro level, globalization has increased competition and put pressure on service providers to innovate and increase efficiency so as to remain competitive [2]. Globalization can also lead to various negative impacts on local service economies, such as economic instability, social unrest, environmental degradation, cultural erosion, and health risks. Rapid globalization can result in economic instability for local businesses and services [18,19]. Additionally, social unrest can arise due to growing income inequality and job insecurity, leading to political tensions and even violence [20]. Globalization can also lead to environmental degradation, as increased production and consumption result in higher carbon emissions and other forms of pollution [21,22]. Furthermore, cultural erosion can occur as a result of the global spread of homogenized services, leading to a loss of local cultural identity [20]. Globalization can also lead to health risks, such as the spread of infectious diseases through increased travel and trade [23].

Geopolitical risks such as trade disputes and political instability can also affect service industries by disrupting global supply chains and causing uncertainty [24]. Recessions can have a significant impact on service economies, with decreased consumer spending leading to reduced demand for services [25,26]. Bank and company defaults and collapses, such as the recent falls of Silicon Valley Bank, Silvergate, Credit Suisse, and Signature Bank, can also have a ripple effect on service industries by reducing consumer confidence and causing supply chain disruptions [27]. Technological disruptions, such as the rise in automation and artificial intelligence, pose both opportunities and challenges for service economies [28,29]. While automation can increase efficiency and reduce costs, it can also lead to job losses and the need to retrain workers [28,30]. Climate change is another major challenge facing service economies, particularly those reliant on tourism and outdoor recreation [31]. Extreme weather events and natural disasters can disrupt service industries, while climate change mitigation efforts can also require significant investments and changes to service provision [32].

Demographic shifts, including aging populations and changing family structures, can also impact service industries [33]. As the population ages, demand for healthcare and other services may increase, while changing family structures can lead to changes in demand for childcare and other services [34,35]. Income inequality is another challenge facing service economies, as it can lead to decreased demand for certain services and create social unrest [20]. Regulatory changes, such as new data privacy regulations and labor laws, can also create challenges for service providers by increasing compliance costs and changing the regulatory landscape [32].

1.2. A Call for Responsible, Smarter, and Sustainable Service Economies

Nevertheless, the technological progress achieved so far, while commendable, is lacking the level of responsibleness, smartness, and sustainability needed to tackle the challenges of our time and into the future [36,37]. Thus, there is an urgent need for innovative approaches for smarter and more sustainable services and service economies that can support the formation of sustainable cities and societies. We elaborate on this further below.

The service sector and service economies have become increasingly important to modern societies. However, they face a range of challenges, and their impacts on society and the economy are significant and unpredictable [38,39]. The situation requires careful management and adaptation to remain competitive and resilient in the face of changing economic, social, and environmental conditions [40,41]. It is essential for all stakeholders to collaborate and develop sustainable and responsible service practices [13,42]. This can be achieved by holistically and locally understanding the diverse needs and expectations of customers and the complex interrelationships among service providers, customers, and the environment [31,43]. For instance, in the context of the globalization challenges mentioned earlier, by studying service economies locally, policymakers and businesses can better understand and address these challenges, considering the specific needs and cultural contexts of local communities and working towards sustainable and responsible practices.

Therefore, a dynamic and interactive comprehension of the service sector and its related cultural, national, regional, and global issues is necessary to foster improvements and innovation on the way to smart and sustainable services. Furthermore, a holistic approach to service can help address issues such as income inequality, climate change, and demographic shifts.

Additional information regarding the gap in research is available in Section 2, while Section 6 provides a discourse on the originality, theoretical contributions, and practical applications of this study.

1.3. Scope of the Study

The main aim of this research has been to advance a methodology that allows for a comprehensive understanding of the service sector using artificial intelligence and that will drive future research in this field. Our ultimate aim has been to create a theory and approach for smarter and more sustainable services and service economies that can support sustainable future societies through the development of autonomous systems using innovative technologies and solutions (we elaborate on this in Section 6).

This research employs a data-centric methodology to comprehensively model the service sector. To achieve this, we utilize a combination of the academic literature and public opinion gathered from X (formerly known as Twitter). By leveraging advanced technologies such as deep learning and big data, we extract key parameters from both sources to gain a unique understanding of the service sector from two distinct perspectives. Although these perspectives can influence each other, they exhibit significant differences. To enhance our holistic understanding of service economies, additional perspectives can be gained from various data sources, including industrial news (offering an industrial perspective) and government documents (providing a governmental viewpoint).

We have created a software tool that utilizes our data-driven approach and a range of machine learning (ML) and other technologies. To uncover the key elements of the academic view of services, we constructed a dataset using the Scopus database. This dataset consists of 175,918 article data, published in English during the January 2018–June 2022 period. After analyzing the academic dataset, 29 distinct parameters related to the service sector were identified, which we grouped into 6 main categories (called macro-parameters): education & learning, healthcare, transportation & mobility, smart society & infrastructure, digital transformation, and service lifecycle management. From 9 October 2022 to 13 November 2022, we procured a dataset from Twitter to illustrate how the general population views the service industry within Saudi Arabia. The objective is to concentrate on concerns specific to the regional service industry and contrast them with global perspectives, and therefore, we limited the dataset to the region of Saudi Arabia. The dataset includes 112,862 tweets, and 11 parameters were revealed through our tool, which were structured into 2 wider sets of parameters (macro-parameters): private sector services and government services. Details about the software tool can be found in Section 3.

The generated multi-dimensional taxonomy shown in Figure 1 provides a comprehensive overview of the service sector, incorporating multiple perspectives from academia and the general public. It offers a global outlook as well as a localized perspective specific to Saudi Arabia, highlighting the sector's diversity. The academic and global perspective helps to identify a wide range of services in the service sector, including education, healthcare, transportation, smart society and infrastructure, digital transformation, and service lifecycle management. It provides insights into the use of technology to improve service delivery and develop new business models, and it offers a comprehensive understanding of the current trends and developments driving the evolution of the service sector. Conversely, the local and public view provides insights into the types of services offered by the private sector and government in the Kingdom of Saudi Arabia (KSA). The private sector services include food delivery apps and services, logistics services, and others. The government's services include workforce development services, digital transformation services, and others. These services help to provide a comprehensive understanding of the types of services available to the public and how they are being delivered by both private and public entities. Understanding the availability, quality, and accessibility of these services can help policymakers identify gaps and develop strategies to improve the overall service delivery in the region.

The article exhibits a frame of knowledge, taxonomies, and a framework of the service sector generated with the help of the software tool, in addition to a detailed literature review based on over 300 research articles.

Figure 2 provides a framework for the autonomous design and operations of the service sector. It was developed using the parameters and information discovered in this paper. It is a systematic approach to automating services using data analytics, AI, machine and deep learning, and robotic systems to improve service quality and efficiency, reduce costs, and enhance customer satisfaction while ensuring data security and compliance with ethical and legal considerations. The framework encompasses a circular pattern that illustrates the iterative and continuous nature of the autonomous system design and operations process. It involves identifying services to be automated, defining scope and objectives, developing architectures, choosing the right technology, ensuring interoperability, implementing cybersecurity measures, establishing monitoring and feedback mechanisms, addressing ethical and legal concerns, implementing service lifecycle management, and developing a roadmap for implementation. Through the discovery of relevant parameters, the framework provides a comprehensive approach to the design and effective operation of autonomous systems for the service sector. The framework is further elucidated as we explore the specific parameters discovered throughout this paper.

The rest of the article is structured as follows. In Section 2, the relevant literature is explored, and gaps in research are identified. Section 3 elaborates on the proposed tool's research methodology and design. Section 4 investigates the academic and international parameters identified from academic data. Section 5 evaluates the public parameters identified through Twitter data. A discussion is presented in Section 6. Section 7 concludes the paper by summarizing key findings and indicating potential research opportunities.

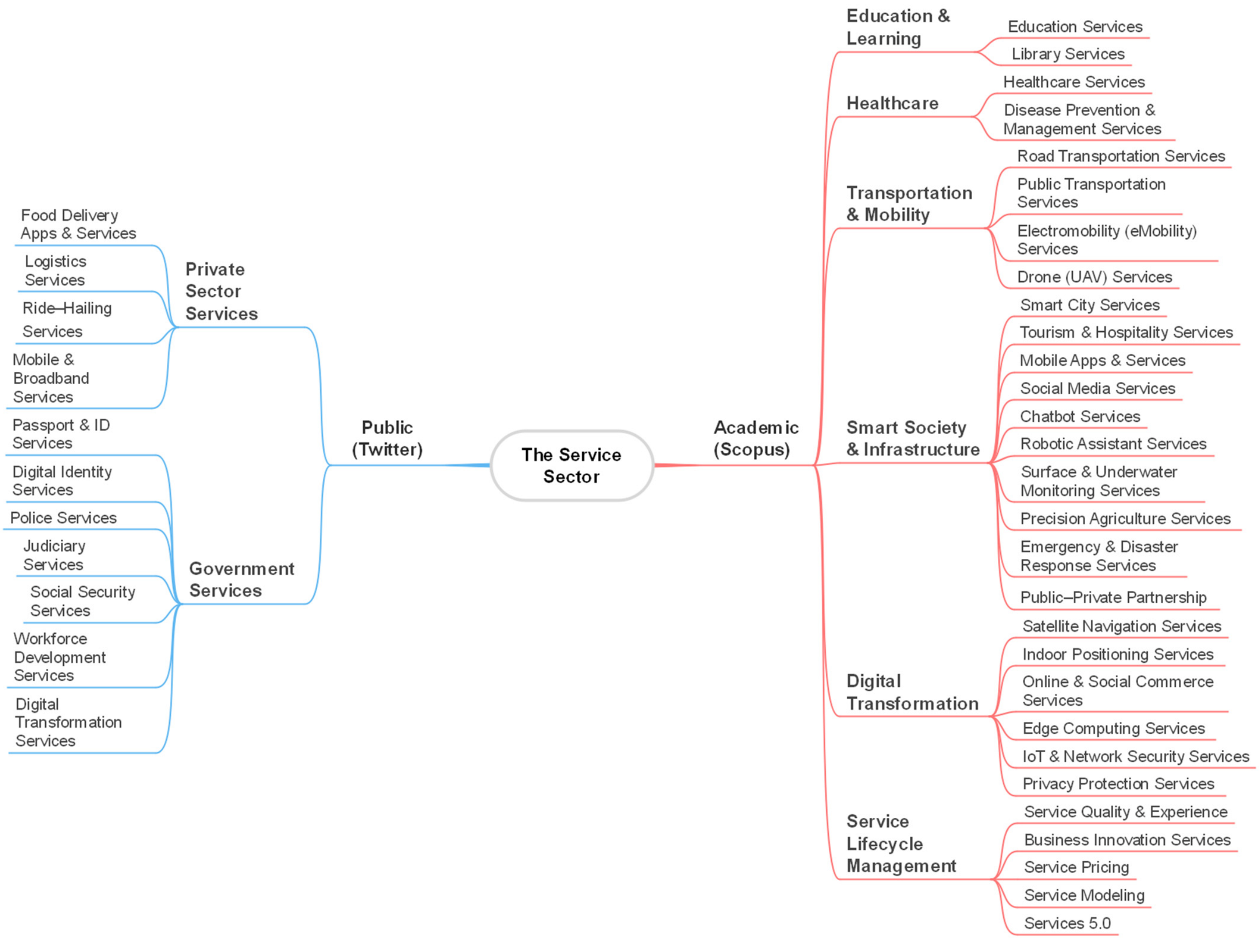

Figure 1. The service sector taxonomy providing a multi-perspective view dataset.

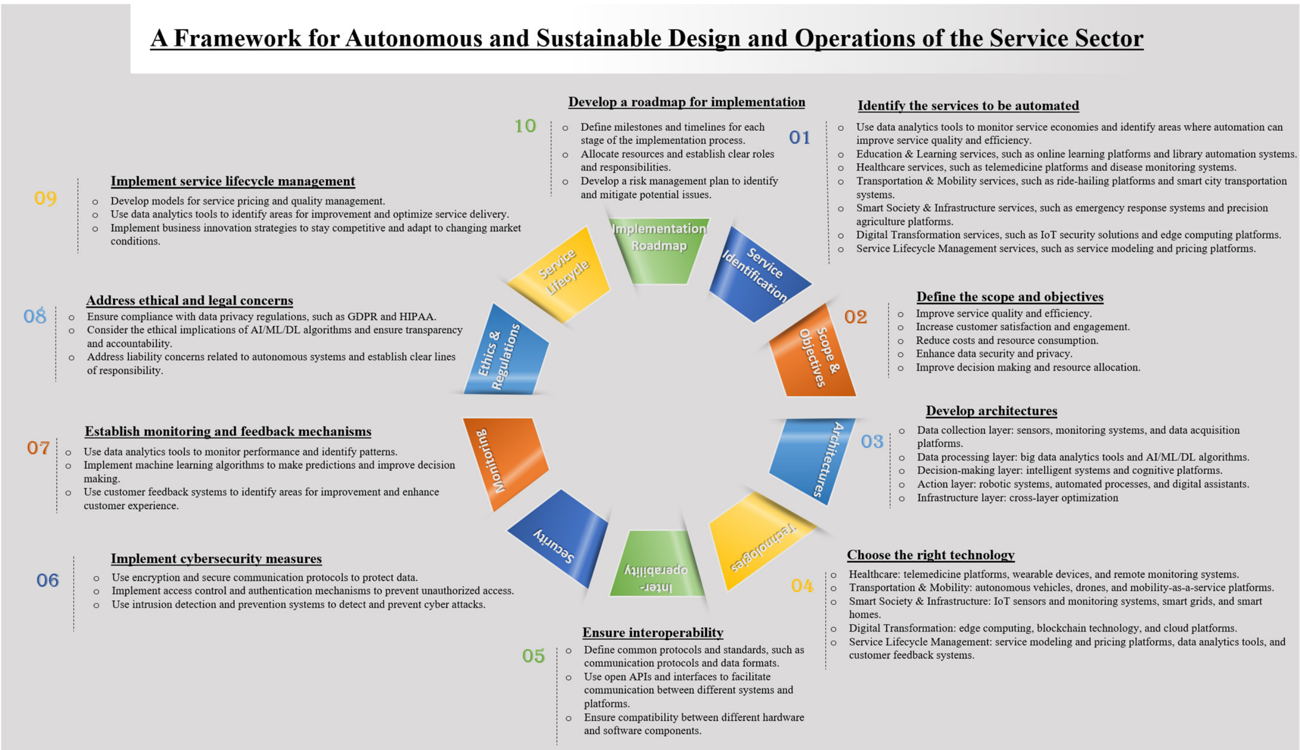

Figure 2. A framework for autonomous and sustainable design and operations of the service sector.

2. Related Works

This section reviews works related to our study. Our approach leverages machine learning to holistically map research in the service sector using a dataset of 175,918 papers from the Scopus database. Nevertheless, no research was found (in such a large dataset of nearly 200 K papers) that would directly relate to our study, which aims to discover holistic and multi-perspective parameters of the service sector using machine learning. Thus, we contextualize our work by discussing related research from two fields. The first field pertains to analyzing the scientific literature on services using scientometrics, as our work is based on analyzing the scientific literature. The second field relates to research on the use of machine learning for social media analysis in the service sector, which is relevant due to Twitter being a source of data in this work. The gaps in research are discussed next.

2.1. Service Sector Analytics Using Data from the Academic Literature

Bibliometric and scientometric analyses are widely employed for evaluating research in diverse areas, such as construction [44], finance [45], labor markets [35], explainable artificial intelligence [46], transportation [47,48], and smart families [49]. Notably, these analytical tools are also used in the service sector to study and comprehend the current literature on various topics related to services. For example, Ali et al. [50] identified trends in healthcare service quality, Arcese et al. [51] examined the family business model's role in the tourism sector, Dubina et al. [52] explored customer loyalty to banking services, and Vaz et al. [53] investigated the impact of sustainability and innovation on the automotive industry. Chang et al. [54] developed a paper categorization system in the field of tourism; Alsahafi et al. [31] investigated the tourism sector using Scopus data; Yas et al. [55] explored customer loyalty, satisfaction, and service quality in the marketing sector; and Ozyurt and Ayaz [56] studied the effect of publications from a journal on education.

Some work on data-driven design of services and product service systems is discussed below. Sassanelli et al. [57] highlight the rise in product-service systems and smart products, emphasizing the challenge for manufacturers to acquire knowledge and introducing a solution—the lean design rules tool (LDRT)—to enhance PSS design knowledge sharing. Pezzotta et al. [58] introduce the Product Service System Lean Design Methodology (PSSLDM), providing a structured approach for manufacturers adopting servitization and emphasizing integrated product and service design throughout the PSS lifecycle, with reported benefits by implementing companies. Additionally, Sassanelli et al. [59] delve into the transition from product to solution-based sales in digitalized manufacturing, focusing on integrating intangible services and introducing "lean PSS" through a literature review to define its features and research prospects.

While these studies have provided valuable insights into specific areas of research, such as healthcare, tourism, marketing, and education, there is a lack of holistic focus on the service sector. Each study has focused on a particular aspect of the service sector rather than investigating the sector as a whole. This suggests that there is a need for more comprehensive studies that consider the various dimensions of the service sector. By conducting such studies, researchers can gain a better understanding of the service sector as a whole, which can contribute to making informed policy decisions and business strategies.

2.2. Service Sector Analytics Using Social Media Data

Information obtained from online platforms, particularly Twitter, has been extensively utilized through textual analysis to explore diverse issues and subjects across numerous fields, including transportation [60], city logistics [61], COVID-19-related studies [62], education [63], smart homes [49], and healthcare [64]. Similarly, a considerable number of studies have applied textual analysis to Twitter data in the service industry. For instance, researchers have explored various service-related themes using social media data. Alahmari et al. [12] proposed co-creating cancer-related health services on Twitter. Zhan et al. [65] developed a framework to identify the most discussed topics concerning pharmacy organizations in the UK. Lee et al. [66] proposed a method for evaluating service quality in public health. Ibrahim and Wang [67] analyzed Twitter to identify customer opinions and concerns about retail brands. Tian et al. [68] attempted to predict service quality in the airline industry. Numerous studies have explored the use of social media data to enhance service quality across various industries, including the transport sector [69], retail sector [70], food supply chains [71], food delivery applications [72], government policy development [73], and customer relationship management [74]. These studies demonstrate the potential of social media data and analytics to improve services across various industries. Despite several studies that have attempted to investigate different aspects of the service industry using social media data, none have done so holistically and nationally. Moreover, there have been only a limited number of studies that have utilized social media to investigate various service sectors in the Arabic language. These studies have predominantly focused on specific service sectors.

2.3. Research Gap

The analysis of the existing research literature shows that the service sector has received significant attention from researchers, with a particular focus on examining specific service sectors, service quality, and other elements that contribute to the overall service experience. While the current literature offers a wealth of information and insights into various aspects of the service sector, there is a need for a more comprehensive understanding of the landscape that considers the potential benefits of emerging technologies that can facilitate holistic optimization across different systems and sectors.

We seek to fill this void by offering a comprehensive analysis and visualization of the service industry landscape from a range of international and national perspectives. Our approach integrates advanced techniques in machine learning to facilitate the discovery and interpretation of knowledge and data. Unlike earlier works, which have focused on specific aspects of the service sector, our research takes a more holistic approach that examines the service sector as a whole and seeks to identify design and operation parameters that can improve overall efficiency and effectiveness.

A key contribution of our work is the development of a deep learning tool that can discover the structure and taxonomy of information related to the service sector, as well as identify opportunities for optimization across different systems and sectors. This tool is based on a rigorous methodology that draws on a range of data sources and analytic techniques, including bibliometric analysis and social media data analytics. The datasets used in this work have been gathered/developed from scratch, and no such datasets have been reported in the literature.

Moreover, aside from furnishing an all-encompassing perspective of the service sector landscape, our work also offers a review of the current literature on the service sector, highlighting key findings and insights that can inform policymaking and other decision-making processes. Using the discovered information, we also develop a comprehensive framework for the autonomous design and operations of service sectors using data analytics, AI, machine and deep learning, and robotic systems to improve efficiency, reduce costs, enhance customer satisfaction, and ensure data security and compliance with ethical and legal considerations.

In brief, our research contributes to a deeper understanding of the service sector and offers new insights and opportunities for optimizing the sector using cutting-edge technologies and analytical methods.

3. Methodology and Study Design

This section delves into the intricate details of our methodology and design. Figure 3 is the software architecture of our system, with its four components depicted in four vertical blocks. The architecture is expounded on in this section. From Sections 3.1–3.6, we provide an overview of the system and then discuss the various phases involved in the research and the tool.

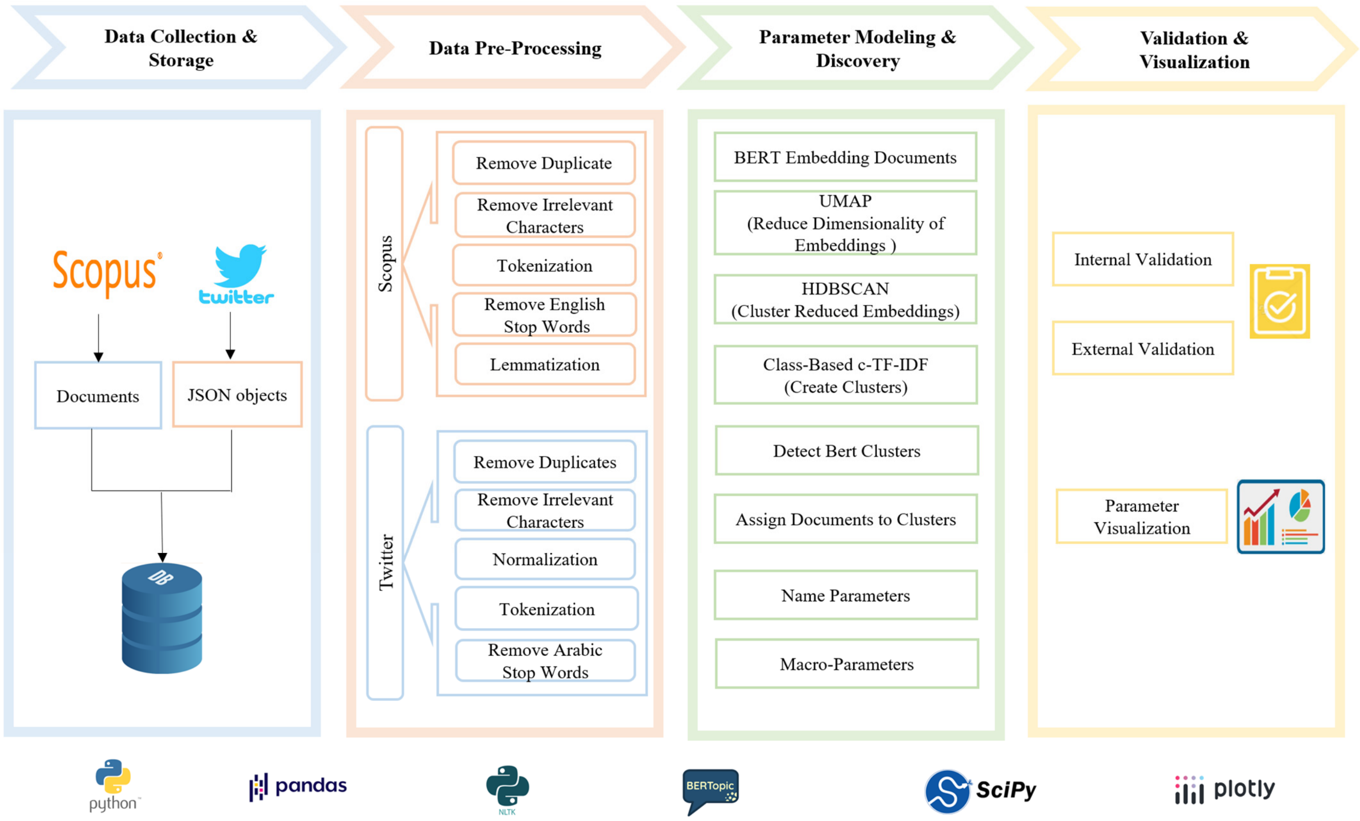

Figure 3. System architecture.

3.1. System Overview

Our dataset was created using a predefined search query, and the information was then saved in the CSV format. The data are then processed before the main processing with Pandas to implement the data pre-processing functions, such as removing duplicates from the dataset, removing characters that are irrelevant, accomplishing tokenization, and eliminating stop words from the dataset, as well as implementing lemmatization and then producing cleaned tokens. After that, we used the BERTopic model in our experiment with word embedding representations. The pre-trained BERT word embedding model has been utilized to identify the contextual relationships among words [75]. Then, we invoked UMAP to reduce embedding dimensions [76] and HDBSCAN to cluster semantically similar data together [77]. Using domain knowledge, hierarchical clustering, similarity matrix, and different quantitative analysis techniques, the clusters are then investigated, retagged as parameters, and further combined around macro-parameters. Moreover, the parameters were visualized using different numerical analysis techniques. Subsequently, validation of the identified parameters based on the scientific literature, tweets, and other sources is performed.

3.2. The Dataset

For this dataset, we gathered data from Twitter for the public perspective and data from Scopus for the academic viewpoint. Since Scopus is a database that indexes scholarly research, we believe that it offers an academic perspective on the service sector. Although public perspectives and circumstances could be described in academic publications, as they are viewed and voiced by academics, these perspectives could still be regarded as academic. In addition, we used Twitter to learn what the general population thinks about services. Twitter may contain posts from different stakeholders; therefore, it might be used to capture the perspectives of other stakeholders. Nonetheless, the tweets from diverse stakeholders are primarily intended to interact with people.

3.2.1. Scopus Data

We captured the research articles related to the service sector in the English language from Scopus. In this research, we gathered 175,918 research articles for the period 2018–2022 (collected until June 2022, the time of data collection) using the term "service" and the subject area "Computer Science". The final dataset, after cleaning and removing duplicates and irrelevant papers, comprised 42,389 documents. The document types of the collected data were not restricted to any type and included journal articles, etc.

3.2.2. Twitter Data

The Twitter REST API was used to acquire the Arabic tweets. Tweets were collected by using different key terms related to services. For example, we used the key terms "خدمة حكوميه" (government service), "خدمة ناجز" (Najiz service), "خدمات النقل" (transport services), "تطبيقات التوصيل" (delivery apps), "الاقتصاد الرقمي" (digital economy), and others. We exclusively collected tweets sent within Saudi Arabia using geolocation filtering to find important services pertaining to Saudi society. The total number of tweets collected from Twitter was 112,862 tweets during the period from 9 October to 13 November 2022. The Twitter data were in the form of tweet objects in JSON with a series of attributes such as "created_a", "text", and others. We converted the collected JSON file into CSV format. Also, the dataset was cleaned by removing duplicates, resulting in a total of 84,271 tweets.

3.3. Data Pre-Processing

3.3.1. Scopus Data Pre-Processing

Data pre-processing involves various steps to data manipulation or deletion before usage in order to guarantee or improve performance. Data pre-processing includes the following steps: remove duplicate articles, remove irrelevant symbols, tokenize, remove English stop words, and lemmatize. First, using the Python library "Pandas", we read the CSV file into a data frame. To avoid the frequency of the same articles, we removed duplicate articles. Then, we removed all irrelevant digits, characters, and extra spaces. Fourthly, we implemented tokenization on the dataset using tokenize() to split a string into a list of words. The step that followed involved removing the English stop words using a predefined list of stop words, a natural language toolkit (NLTK). Finally, we implemented the lemmatization process using the WordNet Lemmatizer module. Consequently, we received and stored the cleaned articles.

3.3.2. Twitter Data Pre-Processing

The text posted on social media is unstructured data that needs cleaning. The main data pre-processing steps are as follows: remove unessential characters, normalize, tokenize, and remove stop words. We loaded the tweets into Panda Data Frames. To avoid the frequency of the same tweets, we removed duplicate tweets. We removed extra spaces, lines, emails, repeated characters, single quotes, the English alphabet, and all emojis from the tweet. Additionally, we removed the punctuation by making a list of all punctuation, such as semi-colons (;), periods (.), colons (:), question marks (?), and others. Also, we removed diacritic marks such as Fatha (َ), Kasra (ِ), Damma (ُ), Tanwin Fath (ً), Tanwin Kasr (ٍ), Tanwin Damm (ٌ), Sukun (ْ), and Tashdid (ّ). This step has made information more valuable and decreased the size of the feature set.

Then, we implemented tokenization on the dataset using tokenize() to split each tweet into a list of tokens. The step that followed involved normalizing the letters that have multiple shapes into a consistent form, such as the Arabic letter Alif (أ). We normalized three letters (آ ا إ) to (ا). Also, the letter Yaa (ي) was normalized to (ى), and Taa Marboutah (ة ه) was normalized to Taa (ة). Then, we removed stop words that were not important in extracting the information. We used NLTK to remove the stop words by adding a new list of stop words used in dialectical Arabic, including "انتو", "وين", "علشان", "بينما", and

"بيني". Before implementing Bert topic modeling, we used clustering to obtain the tweets that are related to services in Saudi Arabia alone. We used a list of service keywords to filter the tweets. For example, we used the key terms: "اقتصاد" (economy), "التوصيل" (delivery), "الشحن" (shipping), "النقل" (transport), "اللوجستية" (logistics), "القضاء" (judiciary), "الاتصالات" (telecommunications), and others.

3.4. Parameter Modeling

We employed BERTopic modeling to classify the collected dataset into topic clusters. BERT is used to understand language, and it is a pre-trained version of deep bidirectional transformers. We created a word embedding model using a transformer-based technique called BERT [75]. Contextualized word representations are extracted for all tokens using embedding models and subsequently fed into BERTopic. In our experiment, we used pre-trained language models of sentence transformers, called "distilbert-base-nli-mean-tokens", with the Scopus dataset, used for clustering and semantic search tasks. For the Twitter dataset, we used pre-trained language models of sentence transformers, called "aubmindlab/bert-base-arabertv2"; AraBERT is an Arabic pre-trained language model. After the embedding step, we performed a dimensional reduction algorithm, UMAP to reduce the dimension of the embedding. After that, we used HDBSCAN to cluster semantically similar clusters together. If we consider all documents in the cluster as a single document and implement TF-IDF, this has enabled us to obtain a significant score for each word in the cluster, which is named the c-TF-IDF score. When the words in a cluster carry greater importance, the parameter becomes a more accurate reflection of the group of words. So, we can find a set of keywords that describe every parameter.

Estimating the number of parameters to be retrieved from the documents prior to model training is a challenging task. Thus, to achieve optimal outcomes, BERTopic was trained on the documents, and a series of trials were executed. The most favorable model was then preserved. The domain knowledge of the authors, the information gained from the modeling, and their quantitative analysis were used to convert a set of clusters to a set of parameters and consolidate them into macro-parameters.

3.5. Quantitative Analysis and Visualization

BERTopic provides different visualization possibilities that help to obtain more insight into each topic. These quantitative analysis methods with domain knowledge contribute to discovering the parameters and macro-parameters. The main methods of quantitative analysis are discussed as follows. Inter-topic Distance Map: It can be described as a two-dimensional representation of topics. In BERTopic, an inter-topic distance map can be visualized by using the visualize_topics() function to represent the topics that were generated as circles with the top 10 most frequent terms for each topic and the distance between topics. Keyword Score: A BERT model is given a list of keywords that describe the parameters. Each keyword has to explain the context of the parameter and represent the value of c-TF-IDF (see Section 3.4). Term Score: Term score is a method for the visualization of the ranks of all terms (keywords) for all topics. Each topic is represented with a set of terms in terms of how representative they are of the topic in terms of the c-TF-IDF scores. A higher score indicated a higher representation. A term score graph depicts the scores of c-TF-IDF for every topic with each word's term rank. Hierarchical Clustering: Hierarchical clustering helps to visualize the hierarchical structure of the topics via systematically pairing clusters and visualizing how they relate to one another. We used Ward's linkage function to implement hierarchical clustering using a cosine distance matrix between topics. Similarity Matrix: It is visualized using the matrix of cosine similarity among topic embeddings. We utilized the Plotly library to visualize the heatmap using a similarity matrix. To demonstrate the relationship between the topics, the similarity matrix was generated by calculating the cosine similarity between the topics. We have used the continuous color scale "BnGu", green to blue, from Plotly, where clusters with the highest similarity are represented with dark blue, while those with the least similarity are depicted in light green.

3.6. Evaluation and Validation

To validate our results for the proposed system, we used two different approaches: internal and external validation. The internal one is implemented by determining whether the documents involving academic articles or tweets are associated with a specific parameter. We define and expound upon the parameters by drawing insights from related academic articles as well as pertinent tweets. The external validation is achieved by performing comparisons for taxonomies and quantitative data between the two datasets. We also utilized different online sources to validate the information about the parameters. Additionally, we performed both types of validation using visualization. These visualization methods allow for elaboration on the datasets and the discovered services, such as taxonomies, temporal progression plots, similarity matrices, and others. A number of Python libraries have been used with our tool to perform the visualizations, such as Plotly, Matplotlib, and others.

4. Global Analysis Results: Service Sector Parameters from Scopus

This section describes the parameter space of the parameters that were extracted using our tool from the Scopus data. The parameter space is discussed in Section 4.1, followed by a quantitative analysis in Section 4.2. Sections 4.3–4.8 go into more depth about each specific macro-parameter. For each macro-parameter, we describe it using its clustered articles and sources external to the dataset.

4.1. Overview

Using our tool and the Scopus dataset, we identified a total of 30 clusters, numbered 0 to 29. One of the 30 clusters was unrelated to the topic of the work, cluster number 12, so we excluded it from the analysis. On the basis of domain expertise and quantitative techniques, we identified and labeled 29 parameters for the service sector, categorized into 6 macro-parameters. The macro parameters are listed in Column 1 of Table 1, namely education & learning, healthcare, transportation & mobility, smart society & infrastructure, digital transformation, and service lifecycle management. The names of each parameter and their associated cluster numbers are presented in Columns 2 and 3. In Column 4, we listed the percentages of the articles for each parameter. Column 5 includes the top ten parameter-affiliated terms. The taxonomy presented in Figure 4 illustrates the map of the parameter space in the service sector, as detected with our tool. The classification was derived from the information presented in Table 1. The topmost layers of the taxonomy represent the macro-parameters, followed by the parameters in the middle layers, and the dimensions associated with each parameter in the lowermost layers.

Table 1. The service sector parameter space providing an academic view.

Macro-Parameters	Parameters	Cluster No.	%	Keywords
Education & Learning	Education Services	4	2.14	Student, Learning, Education, Teaching, University, Course, Educational, School, Online, Research
	Library Services	23	0.55	Library, Research, Service, Data, University, Academic, Digital, Science, Community, Project
Healthcare	Healthcare Services	0	8.14	Patient, Health, Healthcare, Medical, Care, Data, Hospital, System, Disease, COVID
	Disease Prevention & Management Services	22	0.57	Web, Available, Tool, Data, Disease, Analysis, Database, Prediction, Structure, Site

Table 1. *Cont.*

Macro-Parameters	Parameters	Cluster No.	%	Keywords
Transportation & Mobility	Road Transportation Services	10	1.42	Vehicle, Taxi, Car, Road, Driver, Traffic, Driving, Safety, Transportation, Service, System
	Public Transportation Services	14	0.88	Bus, Passenger, Train, Railway, Rail, Transit, Stop, Travel, Track, Line, Station
	Electromobility (eMobility) Services	8	1.85	Energy, Charging, Electricity, Renewable, System, Electric, Wind, Demand, Control, Market
	Drone/UAV Services	24	0.55	Drone, Aircraft, Airport, Flight, Air, Ground, Aviation, Passenger, Service, System
Smart Society & Infrastructure	Smart City Services	11	1.22	City, Smart, Urban, Data, Citizen, Technology, Service, Development, Public, Sustainable
	Tourism & Hospitality Services	28	0.46	Tourism, Tourist, Hotel, Industry, Service, Information, Customer, Travel, Review, Development
	Mobile Apps & Services	7	1.87	Mobile, User, Apps, Smartphone, Smartphones, Device, App, Android, Privacy, Application
	Social Media Services	17	0.78	Social, Twitter, Tweet, Medium, User, Facebook, Sentiment, Opinion, Information, News
	Chatbot Services	21	0.58	Chatbots, Chatbot, Customer, Service, User, Research, Factor, Conversation, System, Data
	Robotic Assistant Services	6	1.88	Robot, Human, Robotic, Object, Task, Robotics, Environment, System, Service, Autonomous
	Surface & Underwater Monitoring Services	27	0.48	Water, Marine, Sea, System, Sensor, Data, Monitoring, Acoustic, River, Ocean
	Precision Agriculture Services (PAS)	19	0.66	Agricultural, Forest, Agriculture, Crop, Soil, Data, Farm, Land, Production, Rural
	Emergency & Disaster Response Services	15	0.88	Disaster, Flood, Weather, Emergency, Fire, Earthquake, System, Event, Response, Data
	Public–Private Partnership (PPP)	13	0.94	Service, Process, System, Government, Information, Design, Approach, Data, Research, Management
Digital Transformation	Satellite Navigation Services	16	0.84	Satellite, Orbit, Navigation, GNSS, Bd, Positioning, Signal, System, Constellation, Earth
	Indoor Positioning Services (IPS)	20	0.65	Indoor, Positioning, Localization, Location, Fingerprint, Accuracy, Signal, Environment, System, Navigation
	Online & Social Commerce Services	18	0.68	Customer, Online, Review, Commerce, Consumer, Product, Social, Service, Brand, Purchase
	Edge Computing Services	9	1.56	Network, Resource, Service, Reduce, Problem, Cost, Task, Energy, Computing, User
	IoT & Network Security Services	2	3.51	Attack, Detection, Network, Denial, Security, Do, Traffic, Malicious, Detect, Threat
	Privacy Protection Services	5	2.07	Privacy, Data, Security, User, Encryption, Cloud, Authentication, Key, Secure, Encrypted

Table 1. *Cont.*

Macro-Parameters	Parameters	Cluster No.	%	Keywords
Service Lifecycle Management	Service Modeling	25	0.54	Queue, Customer, Arrival, Distribution, Queueing, System, Service, Probability, Time, Packet
	Service Pricing	29	0.44	Price, Profit, Customer, Service, Pricing, Provider, Market, Optimal, Consumer, Cost
	Service Quality & Experience	1	5.07	Wireless, Network, Communication, Mobile, Energy, User, Service, Performance, Transmission, Access
	Business Innovation Services	26	0.52	Business, Digital, Product, Company, New, Process, Industry, Service, Manufacturing, Innovation
	Services 5.0	3	2.30	Cloud, Home, IoT, Data, Service, Smart, Application, Computing, Device, Internet

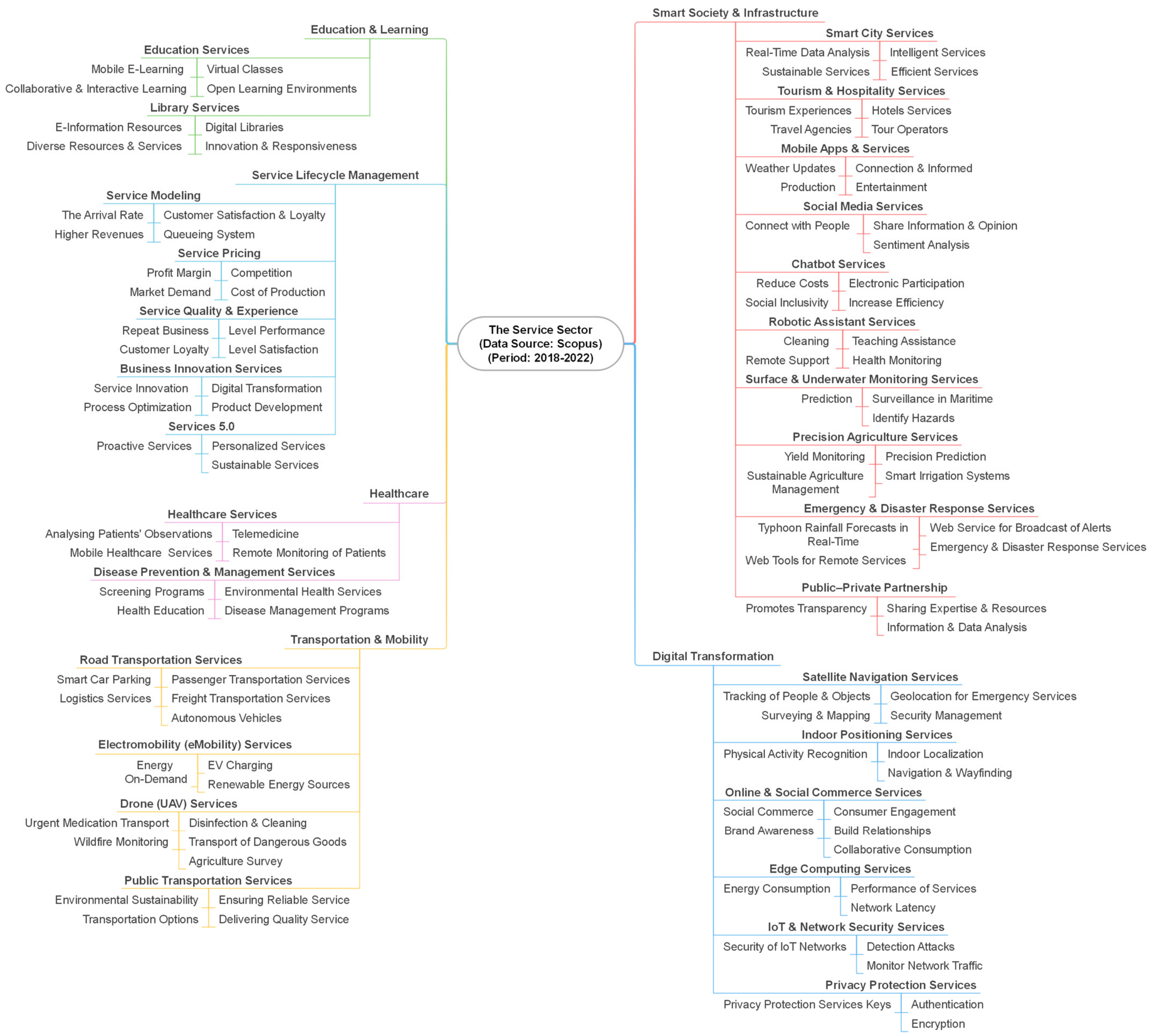

Figure 4. The service sector taxonomy providing an academic view.

4.2. Quantitative Analysis (Scopus Dataset)

A quantitative analysis of the results has been carried out using our software tool and the Scopus dataset. The analysis includes a term score decline graph, an inter-topic distance map, a similarity matrix, keyword scores, and a hierarchical clustering map. To keep this brief, we have omitted these graphs, but they are available upon request.

4.3. Education & Learning

This macro-parameter encompasses all services related to education & learning, from traditional classroom education to online learning and educational support services [78,79]. The goal of these services is to provide learners with the skills and knowledge they need to succeed in their personal and professional lives. Education services can include everything from K-12 education to post-secondary education, vocational training, and adult education. Library services are also included in this macro-parameter, as libraries serve as important resources for learners of all ages by providing access to information and knowledge.

4.3.1. Education Services

Education services are professional support provided by educators or educational institutions to facilitate personal and professional growth through teaching, curriculum development, assessment, technology implementation, and advisory services [80]. The parameter encompasses various dimensions of education services, including the importance of open learning environments for reducing geographical and time limitations [78], the use of modern technology in delivering virtual classes [81], mobile e-learning [82], the impact of online social networks on students' development [83], educational sustainability in general, and, in particular, the use of social media platforms and modern technologies for educational sustainability during pandemics and disasters [84,85]. Other dimensions include improving learning outcomes [82,86], continuing out-of-class communication (OCC) [83], evaluating the quality of services in education systems [81], enhancing self-efficacy for online learning [87], overcoming the barriers of traditional education [86], and promoting collaborative and interactive learning [88]. For instance, regarding education sustainability, Baytiyeh [84] highlighted how social media platforms can contribute to educational sustainability and accessibility during times of disaster when educational institutions are unable to guarantee students' safety or provide secure learning conditions.

4.3.2. Library Services

Library services are a collection of resources, facilities, and support provided by a library to meet the information and educational needs of its users [89,90]. Library services support research and learning, promote literacy, and enrich the cultural and intellectual life of the community [91,92]. Library services are diverse and aim to provide quality standards and efficient delivery of information to support learning and research goals [93,94]. This parameter is characterized by various dimensions of library services. These dimensions include access to diverse resources and services, both physical and digital, effectiveness in meeting user needs, innovation and responsiveness to changing user needs and new technologies, collaboration with other institutions and stakeholders, outreach to the wider community, quality standards in terms of resources, expertise of staff, and user experience, and providing electronic information resources through digital libraries to support e-learning [95–98]. For example, see [99] (use of mobile augmented reality (MAR) technology to access library services) and [100] (the role of libraries in supporting e-learning).

4.4. Healthcare

This macro-parameter encompasses all services related to healthcare [101,102], including preventative care, treatment of illnesses and injuries, and management of chronic conditions. The goal of healthcare services is to maintain and improve the health of individuals and communities [103]. Examples of healthcare services include hospitals, clinics, medical practices, and public health organizations. Disease prevention and management services are also included in this macro-parameter, as they play a crucial role in maintaining the health of individuals and communities.

4.4.1. Healthcare Services

Healthcare services encompass a wide range of medical and therapeutic interventions, provided by healthcare professionals and facilities, aimed at diagnosing, treating, and preventing illness, injury, and disease through primary care, specialized care, diagnostic services, and therapeutic interventions [12]. Healthcare organizations and service providers endeavor to improve the quality of services provided to patients [104] and analyze and track patient data to improve healthcare services [101,105].

This parameter helped to cover multiple dimensions of healthcare services, including telemedicine for remote healthcare delivery [106,107] and ICTs for disease detection and prediction [64,108]. Additionally, it highlights the importance of providing healthcare services in rural and remote areas [106] and engaging citizens in co-creating value for services [12].

4.4.2. Disease Prevention & Management Services

Disease prevention and management services include interventions to prevent or reduce the impact of diseases on individuals and communities [64]. These services comprise immunizations, health education, screening programs, disease management programs, and environmental health services [12]. These services are vital for promoting healthy communities and reducing the burden of illness by providing education, immunizations, screenings, and disease management programs. In the age of digital technology, the web has become a vital platform for accessing and sharing information. One area where the web has proved particularly useful is in disease analysis and prediction. Thanks to the availability of data and the development of powerful tools for data analysis, researchers and healthcare professionals can now use digital and web-based databases and sites to gather, store, and analyze vast amounts of health-related information [62]. These databases and sites are structured to enable efficient and accurate data retrieval and analysis, making it easier to identify patterns, trends, and risk factors associated with different diseases [109]. Using these tools, researchers and healthcare professionals can develop predictive models that can help anticipate and prevent disease outbreaks, ultimately leading to better health outcomes for individuals and communities [110,111].

This parameter covered multiple dimensions of these services, including IoT, smart farming systems, disease prediction using social media and networks, activity recognition, and smart homes. These technologies allow for remote monitoring, timely interventions, personalized prevention and management plans, and healthier living environments [112,113].

4.5. Transportation & Mobility

This macro-parameter encompasses all services related to transportation & mobility [114], from traditional road transportation to innovative services such as electromobility and drone services. The goal of these services is to provide individuals and goods with safe, efficient, and reliable transportation options [115]. Examples of transportation services include public transportation services such as buses and trains, ride-sharing services such as Uber and Lyft, and eMobility services such as electric cars and bikes [116]. Drone services are also included in this macro-parameter, as they represent an emerging technology that has the potential to revolutionize the way goods are transported.

4.5.1. Road Transportation Services

Road transportation services involve the movement of people, goods, and services from one place to another using various vehicles, including cars, taxis, trucks, motorcycles, and other automobiles [117]. Drivers operate these vehicles on the road system, which can be affected by traffic congestion, weather conditions, and other factors that impact driving safety. Road transportation services play a crucial role in facilitating trade and commerce, as well as providing access to essential goods and services. With the continued development of technology and innovation [118], these services are expected to continue to improve and enhance the quality of life for individuals and communities [119].

Our tool helped to cover multiple dimensions of these transportation services, such as passenger transportation and freight transportation, logistics, and warehousing. With the emergence of technology, road transportation services have evolved to include systems such as autonomous vehicles, connected vehicles, and the internet of vehicles (IOV) [120]. These systems aim to optimize traffic and improve safety by enabling information sharing and traffic optimization. For example, see the benefits of autonomous and connected vehicles in enhancing safety and reducing traffic congestion [118] and the internet of vehicles to improve road safety by exchanging information among vehicles to prevent accidents [121].

4.5.2. Public Transportation Services

This parameter covered various dimensions of public transportation services, including congestion reduction, resilience, performance, quality of service, and sustainability [122,123]. These dimensions encompass aspects such as providing effective transportation options, ensuring reliable service, delivering quality service, and maintaining environmental sustainability [48]. Public transportation services such as buses, trains, subways, and trams provide affordable and efficient transportation options for passengers in cities and regions. Buses have features such as air conditioning, wheelchair accessibility, and bike racks, while trains and subways offer faster and more efficient options with designated stations and tracks that provide higher passenger capacity. These services play a crucial role in reducing traffic congestion, promoting sustainable modes of travel, and providing access to transportation for a wide range of people [124,125]. For example, see an integrated system of wireless communication in urban rail transit with a high QoS to share data pertaining to train safety [126] and integrate QoS and energy savings parameters in urban rail transit systems [127].

4.5.3. Electromobility (eMobility) Services

This parameter helped cover a range of dimensions of electromobility (eMobility) services. The term eMobility refers to a range of products and services that facilitate the use of electric vehicles (EVs) as a mode of transportation [114,128]. These services play a crucial role in reducing greenhouse gas emissions and supporting the transition to a more sustainable energy system [129]. Electromobility services involve the development, installation, and maintenance of EV charging infrastructure and related services such as battery swapping, fleet management, and energy storage [130]. The EV charging infrastructure uses electricity, which can be sourced from renewable sources such as solar and wind, to meet the growing demand for EV charging. Smart charging solutions that optimize charging times based on energy demand and pricing help control electricity usage [131]. The integration of EV charging with renewable energy sources and the implementation of energy storage solutions for EV charging further help in the transition to a more sustainable transportation system. Various players in the market offer eMobility services, and the market for these services is growing as more people adopt EVs [48]. We discovered a significant amount of interesting research that relates to this parameter. For example, enhancing eMobility services and QoE for end users by processing content at the network's edges [132], EV charging services as a promising solution to address excessive fuel consumption and greenhouse gas emissions [133], eMobility services to aid in reducing environmental pollution [134], and promoting economic power systems that rely on renewable energy sources [135].

4.5.4. Drone/Unmanned Aerial Vehicle (UAV) Services

This parameter captured multiple dimensions of drone (or unmanned aerial vehicle (UAV)) services, including agriculture surveying, delivery services, wildfire monitoring, medical and healthcare services, transport of dangerous goods, disinfection and cleaning, and urgent medication transport. Drones and UAVs are terms that are used interchangeably, though some may differentiate between them. Additionally, the terms RPAS and UAS are also sometimes used instead of drones or UAVs. While these terms all refer to unmanned aerial vehicles, they may also be used to specify certain features or applications of the aircraft [136]. Drones have revolutionized various industries by providing numerous benefits [137–141], such as improved safety, efficiency, and cost-effectiveness. However, there are concerns about their use near airports and controlled airspace, as well as in other areas such as residential neighborhoods, public spaces, and critical infrastructure. The potential risks include collisions with other aircraft, invasion of privacy, and disruption of public safety operations.

Examples of research related to this parameter include the following: the usefulness of drone fleets in large-scale agriculture and forestry surveying [142], the utilization of drones for remote wildfire monitoring [143], the benefits of deploying drones for medical and healthcare-related services, especially for patients in hard-to-reach areas [144], the significance of using drones for the safe transportation of dangerous goods in medical logistics [145], and the role of drones in the disinfection and cleaning of surfaces during COVID-19 [146].

4.6. Smart Society & Infrastructure

This macro-parameter encompasses a wide range of services related to the development of smart societies and infrastructure. These services utilize innovative technologies such as AI, machine learning, and IoT to create more efficient and effective ways of delivering services to individuals and communities [147]. Examples of services in this macro-parameter include emergency and disaster response services, surface and underwater monitoring services, tourism & hospitality services, public–private partnership services, and social media and chatbot services. These services are designed to improve the overall quality of life for individuals and communities by providing them with more effective and efficient services [148].

4.6.1. Smart City Services

Smart city services refer to a set of advanced technological solutions aimed at making urban areas more intelligent, efficient, sustainable, and livable [149]. Smart city services enhance urban development by providing accessible, citizen-focused services that promote sustainability, economic competitiveness, and quality of life [150]. These services utilize data-driven development and real-time data analysis to provide accessible digital services that are responsive to the needs of citizens [151]. These services create a more responsive, efficient, and sustainable urban environment for citizens and are designed to be accessible to both inhabitants and city authorities, with the government, citizens, and businesses co-creating digital solutions that provide value to all stakeholders.

Smart waste management systems use sensors and real-time data analysis to improve waste recycling, garbage collection, and waste disposal [152]. Similarly, smart water management solutions leverage technology to manage water supply, reduce water waste, and promote sustainable development. Among the articles in this parameter, consider, for example, citizen participation in new ICT services and applications across various aspects of urban life to achieve sustainability, reliability, resilience, and smartness in cities [153], as well as the use of data-driven approaches to sustainable urban development to help engage companies and citizens in the process of monitoring, planning, and analyzing urban processes, optimizing urban services, and increasing the level of smartness and sustainability in cities [154].

4.6.2. Tourism & Hospitality Services

Tourism & hospitality services refer to a range of businesses and organizations that provide services to people who are traveling or seeking leisure activities [155]. These services can include accommodation, food and beverage, transportation, entertainment, and other activities. Tourism & hospitality services are integral parts of the global travel and tourism industry, which has experienced significant growth over the past decade (though there was a significant decline due to COVID-19 [31]).

Our tool helped to cover various dimensions of tourism & hospitality services that cater to the needs of tourists [156], including hotels, restaurants, transportation services, tour operators, and travel agencies. For example, utilizing vast amounts of data (i.e., big data) generated by visitors to offer personalized travel options and assist tourism stakeholders in making strategic decisions [157]; the contribution of tourism services to improve people's welfare through a creative process that drives the economy [158]; the role of smart tourism in significantly improving tourism management, economics, and services for the growth of the tourism sector [159]; and an in-depth recent review of the tourism sector [31].

4.6.3. Mobile Apps & Services

Mobile apps & services have become an essential part of modern life, enabling users to stay connected and informed, be more productive, and engage in a variety of activities on-the-go [160]. Mobile apps and services are software applications designed for mobile devices such as smartphones, tablets, and wearables [161]. These apps can be downloaded from app stores, which are online platforms operated by smartphone operating system providers or independent developers.

Mobile apps and services offer numerous benefits to users, including convenient access to a range of features such as social networking, entertainment [162], productivity, e-commerce [160], and education [163]. However, the use of mobile apps and services also raises privacy concerns due to the amount of personal information that they collect from users. Therefore, it is essential to implement privacy controls to ensure that users' personal information is protected. In addition, mobile apps and services may consume significant amounts of resources, such as battery life, data, and processing power. For instance, Ren et al. [164] explained that the EasyPrivacy system for Android smartphones provides an automatic context-aware resource usage control system when using numerous applications.

4.6.4. Social Media Services

This parameter covered several dimensions of social media services, which are online platforms that allow users to create and share information, news, and opinions, interact with others, and connect with people from all around the world [165]. Twitter is one such platform; it allows users to share their thoughts and opinions in the form of tweets [60].

Social media services offer diverse features, such as profiles, where users can provide information about themselves and their interests. Sentiment analysis is a technique that analyzes social media information to determine the opinions, attitudes, and sentiments expressed by users [166,167]. This can be useful in various fields, such as understanding customer satisfaction, analyzing online reviews, and assessing service quality. Businesses can use a sentiment analysis to make data-driven decisions based on consumer behavior and opinions expressed on social media.

The availability and accessibility of social media data and information have facilitated the spread of information. This has led to a shift in the way information is consumed and has influenced consumer behavior. The spread of social media information and news has also made it easier for businesses to monitor and analyze customer sentiment and opinions, which can inform their business decisions. For examples of research on this parameter, see [168,169].

4.6.5. Chatbot Services

A chatbot service is an innovative computer program designed to facilitate electronic participation and co-designing processes between businesses and their customers [170,171]. Chatbots are designed to simulate human-like conversations with users via messaging platforms or mobile devices [172–174]. These systems are powered by data and research, ensuring they can deliver high-quality customer service. Chatbots can be rule-based or AI-powered [175,176], with the latter being able to understand natural language and provide more personalized and context-aware responses. Chatbots can help businesses reduce customer service costs and increase efficiency. They can also facilitate customer feedback and social commerce, enabling businesses to build strong customer relationships and promote sustainability. Additional examples of research on the topic include [177,178].

4.6.6. Robotic Assistant Services

This parameter covered multiple dimensions of robotic assistant services [179]. These robots are designed to perform specific functions using a combination of sensors, AI, and ML. Robotic assistant services offer numerous benefits, including increased efficiency, improved accuracy, and reduced labor costs. They provide assistance in a number of domains, including personal and professional tasks. For instance, personal assistant robots can help humans with scheduling, setting reminders, and organizing appointments. Eldercare robots can assist the elderly with medication reminders, physical therapy, and health monitoring [180]. Cleaning robots, on the other hand, can clean floors, windows, gutters, and other hard-to-reach areas, which can be challenging for humans [181]. Robots can also perform tasks in hazardous or challenging environments, reducing the risk of injury to humans. Teaching assistance robots can be used in educational settings to help students learn, interact, and communicate with others. Social interaction robots can help individuals with social skills training or assist those who suffer from mental health issues. Additional examples of studies that belong to this parameter include [182,183].

4.6.7. Surface & Underwater Monitoring Services

This parameter is about surface and underwater monitoring services, which are critical for understanding, protecting, and managing the complex system of water resources and marine ecosystems [184]. By collecting and analyzing data, these services provide valuable insights that can inform policies and practices to protect our natural resources and ensure their sustainable use for generations to come. These services rely on a variety of specialized equipment and techniques [185], including IoT, autonomous underwater vehicles (AUVs), and acoustic systems, to collect data on the water surface and underwater environments, including marine life, climate change, statistics of the inhabitants of coral reefs, water quality, temperature, salinity, and other physical and chemical properties. In rivers and oceans, acoustic sensors can be used to monitor the movement of marine life and the presence of underwater structures, such as oil rigs or offshore wind turbines. These data can be used to assess the impact of human activities on marine ecosystems and identify potential hazards. Additional examples of research related to this parameter include [186,187].

4.6.8. Precision Agriculture Services (PAS)

This parameter helped to cover multiple dimensions of precision agriculture services (PAS) such as productivity enhancement, resource management, precision prediction, smart irrigation systems, e-commerce for agricultural products, crop pest detection, digital twin in agriculture, and sustainable agriculture management [188,189]. PAS is an advanced agricultural management approach that utilizes technology and data to optimize crop production and reduce waste [190,191]. This technique is widely used in both the agricultural and forest industries, where it is vital to increase productivity while minimizing environmental impact. PAS incorporates various technologies, such as GPS, sensors, drones, and machine learning algorithms, to collect data on factors that influence crop growth, including soil moisture, nutrient levels, temperature, and weather patterns. By analyzing the data collected through these technologies [192,193], farmers can make informed decisions about when and where to apply fertilizers, water, and pesticides, among other inputs. This parameter has been the focus of a considerable number of research studies, some of which are [194,195].

4.6.9. Emergency & Disaster Response Services

Emergency and disaster response services are essential in responding to natural disasters and other events that can cause significant damage to property and threaten human life [196]. Emergency response teams utilize advanced systems to collect data and assess the situation to help coordinate the response efforts effectively [197,198]. This parameter covered multiple dimensions of emergency and disaster response services, including disaster and agriculture sentinel applications, web tools for remote services, satellite earth observation (EO) of vegetation regions, web services for broadcasting alerts and early warnings, typhoon rainfall forecasts in real-time, decision-making support, better rescue plans, and aid for both individuals and disaster management authorities. For instance, Doxani et al. [199] highlighted the importance of disaster and agriculture sentinel applications to reduce and support decision making for disaster management.

4.6.10. Public–Private Partnership (PPP)

PPP is a collaborative approach that brings together the resources and expertise of the public and private sectors to jointly fund, design, build, operate, and/or maintain public infrastructure, facilities, or services [200]. PPPs typically involve a government entity seeking to provide a service or build a system but lacking the financial or technical resources to do so on its own. This partnership approach relies on stakeholder participation, research, data analysis, and management to drive the design and implementation process [201]. PPPs can take various forms [202], including build–operate–transfer (BOT) contracts, concession agreements, joint ventures, or service contracts, and can be used to fund a wide range of projects, from transportation infrastructure to social infrastructure (such as schools and hospitals) and information technology systems. Ultimately, PPPs offer an opportunity to leverage the strengths of both the public and private sectors to create sustainable and innovative solutions that benefit society as a whole. Additional examples of research related to this parameter include [203,204].

4.7. Digital Transformation

This category includes services that help organizations leverage technology to transform their operations and processes [205,206]. It focuses on using digital tools and technologies to improve efficiency, productivity, and innovation. The services in this category are geared towards organizations that want to stay competitive in a rapidly changing digital landscape. Some of the services in this category include satellite navigation services, indoor positioning services (IPS), online and social commerce services, edge computing services, IoT and network security services, and privacy protection services. These services are designed to help organizations make better use of data, improve their online presence, and secure their digital assets.

4.7.1. Satellite Navigation Services

Satellite navigation services, also known as global navigation satellite systems (GNSS), are a network of satellite-based positioning systems that provide location and time information to users around the world [207,208]. These services use a constellation of satellites in orbit around the Earth to transmit signals to a receiver on the ground, which determines its precise position. The most well-known system is GPS [209], and other systems include the Russian GLONASS [210], the European Galileo [211], the Chinese BeiDou (BD) [212], and more. These systems work by measuring the time it takes for signals to travel from the satellites to the receiver on the ground, enabling the receiver to determine its position with high accuracy. Satellite navigation services have a wide range of applications, including navigation for aircraft, ships, and vehicles, surveying and mapping, disaster prevention and management, including geolocation for emergency services, security management, communications, and tracking of people and objects. This parameter helped to cover the different dimensions of GNSS, including those mentioned above, such as precise point positioning, GNSS effectiveness and comparisons, vehicle tracking with GNSS, and GNSS applications in police and insurance. For instance, see [213,214].

4.7.2. Indoor Positioning Services

Indoor positioning services are becoming increasingly important as people spend more time indoors, especially in large commercial or public buildings [215,216]. IPS use a combination of technologies to accurately locate objects and people in indoor environments, making it an essential tool for navigation and wayfinding. IPS rely on various signals, including Wi-Fi [217,218], BLE [219], magnetic positioning, and visual positioning, to create a fingerprint of the environment and provide accurate location information. Among the key benefits of IPS is their high level of accuracy. With an accuracy of up to several centimeters, IPS can help people navigate indoor spaces more efficiently and reduce the time spent searching for a specific location [220].

In addition to navigation, IPS can also be used for asset tracking, which helps organizations optimize their operations and reduce costs. IPS can also provide valuable data insights into how people move through indoor spaces [221]. These data can be used to optimize building layouts, improve traffic flow, and identify areas for improvement. Moreover, in emergency situations such as fires, floods, or earthquakes, IPS can quickly locate people and assets, allowing for a timely and effective response. As buildings become more complex and users' expectations increase, IPS will continue to play an essential role in providing an accurate, efficient, and enjoyable indoor experience. This parameter covered a range of IPS dimensions, including those mentioned above, such as indoor localization, navigation and wayfinding, physical activity recognition, smart homes and public well-being, indoor/outdoor environment identification, and IoT localization. For example, see [222,223].

4.7.3. Online & Social Commerce Services

Online and social commerce services provide a powerful tool for businesses to grow their brand and increase revenue by creating a more customer-centric approach to commerce [224]. These services have transformed the way businesses operate in the digital age; our model has identified multiple dimensions that enhance the customer experience [225]. These dimensions include technology, marketing, sales, customer experience, and data analytics. With online commerce, businesses can reach a wider audience, increase brand awareness, and drive consumer engagement by promoting their products and services through digital channels. Social commerce takes this one step further, enabling businesses to leverage social media platforms to engage with customers, build relationships, and gain valuable reviews and feedback [226,227]. By optimizing the customer experience, businesses can provide a seamless and enjoyable purchasing journey that encourages repeat purchases, fosters brand loyalty, and ultimately drives sales [228]. Through the use of data analytics, businesses can also monitor and improve their online and social commerce performance by tracking website traffic, consumer behavior, and product reviews [229]. Other dimensions of this parameter that our tool helped to identify include promoting co-creation services [230], supporting collaborative consumption and sharing economies [231], and enhancing social commerce in communities [232].

4.7.4. Edge Computing Services

Edge computing services are becoming increasingly popular due to their ability to provide a distributed computing architecture that brings computing resources closer to the network edge [233]. This proximity allows edge computing services to improve their performance and reduce network latency, a common problem in cloud computing [234]. The various architectures that are used in edge computing services, such as mobile edge computing (MEC), cloud computing, and fog computing, offer unique features and benefits that can be leveraged in different use cases [235].

One significant advantage of edge computing services is that they reduce the workload of centralized cloud computing resources [236]. By processing data closer to the source, edge computing services can offload tasks from the cloud and reduce the amount of data that needs to be transferred over the network [234]. This reduction in data transfer also leads to a reduction in the energy consumption required for data transfer. Edge computing services also enable the deployment of new services that were not possible before due to the limitations of cloud computing [237]. Additional examples include [238,239].

4.7.5. Internet of Things (IoT) & Network Security Services

The IoT is a rapidly growing network of physical devices that are connected to the internet, enabling them to collect and exchange data. However, with the increase in the number of IoT devices being deployed, there is a significant need for network security services to ensure that the data collected and exchanged remains secure [240]. This is because the devices can be vulnerable to a range of security threats, including malicious attacks and distributed denial of service attacks (DDoS) [241]. IoT network security services are multifaceted and involve several critical dimensions to ensure the security of IoT devices and the data they collect and exchange [242]. One of the key dimensions is the ability to detect and prevent attacks, which is crucial for maintaining the integrity and security of IoT networks [243]. Techniques such as firewalls and intrusion detection or prevention systems can be used to monitor network traffic to and from IoT devices and detect any potential threats [233]. Additional examples for this parameter include [244,245].

4.7.6. Privacy Protection Services

In today's digital age, the protection of privacy and data security has become a growing concern [246]. Personal data are being collected and stored online at an increasing rate, which makes it essential to ensure that this information remains secure and private. This is where privacy protection services come in [247]. Privacy protection services are designed to safeguard personal data and prevent unauthorized access, use, or disclosure [248]. Encryption is a key technology used in these services [249,250]. There are several other important technologies used in privacy protection services, such as IoT access control, privacy-aware authentication, single sign-on, virtual identity, and identity-as-a-service (IDaaS). For instance, Zhang et al. [251] presented a secure smart health (SSH) system with IoT access control and privacy-aware aggregate authentication.

4.8. Service Lifecycle Management

This category includes services that help organizations manage the entire lifecycle of their products and services [252]. It covers everything from service modeling and pricing to quality and innovation. The services in this category are geared towards organizations that want to improve the customer experience, streamline their operations, and stay competitive. Some of the services in this category include service modeling, service pricing, service quality and experience, business innovation services, and Services 5.0. These services are designed to help organizations create new service offerings, improve existing ones, and better manage their customer relationships throughout the service lifecycle.

4.8.1. Service Modeling

Service modeling is a process that involves creating a detailed representation of a service system by analyzing its various components, relationships, and functionality [253]. Service modeling is an essential tool for service designers and managers [254], allowing them to gain a deep understanding of the complexities of service systems. By identifying potential inefficiencies and bottlenecks, service designers can make informed decisions and optimize the system to provide the best possible service. This optimization can result in increased customer satisfaction and loyalty, ultimately leading to higher revenues for the business. Additional examples include [255,256].

4.8.2. Service Pricing

The pricing of services is an essential aspect of our modern economy [257]. It is a critical aspect of any service-based business, as it determines the generated revenue and ultimately affects the profitability of the business [258]. Pricing a service requires the careful consideration of various factors, including cost, competition, value proposition, market demand, profit margin, seasonal factors, and consumer satisfaction. Competition in the market plays a crucial role in determining the price of services [259,260]. Market demand can also affect pricing [261]. Profit margin is also a crucial factor to consider when pricing services [262].

However, it is essential to recognize that pricing strategies are not always fair to consumers [263]. In some cases, businesses use complex pricing models that take advantage of information asymmetry to charge higher prices than necessary. This can lead to market inefficiencies and unfairness for consumers. Furthermore, pricing strategies can also have significant impacts on the environment and society. For instance, some pricing models encourage excessive consumption and waste, leading to negative environmental impacts. Additional examples of research related to this parameter include [264,265].

4.8.3. Service Quality & Experience

This parameter covered multiple dimensions of service quality and experience that refer to the level of performance and satisfaction users receive from a product or service [266]. It is an essential aspect of any industry that provides a service, from healthcare to hospitality, from banking to technology. By providing high-quality, reliable, and efficient services, businesses can increase customer satisfaction, loyalty, and profitability. Service quality refers to the level of satisfaction that a customer experiences when interacting with a business or organization [267,268]. It is evaluated based on factors such as reliability, responsiveness, empathy, assurance, and tangibles. In healthcare, service quality and experience can be the difference between life and death. It is essential to provide a safe, timely, and effective service, along with empathy and professionalism, to ensure patients receive the best care possible [12]. In the hospitality industry, service quality and experience can impact customer loyalty and repeat business. By providing a positive service experience through a clean and welcoming environment, attentive and friendly staff, and high-quality amenities, hotels and restaurants can attract and retain customers [31]. A large proportion of articles in this parameter were focused on communication networks, such as [269,270].

4.8.4. Business Innovation Services

Business innovation services refer to a wide range of specialized solutions that help businesses identify, develop, and implement innovative ideas, products, services, and processes [271]. These services are essential for businesses to succeed in today's rapidly changing marketplace, enabling them to adapt and thrive in the face of constant disruption and uncertainty [272,273]. These services cover a range of areas, including ideation, technology, strategy, marketing, and training [274,275]. This parameter—i.e., business innovation services—covered multiple dimensions, including digital transformation [276], product development [277], process optimization, and service innovation [278]. Additional examples of related research can be found in [279,280].

4.8.5. Services 5.0

This parameter covered the different dimensions of Services 5.0, which is a digital, cloud-based, and smart service delivery model that leverages advanced technologies to provide personalized, proactive, and sustainable services [281]. Services 5.0 represents the future of service delivery, characterized by personalization, proactivity, co-creation, and sustainability [282]. This evolution is driven by advanced technologies such as IoT; cloud, fog, and edge computing; big data analytics; digital twins; and social media.

In Services 5.0, customers play an active role in the design and delivery of services through co-creation [283]. This is facilitated by social media and collaborative tools that allow customers to provide feedback and suggestions in real-time. Services 5.0 is characterized by a focus on sustainability [284], with service providers seeking to minimize their environmental impact and maximize their social impact. This is achieved with green technologies and sustainable business practices, as well as by engaging with customers and other stakeholders to promote social responsibility. Service 5.0 is an advanced service delivery model that builds on the foundation of Service 4.0. While both models integrate advanced technologies such as IoT, cloud computing, and big data analytics, Service 5.0 adds new features, including personalization, proactivity, co-creation, and sustainability. Service 5.0 is more customer-centric and collaborative, with a focus on tailoring services to individual needs and preferences, anticipating customer needs, involving customers in service design, and promoting environmental and social responsibility.

5. Regional Analysis Results: Service Sector Parameters from Twitter

In this section, we describe the outcomes of our tool's analysis of the Arabic Twitter dataset concerning different services offered in Saudi Arabia. We provide a summary of the parameter space in Section 5.1. The modeling-related findings are quantitatively assessed in Section 5.2. In Sections 5.3 and 5.4, we examine each macro-parameter individually, along with its associated parameters, and furnish instances of Twitter posts to support our explanations.

5.1. Parameters and Macro-Parameters: An Overview

After analyzing the Twitter dataset related to the services sector, we identified a total of 15 clusters. To avoid redundancy, we merged some clusters with similar themes, which led to the identification of 11 parameters, organized into 2 macro-parameters, namely private sector services and government services. Table 2 presents the results in the same format as Table 1 (see Section 4). Figure 5 gives a taxonomy of the parameter space of the Twitter dataset.

Table 2. The service sector parameters (source: Twitter).

Macro-Parameters	Parameters	Cluster No.	%	Keywords
Private Sector Services	Food Delivery Apps & Services	1	5.47	Hungerstation App, Jahez App, Mrsool App, Jeeny App, Registration, ToYou App, Driver, Benefit, Applications, Shgardi App, Applications, Code, Inquiry, Order It, Healthy
		14	2.28	Mrsool App, Hungerstation App, Jahez App, To You App, Registration, Apps, Inquiry, Whatsapp, Apps, Free, Coupon, Shgardi App, To Order, By Whatsapp, Quality
	Logistics Services	7	3.93	Naqel, Car, Zajil, Transport, Order, Prices, SMSA, Check, Payment, Sale, The Naqel, Possibility, Use, Transfer, Snapchat
	Ride-Hailing Services	0	5.77	Uber, Registration, Jeeny, Rides, Taxi, Train, Shopping, Code, Discount, Trip, Coupon, Careem, Applications, Traveler, Transportation
		12	3.05	Uber, Mobily, Trip, Man, Transportation, Rides, Able, Taxi, Easy, Pictures, Drivers, Needy, Metro, Stop, The Only One
		13	2.43	Uber, Careem, Airport, Cheapest, Metro, Naqel, Trip, Cars, Healthy, General, Trip, Transport, Driver, Passenger, Car
	Mobile & Broadband Services	3	5.20	Mobily, Zain, Service, Customers, Installment, Online, Easily, Immediately, Shopping, Payment, Package, Services, Bill, Viber, WhatsApp
		10	3.11	Mobily, Store, Electronic, To Stop, Send, Its Features, Qitaf, Purchase, Smart, Its Offers, Available, Messages, Devices, Packages, iPhone
Government Services	Passport & ID Services	2	5.30	Appointment, Reservation, AljawazatKSA, Requires, Passport, Receipt, Travel, Procedure, Electronic, E-Mail, My Health, To Check, The Sessions, The Session, The Kindergarten, The Judiciary
	Digital Identity Services	6	4.10	Mobily, Systems, Access, Unified, Identity, Postpaid, Shop, To Mobily, Bills, Electronic, The Offer, Offer, Ease, Transfer, Payment
	Police Services	11	3.06	Communication, Kollona Amn, Najiz, Procedure, Number, We Wish, Requests, Mobily, Request, Through, Send, Our Client, Log In, To Help You, Corruption

Table 2. *Cont.*

Macro-Parameters	Parameters	Cluster No.	%	Keywords
Government Services	Judiciary Services	8	3.85	Najiz, Judiciary, Lawsuit, Agency, Issuance, Entry, Court, Inquiry, Agency, Service, Requests, Platform, Required, Justice, Steps
	Social Security Services	4	5.09	Zajil, Sakani, The Citizen's Account, Hafez, Download, Social Security, Electronic, Developer, Appointments, Social, The Reservation, Reservation, Document, Problems, Financing
	Workforce Development Services	5	4.84	Communication, Text, Government, Messages, Administrative, Announce, Job, Technical, Application, Jobs, Government, Technology, Fields, Employment, Through
	Digital Transformation Services	9	3.83	Services, Economy, Transportation, Communications, Judiciary, Growth, Judgments, Judicial, Department, SAR (Saudi Arabia Railways), Digital, Orders, Najiz, Smart, Entry

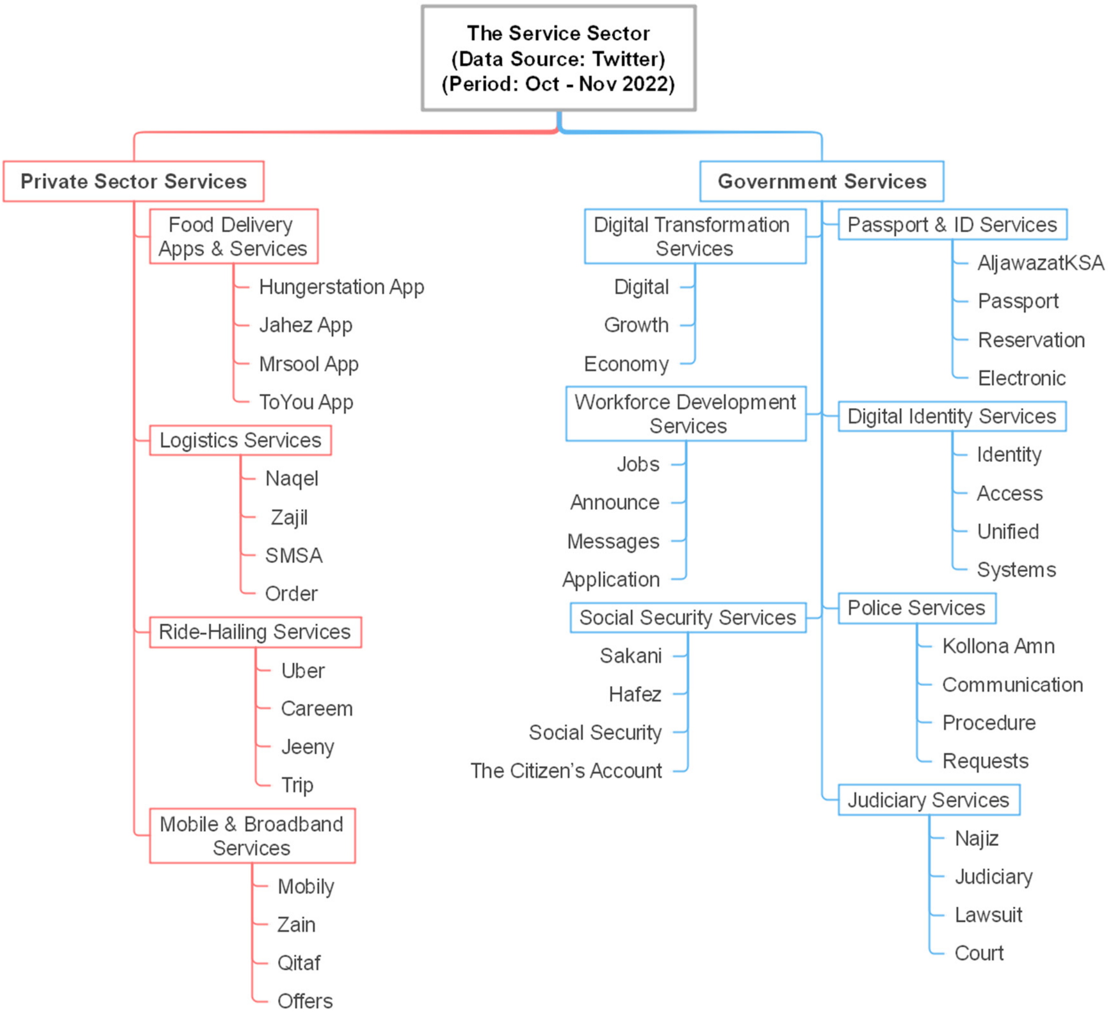

Figure 5. Taxonomy of the service sector from the Twitter dataset.

5.2. Quantitative Analysis (Twitter Dataset)

Similar to Section 4.2, we conducted a quantitative analysis of the results obtained with modeling parameters using our software tool and the Twitter dataset. Our analysis includes a term score decline graph, an inter-topic distance map, a similarity matrix, keyword scores, and hierarchical clustering.

The "term score decline" results indicate that the difference between keyword scores for clusters becomes insignificant after 13 to 17 terms. This suggests that having 13 to

17 terms in the ranking of each topic adequately captures the concept of the topic. This information was used to examine the top 15 related parameter keywords. The c-TF-IDF score was used to rank the parameter keywords (see Section 3.5).

The distance map between topics, the hierarchical clustering map, and the similarity matrix, along with domain expertise, were employed to develop parameters and group them into macro-parameters. We did not include these figures in the paper to avoid excessive length. We would be happy to provide these graphs upon the reader's request.

5.3. Private Sector Services

This macro-parameter gathers four parameters that relate to the services offered by the private sector. Private sector services are provided by private individuals or organizations to meet consumer needs and generate profits [285]. They range from basic necessities to specialized offerings across sectors such as finance, healthcare, education, retail, hospitality, and technology. Private sector services play a significant role in the economy, contributing to employment, GDP, and meeting consumer demands.

5.3.1. Food Delivery Apps & Services

Food delivery apps and services are online platforms that allow users to order a wide range of cuisine options from multiple restaurants, customize their orders, save time, ensure safety, and receive loyalty benefits [286,287]. Popular services include Uber Eats, Grubhub, DoorDash, Postmates, and Deliveroo. Our tool detected from the tweets that a number of food delivery apps were being used in Saudi Arabia, including Hungerstation, Jahez, Mrsool, Jeeny, ToYou, and Shgardi. The following tweet exemplifies this parameter: "We do not provide food delivery services, but it is possible to order from mobile apps such as Mrsool, Jahez, Hungerstation, or ToYou".

5.3.2. Logistics Services

Logistics services involve the planning, implementation, and control of the movement of goods and services [288,289]. This includes transportation, warehousing, inventory management, and information flow management [61]. The goal is to ensure that products are delivered efficiently, on time, and at the lowest possible cost. With the increasing trend of people buying online, the burden on shipping companies has increased, and competition has flared up among them to provide the best services at competitive prices, with the importance of maintaining the security of transported goods and their delivery without damage. The following tweet exemplifies this parameter: "I have dealt with all the shipping companies including SMSA, Aramex, and Naqel, and have found that they all deliver orders as quickly as is possible".

5.3.3. Ride-Hailing Services

Ride-hailing services provide on-demand transportation through a mobile application [290], connecting passengers with nearby drivers who use their personal vehicles. These services have gained popularity due to their convenience and low cost, and major companies include Uber, Lyft, Grab, and DiDi. Additionally, these services improve mobility for low-income and elderly people, as well as disabled persons [291]. Our tool has identified these services in Saudi Arabia from various companies, including Uber, Jeeny, and Careem. In Saudi Arabia, people are also using these services for other tasks, such as calling a taxi and requesting to bring food or perform other chores, as expressed in the following tweet: "I prefer using Careem and Uber for my deliveries because they are cost-effective. Typically, the price of delivery remains within 25 Saudi Riyals".

5.3.4. Mobile & Broadband Services

Mobile services use mobile networks to allow communication using portable devices [292,293], while broadband services provide high-speed internet access through various technologies such as cable, fiber, DSL, and satellite. They enable a range of applications, including video conferencing, online gaming, cloud computing, and remote work, and are essential for individuals and businesses to stay connected and access information anytime and anywhere. Our tool has identified these services in Saudi Arabia from various companies, such as STC, Mobily, Zain, and the Qitaf service.

5.4. Government Services

This macro-parameter gathers seven parameters that relate to the services offered by the government sector. Government services are the programs and initiatives provided by the government to its citizens [294,295]. These services are developed to meet the requirements of the people, to promote their welfare, and to ensure their safety and security. The government's services may vary depending on the country and its political system. Examples of government services include passport & ID services, digital identity services, police services, judiciary services, social security services, workforce development services, and digital transformation services. These services provide assistance with travel documents, online identity verification, maintaining law and order, administering justice, providing financial assistance, improving employability, and promoting transparency and efficiency in government operations.

5.4.1. Passport & ID Services

Passport and ID services are government services that provide citizens and residents with identification documents [296], including passports, national IDs, and driver's licenses. These documents are essential for verifying identity and citizenship, facilitating travel, and accessing government services and benefits. In Saudi Arabia, these services indicate, for instance, that government documents can be created and renewed electronically—such as passports—through the Absher platform, which saves time and effort, as mentioned in the following tweet: "The Civil Status and Passports Department has introduced new electronic services for issuing family books".

5.4.2. Digital Identity Services

Digital identity services enable the secure and convenient establishment and verification of online identities through authentication and verification services, biometric identity services, and identity management platforms [297,298]. These services play a crucial role in ensuring secure online transactions and communication while protecting users from identity theft. An important example of digital identity services that our tool detected from Twitter data is the Nafath service in Saudi Arabia. This is because a number of government and private organizations have begun offering services through electronic portals and electronic identifiers (using usernames and passwords) as a verification tool that allows entry to their electronic service sites in Saudi Arabia. The Ministry of Interior has launched a national initiative to produce and control digital identities for citizens and others. It is referred to as a "digital identity" and is related to individuals, serving as a representation of their identities in electronic transactions. This initiative aims to find a comprehensive solution for managing digital identities to enable unified electronic access services at the national level, enabling governments and private sector organizations to contribute to the delivery of different services. The following tweet highlights this: "Dear customer, verify your account through the unified national access (Nafath) to enjoy all STC Pay services easily in few steps".

5.4.3. Police Services

Police services are a critical component of law enforcement [299,300], responsible for maintaining public safety, enforcing the law, and preventing crimes. They work closely with other law enforcement agencies and community organizations to promote public safety. The effectiveness of police services is measured by their ability to prevent and solve crimes and maintain good relationships with the communities they serve. Kollona Amn, detected with our tool, is a service that enables Saudi Arabian citizens and residents to assume the position of a police officer. This expedites rescue operations and lessens losses and damages. Residents and citizens can send an incident with a video, photo, or voice remark attached. The following tweet highlights this: "Electronic crimes can be reported through the Kollona Amn app".

5.4.4. Judiciary Services

Judiciary services are responsible for interpreting and enforcing laws, resolving disputes, and ensuring justice is served [301,302]. The branch includes judges, lawyers, and court personnel who work together to maintain the balance of power between branches of government and uphold the rule of law. In Saudi Arabia, the government is keen to unify judicial procedures and the completion of legal transactions electronically. Najiz is an electronic platform affiliated with the Saudi Ministry of Justice that aims to facilitate court services provided to beneficiaries, including citizens, residents, and business owners, and complete the beneficiaries' transactions in agencies, courts, real estate, and others. This is highlighted in the following tweet: "Najiz is a judicial system that offers all the services of the Ministry of Justice in the areas of judiciary, implementation, and documentation through a team of specialized legal professionals".

5.4.5. Social Security Services

Social security services are an important aspect of many countries' social welfare systems [303,304], offering financial support to individuals and families in the event of retirement, disability, or death. These programs are administered by government agencies and may include retirement benefits, disability benefits, survivor benefits, income supplements, and healthcare coverage. The specific types of programs and eligibility requirements may vary by country. This parameter encompasses the range of social security services introduced by the Saudi government to sustain communities and meet their needs. These services include financial, family-related, healthcare, housing, employment, psychological care, agricultural, and others. Examples of these services are the Sakani, Reef, and Hafez programs.

5.4.6. Workforce Development Services

Workforce development services are programs and initiatives designed to support individuals in developing the skills, knowledge, and experience needed to enter, re-enter, or advance in the workforce [305,306]. These services can be offered by government agencies, non-profit organizations, or private companies and may include job training and skills development, education and credentialing, career counseling and guidance, and job placement and support. The overarching goal of these services is to help individuals achieve their career goals and succeed in the workforce. An example of the tweets in this parameter is as follows: "The unified national platform for employment simplifies various stages for job applicants, whether in the private or government sectors, and saves time in securing the right job".

5.4.7. Digital Transformation Services

Digital transformation services are a set of strategies, processes, and technologies that help businesses, governments, or other organizations leverage digital technologies to enhance their operations, develop novel ways of conducting business, and enhance customer satisfaction [205,307]. It involves developing a comprehensive digital strategy, implementing the right digital technologies, managing data and analytics, change management, and digital marketing. The digital transformation of services has led to the prosperity of countries, the expansion of activities, and the growth of economies around the world. This parameter helped to cover digital transformation activities in Saudi Arabia, as exemplified with the following tweets: "Government agencies are making great progress in their digital transformation journey. The Digital Government Authority has now announced the government agencies that have reached the stage of creativity and are the most advanced in measuring digital transformation in 2022" and "At the Digital Government meeting, the Ministry of Justice was ranked first in terms of digital transformation among government agencies".

6. Synthesis: Global vs. Regional Analyses and Research Implications

This research aims to develop a methodology that employs ML to gain a thorough understanding of the service sector, with the ultimate goal of creating a theory and approach for smarter services and service economies that support sustainable future societies. The study aims to drive future research in this field and achieve this objective through the development of autonomous systems using innovative technologies and solutions.

Earlier, in Figure 1, we depicted a multi-dimensional taxonomy that offers a comprehensive overview of the service sector, combining multiple perspectives from academia and the public. The taxonomy presents a global outlook and a localized perspective specific to Saudi Arabia, emphasizing the richness of the sector. The global and academic perspective covers a wide range of services, such as education, healthcare, transportation, smart society and infrastructure, digital transformation, and service lifecycle management. It provides insights into the use of technology to improve service delivery and develop new business models, and it offers a comprehensive understanding of the current trends and developments driving the sector's evolution. The local and public view provides insights into the types of services offered by the private and government sectors in Saudi Arabia, helping to identify gaps and develop strategies to improve service delivery.

The identification of these macro-parameters and their associated services highlights the depth and breadth of the service sector and provides valuable insights into the various areas of service provision. By utilizing innovative technologies and service offerings, organizations can improve the customer experience, streamline their operations, and stay competitive in today's rapidly changing digital landscape. In Figure 2 (Section 1), we provide a framework for autonomous design and operations of the service sector, which is developed using the parameters and information discovered using AI in this work. The process of developing such frameworks can be automated using our approach in any field.

The study used a data-driven methodology to model the service sector by combining the academic literature and public opinion gathered from Twitter. ML and big data are leveraged to extract key parameters from both sources to gain a unique understanding of the service sector from two distinct perspectives. The study developed a software tool for automated analysis and capture of parameters. The data availability or data-drive/data-centric nature of our methodology is integral to the methodology of AI-based solutions. It enables model training, generalization, and fairness, reducing bias and enhancing robustness. Access to diverse and sufficient data ensures AI systems perform accurately, ethically, and reliably, making it a foundational element of AI development.

Analyzing the Twitter data from a particular country about service economies can provide valuable insights into trends and patterns, customer sentiment, the impact of government policies, and new market opportunities. This information can be used by businesses to develop new products and services, improve their existing offerings, make better strategic decisions, and improve customer service. Governments can use Twitter data to develop more effective policies, and researchers can gain new insights into the service economy.

Analyzing the Twitter data from Saudi Arabia about service economies can be especially beneficial given the large and growing Saudi Arabian service sector, the popularity of Twitter in Saudi Arabia, and the wide range of insights that Twitter data can provide. Specific examples of how Twitter data have been used to analyze the service economy in Saudi Arabia include tracking the growth of the e-commerce industry, measuring the impact of the COVID-19 pandemic, and identifying the most popular services in different Saudi Arabian cities. Overall, analyzing the Twitter data from Saudi Arabia about service economies can be a very valuable tool for businesses, governments, and researchers.

Combining insights from global academic analyses with regional Twitter data provides a holistic view of the service sector. The global analysis highlights industry trends and technological advancements, while the regional perspective, focused on Saudi Arabia, reveals specific service offerings and opportunities for improvement. This synthesis enables more informed decisions and strategies that align local practices with global trends.

6.1. Theoretical and Practical Implications

The work holds substantial consequences both in theory and application, not only for the service industry but also for other fields. In today's fast-paced and ever-changing technological environment, this study is of the utmost importance.

The service industry is continuously facing numerous challenges, including globalization, geopolitical risks, conflicts, economic downturns, technological changes, climate change, demographic changes, income disparities, and regulatory reforms. Previous research (Section 4) and related works (Section 2) indicate that the service sector has a narrow and fragmented focus. To tackle these challenges effectively, it is essential to adopt a holistic approach to studying the service sector, considering economic, social, environmental, governance, and cultural factors. This comprehensive view provides decision makers with a deeper understanding of the interconnectedness of various aspects of the service industry and their impact on each other. It also helps identify potential challenges and opportunities, enabling proactive solutions that stay ahead of economic trends and mitigate negative impacts. A holistic approach leads to sustainable economic and service practices, promoting better quality service and experience for all, benefiting societies, economies, and the planet.

In the current digital era, the impact of service economies and the service sector on local cultures, particularly in Saudi Arabia, has not been extensively researched. Specifically, the analysis of big data from social and digital media in Arabic-language contexts is still scarce. Saudi Arabia's Vision 2030 plan outlines a significant transformation in the country's economic and social structure, with a goal of expanding beyond the oil industry and creating a renewed social contract. The plan envisions a thriving economy achieved through a new economic model that prioritizes increased productivity, with the government shifting from an economic driver to an enabler of private-sector-led growth. The plan focuses on improving human capital, attracting foreign investment through an enhanced business environment, establishing a high-quality public administration, and creating a flexible and competitive labor market [308–310]. The services sector is a main driver of economic growth in Saudi Arabia, as the government has prioritized its development and investment. Research in this sector can provide insights into opportunities and challenges facing the sector, the effectiveness of policies, competitiveness compared to other countries, and barriers to entry for new businesses. Such research can be valuable for policymakers, businesses, and investors seeking to capitalize on the growth potential of the services sector [311,312].

The study presents a new approach for gathering and analyzing diverse and impartial information related to the service industry using advanced ML techniques. The method allows for the examination of multiple datasets to uncover valuable insights that can benefit different stakeholders, such as academic researchers, corporate decision makers, government officials, and the public. The study's findings contribute significantly to the understanding of the service industry and can provide a foundation for future research and informed decision making.

Moreover, using the discovered knowledge in this work, a framework (Figure 2) for autonomous design and operations of the service sector is developed in this paper using data analytics, AI, machine and deep learning, and robotic systems to improve service quality and efficiency, reduce costs, and enhance customer satisfaction while ensuring data security and compliance with ethical and legal considerations. The framework involves identifying services to be automated, developing architectures, choosing the right technology, implementing cybersecurity measures, establishing monitoring and feedback mechanisms, addressing ethical and legal concerns, and developing a roadmap for implementation.

This study proposes a new method for utilizing AI techniques to gather and analyze comprehensive and adaptable information from various sources, such as social media, the scientific literature, and other datasets. This approach can be applied to optimize systems and applications and facilitate autonomous capabilities for information discovery and parameter identification. Moreover, it has the potential to promote innovative research in the service sector and contribute to the creation of sustainable, responsible, and smarter economies. As the trend towards autonomy in various systems continues, understanding the system parameters is becoming increasingly important for effective problem solving and decision making.

6.2. Contributions to Sustainability and United Nations Sustainable Development Goals (SDGs)

The paper aligns its findings and approach with the UN SDGs and relevant sustainability frameworks, displaying a dedicated commitment to global sustainability goals. Regarding SDGs, it emphasizes technology-driven optimization and innovation in line with SDG 9 (Industry, Innovation, and Infrastructure) for sustainable industrialization. The focus on creating smarter and more sustainable service economies resonates with SDG 11 (Sustainable Cities and Communities), promoting inclusive, safe, and resilient urban environments. Examining sustainability in service delivery contributes to SDG 12 (Responsible Consumption and Production), reducing waste and resource use. Addressing environmental concerns aligns with SDG 13 (Climate Action).

In terms of other sustainability frameworks, the paper's autonomous service design embodies Circular Economy Principles, enhancing circularity. It considers social and environmental dimensions, reflecting Triple Bottom Line (TBL) sustainability. The local service economy study (Section 5), as well as other relevant findings from Section 4, align with the Local Sustainability Initiatives addressing region-specific challenges.

The paper champions a Holistic Sustainability Approach, acknowledging interconnectedness among economic, social, cultural, and environmental dimensions. It advocates a holistic approach to service economies, underscoring the need to integrate sustainability from the outset. Proactive planning is imperative for enhancing reputation, supporting viability, fostering societal impacts, fueling innovation, and minimizing environmental footprints.

In summary, the paper's significance lies in its dynamic comprehension, cultural sensitivity, and holistic approaches to addressing global challenges and advocating smarter, sustainable service practices. Its multifaceted perspective and advanced technologies, including big data and machine learning, position it as a valuable asset in the pursuit of sustainability in service economies, contributing significantly to the literature.

7. Conclusions and Outlook

This study presents a data-centric approach to modeling the service sector, using the academic literature and public opinion from X (formerly known as Twitter). Advanced technologies were used to extract key parameters from both sources, and a software tool was developed for this purpose. After analysis, 29 distinct parameters related to the service sector were identified from research articles, while 11 parameters related to public opinion on the service sector were identified from tweets collected in Saudi Arabia. The software tool was used to generate a knowledge structure, taxonomy, and framework for the service sector, in addition to a literature review based on over 300 research articles. In conclusion, as highlighted in the previous section, this study has noteworthy practical and theoretical implications for the development of autonomous capabilities in systems, which can contribute to the creation of smarter and more sustainable societies.

It is important to consider the limitations of this paper's findings. One limitation is the narrow focus on the service sector in Saudi Arabia, which may not be applicable to other regions or contexts. Another limitation is the reliance on data sources for the proposed approach that utilize ML, as the accuracy and reliability of these sources can impact the quality of the results. Furthermore, the complexity of the algorithms employed can make interpretation difficult and potentially introduce biases. These two limitations can be addressed by conducting similar studies on social media data from different countries and the academic literature data from different databases. Lastly, the approach relies heavily on technological infrastructure, which may not be available in all contexts, potentially limiting its applicability to decision makers in certain areas. This can be addressed by providing digital capabilities to those areas or by carrying out similar analyses for those areas and providing them with the insights for decision making.

This paper is part of our ongoing research into using ICT to address challenges in digital societies. The research has covered a wide range of topics, including education [80], healthcare [109], smart families [49], tourism and transportation [31,48], labor economics [35], and journalism [35], among others. Our aim is to enhance the methodology proposed in this article by utilizing cutting-edge machine learning techniques to tackle various challenges associated with the service sector and other social, economic, environmental, and cultural matters. To achieve this, we used data from the Scopus database and Twitter. Going forward, we intend to extend our research by incorporating more scientific databases, digital and social media, and other data sources to gain a more holistic understanding of these challenges.

We believe this study is an important step towards the formation of a theory and approach for smarter and more sustainable services and service economies that can support sustainable future societies through the development of autonomous systems using innovative technologies and solutions.

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List of Abbreviations

Acronym		Acronym	
AI	Artificial Intelligence	ML	Machine Learning
BDS	Beidou Navigation Satellite	NLP	Natural Language Processing
BERT	Bidirectional Encoder Representations from Transformers	NLTK	Natural Language Toolkit
BLE	Bluetooth Low Energy	NSS	Navigation Satellite System
CRM	Customer Relationship Management	O2O	Online-to-Offline
D2D	Device-To-Device	OCC	Out-of-Class Communication
DDoS	Distributed Denial-of-Service Attacks	OGD	Open Government Data
DGs	Dangerous Goods	OI	Open Innovation
DOT	Department of Transportation	OSN	Online Social Networks
EAIT	Education and Information Technologies	PPP	Public–Private Partnership
EO	Earth Observation	PPP-AR	Precise Point Positioning with Ambiguity Resolution
EoS	Experience of Service	QoE	Quality of Experience
FUT	Fixed-Up-To	QoS	Quality of Service
G-D logic	Good Dominant Logic	REP	Retail Electric Providers
GNSS	Global Navigation Satellite System	RPAS	Remotely Piloted Aircraft System
GPS	Global Positioning System	SAML	Security Assertion Markup Language
GST	Goods and Services Tax	SAR	Saudi Arabia Railway
HDBSCAN	Hierarchical Density-Based Spatial Clustering of Applications with Noise	SDG	Sustainable Development Goals
ICTs	Information and Communication Technologies	S-D Logic	Service-Dominant Logic
IDaaS	Identity-as-a-Service	SDN	Software-Defined Network
IoT	Internet of Things	SIUS	Sociocultural Information Urban Space
IOV	The Internet of Vehicles	SM	Social Media
IT	Information Technology	SMA	Social Media Analysis
JIT	Just-In-Time	SSH	Secure Smart Health
JSON	JavaScript Object Notation	TBL	Triple Bottom Line
LDA	Latent Dirichlet Allocation	UAS	Unmanned Aircraft System
MAR	Mobile Augmented Reality	UAVs	Unmanned Aerial Vehicles
MEC	Mobile Edge Computing	UMAP	Uniform Manifold Approximation and Projection
MidSiot	Multistage Intrusion Detection System for Internet of Things	VID	Virtual Identity
MANETs	Mobile Ad Hoc Networks	VSEC	Vehicular Social Edge Computing

References

1. Buckley, P.; Majumdar, R. The Services Powerhouse: Increasingly Vital to World Economic Growth. *Deloitte Insights* **2018**, *12*, 1–17.
2. Kox, H.L.M.; Lejour, A. Dynamic Effects of European Services Liberalisation: More to Be Gained. *Munich Pers. RePEc Arch.* **2006**, *1*, 1–25.
3. Bryson, J.R.; Daniels, P.W.; Warf, B. *Service Worlds: People, Organisations and Technologies*; Routledge: London, UK, 2013; pp. 1–286. [CrossRef]
4. Almeida, F.; Duarte Santos, J.; Augusto Monteiro, J. The Challenges and Opportunities in the Digitalization of Companies in a Post-COVID-19 World. *IEEE Eng. Manag. Rev.* **2020**, *48*, 97–103. [CrossRef]
5. Organisation for Economic Co-Operation and Development (OECD) The Service Economy. Available online: https://www.oecd.org/industry/ind/2090561.pdf (accessed on 11 November 2023).
6. Buera, F.J.; Kaboski, J.P. The Rise of the Service Economy. *Am. Econ. Rev.* **2012**, *102*, 2540–2569. [CrossRef]
7. Kellerman, A. The Evolution of Service Economies: A Geographical Perspective. *Prof. Geogr.* **2010**, *37*, 133–143. [CrossRef]
8. Ochel, W.; Wegner, M. *Service Economies in Europe: Opportunities for Growth*; Routledge: London, UK, 2019; pp. 1–171.
9. Gallouj, F. *Innovation in the Service Economy: The New Wealth of Nations*; Edward Elgar Publishing: Cheltenham, UK, 2002; ISBN 978-1840646702.
10. World Bank. *Services, Value Added (% of GDP)*; World Bank: Washington, DC, USA, 2022.
11. D'aniello, G.; Gaeta, M.; Orciuoli, F.; Sansonetti, G.; Sorgente, F. Knowledge-Based Smart City Service System. *Electronics* **2020**, *9*, 965. [CrossRef]

12. Alahmari, N.; Alswedani, S.; Alzahrani, A.; Katib, I.; Albeshri, A.; Mehmood, R. Musawah: A Data-Driven AI Approach and Tool to Co-Create Healthcare Services with a Case Study on Cancer Disease in Saudi Arabia. *Sustainability* **2022**, *14*, 3313. [CrossRef]
13. Vargo, S.L.; Lusch, R.F. Service-Dominant Logic 2025. *Int. J. Res. Mark.* **2017**, *34*, 46–67. [CrossRef]
14. Lusch, R.F.; Vargo, S.L. *Service-Dominant Logic: Premises, Perspectives, Possibilities*; Cambridge University: Cambridge, UK, 2014; pp. 1–222. [CrossRef]
15. United Nations Conference on Trade and Development. *Trade and Development Report 2021: From Recovery to Resilience: The Development Dimension*; OCHA: New York, NY, USA, 2021.
16. International Labour Organization. *World Employment and Social Outlook 2018: Greening with Jobs*; International Labour Organisation: Geneva, Switzerland, 2018.
17. Organisation for Economic Co-Operation and Development (OECD) Employment Rate (Indicator). Available online: https://www.oecd-ilibrary.org/employment/employment-rate/indicator/english_1de68a9b-en (accessed on 11 November 2023).
18. Kovalčíková, N. Globalisation and the Threats It Poses in the Twenty-First Century. *Eur. View* **2014**, *13*, 169–179. [CrossRef]
19. Sokol, M. *Economic Geographies of Globalisation: A Short Introduction*; Edward Elgar Publishing: Cheltenham, UK, 2011; ISBN 978-1849801492.
20. Wells, A. Globalisation of the Powerless—A Zone of Instability and the Disabled State. In *Seeking Refuge: Asylum Seekers and Politics in a Globalising World*; Coghlan, J., Minns, J., Wells, A.D., Eds.; University of Wollongong Press: Sydney, NSW, Australia, 2005; p. 15.
21. Ehrenfeld, D. Globalisation: Effects on Biodiversity, Environment and Society on JSTOR. *Conserv. Soc.* **2003**, *1*, 99–111.
22. Leal, P.H.; Marques, A.C. The Environmental Impacts of Globalisation and Corruption: Evidence from a Set of African Countries. *Environ. Sci. Policy* **2021**, *115*, 116–124. [CrossRef]
23. Barnett, C.; Robinson, J.; Rose, G. *Geographies of Globalisation: A Demanding World*; SAGE Publications Ltd.: New York, NY, USA, 2009; ISBN 9781847874719.
24. Sodhi, M.M.S.; Tang, C.S. Supply Chain Management for Extreme Conditions: Research Opportunities. *J. Supply Chain Manag.* **2021**, *57*, 7–16. [CrossRef]
25. Martin, R.; Gardiner, B. The Resilience of Cities to Economic Shocks: A Tale of Four Recessions (and the Challenge of Brexit). *Pap. Reg. Sci.* **2019**, *98*, 1801–1832. [CrossRef]
26. International Monetary Fund. *World Economic Outlook, April 2019: Growth Slowdown, Precarious Recovery*; International Monetary Fund: Washington, DC, USA, 2019.
27. Dickson, S. Credit Suisse Crisis: The 11 Days of Turmoil That Brought down Four Banks and Left a Fifth Teetering. Available online: https://economictimes.indiatimes.com/industry/banking/finance/the-11-days-of-turmoil-that-brought-down-four-banks-and-left-a-fifth-teetering/articleshow/98849256.cms?from=mdr (accessed on 2 April 2023).
28. Agarwal, V.; Mathiyazhagan, K.; Malhotra, S.; Saikouk, T. Analysis of Challenges in Sustainable Human Resource Management Due to Disruptions by Industry 4.0: An Emerging Economy Perspective. *Int. J. Manpow.* **2022**, *43*, 513–541. [CrossRef]
29. Bitner, M.J.; Brown, S.W.; Meuter, M.L. Technology Infusion in Service Encounters. *J. Acad. Mark. Sci.* **2000**, *28*, 138–149. [CrossRef]
30. International Labour Organization. *World Employment and Social Outlook Trends 2020*; International Labour Organization: Geneva, Switzerland, 2020.
31. Alsahafi, R.; Alzahrani, A.; Mehmood, R. Smarter Sustainable Tourism: Data-Driven Multi-Perspective Parameter Discovery for Autonomous Design and Operations. *Sustainability* **2023**, *15*, 4166. [CrossRef]
32. Vlahinić Lenz, N.; Fajdetić, B. Does Economic Globalisation Harm Climate? New Evidence from European Union. *Energies* **2022**, *15*, 6699. [CrossRef]
33. Bryson, J.; Daniels, P. *The Handbook of Service Industries*; Edward Elgar Publishing: Cheltenham, UK, 2007.
34. Dobbs, R.; Madgavkar, A.; Manyika, J.; Woetzel, J.; Bughin, J.; Labaye, E.; Kashyap, P. Poorer than Their Parents? Flat or Falling Incomes in Advanced Economies. A New McKinsey Global Institute Report. 2016, pp. 1–99. Available online: https://www.mckinsey.com/featured-insights/employment-and-growth/poorer-than-their-parents-a-new-perspective-on-income-inequality (accessed on 11 November 2023).
35. Alaql, A.A.; Alqurashi, F.; Mehmood, R. Data-Driven Deep Journalism to Discover Age Dynamics in Multi-Generational Labour Markets from LinkedIn Media. *J. Media* **2023**, *4*, 120–145. [CrossRef]
36. Yigitcanlar, T.; Mehmood, R.; Corchado, J.M. Green Artificial Intelligence: Towards an Efficient, Sustainable and Equitable Technology for Smart Cities and Futures. *Sustainability* **2021**, *13*, 8952. [CrossRef]
37. Li, W.; Yigitcanlar, T.; Browne, W.; Nili, A. The Making of Responsible Innovation and Technology: An Overview and Framework. *Smart Cities* **2023**, *6*, 1996–2034. [CrossRef]
38. Gebauer, H.; Gustafsson, A.; Witell, L. Competitive Advantage through Service Differentiation by Manufacturing Companies. *J. Bus. Res.* **2011**, *64*, 1270–1280. [CrossRef]
39. World Economic Forum. *The Future of Jobs Report 2018*; World Economic Forum: Cologny, Switzerland, 2018.
40. Chase, R.B.; Dasu, S. Want to Perfect Your Company's Service? Use Behavioral Science. *Harv. Bus. Rev.* **2001**, *79*, 78–84.
41. Ostrom, A.L.; Parasuraman, A.; Bowen, D.E.; Patrício, L.; Voss, C.A. Service Research Priorities in a Rapidly Changing Context. *J. Serv. Res.* **2018**, *18*, 127–159. [CrossRef]
42. Mahr, D.; Lievens, A.; Blazevic, V. The Value of Customer Cocreated Knowledge during the Innovation Process. *J. Prod. Innov. Manag.* **2014**, *31*, 599–615. [CrossRef]

43. Gummesson, E.; Lusch, R.F.; Vargo, S.L. Transitioning from Service Management to Service-Dominant Logic: Observations and Recommendations. *Int. J. Qual. Serv. Sci.* **2010**, *2*, 8–22. [CrossRef]
44. Zhong, B.; Wu, H.; Li, H.; Sepasgozar, S.; Luo, H.; He, L. A Scientometric Analysis and Critical Review of Construction Related Ontology Research. *Autom. Constr.* **2019**, *101*, 17–31. [CrossRef]
45. Baker, H.K.; Kumar, S.; Pattnaik, D. Twenty-Five Years of the Journal of Corporate Finance: A Scientometric Analysis. *J. Corp. Financ.* **2021**, *66*, 101572. [CrossRef]
46. Alsaigh, R.; Mehmood, R.; Katib, I. AI Explainability and Governance in Smart Energy Systems: A Review. *Front. Energy Res.* **2023**, *11*, 41. [CrossRef]
47. Heilig, L.; Voß, S. A Scientometric Analysis of Public Transport Research. *J. Public Transp.* **2015**, *18*, 111–141. [CrossRef]
48. Ahmad, I.; Alqurashi, F.; Abozinadah, E.; Mehmood, R. Deep Journalism and DeepJournal V1.0: A Data-Driven Deep Learning Approach to Discover Parameters for Transportation. *Sustainability* **2022**, *14*, 5711. [CrossRef]
49. Alqahtani, E.; Janbi, N.; Sharaf, S.; Mehmood, R. Smart Homes and Families to Enable Sustainable Societies: A Data-Driven Approach for Multi-Perspective Parameter Discovery Using BERT Modelling. *Sustainability* **2022**, *14*, 13534. [CrossRef]
50. Ali, J.; Jusoh, A.; Abbas, A.; Nor, K. Global Trends of Service Quality in Healthcare: A Bibliometric Analysis of Scopus Database. *J. Contemp. Issues Bus. Gov.* **2021**, *27*, 2917–2930.
51. Arcese, G.; Valeri, M.; Poponi, S.; Elmo, G.C. Innovative Drivers for Family Business Models in Tourism. *J. Fam. Bus. Manag.* **2021**, *11*, 402–422. [CrossRef]
52. Dubina, O.; Us, Y.; Pimonenko, T.; Lyulyov, O. Customer Loyalty to Bank Services: The Bibliometric Analysis. *Virtual Econ.* **2020**, *3*, 53–66. [CrossRef]
53. Vaz, C.R.; Rauen, T.R.S.; Lezana, A.G.R. Sustainability and Innovation in the Automotive Sector: A Structured Content Analysis. *Sustainability* **2017**, *9*, 880. [CrossRef]
54. Chang, I.-C.; Horng, J.-S.; Liu, C.-H.; Chou, S.-F.; Yu, T.-Y. Exploration of Topic Classification in the Tourism Field with Text Mining Technology—A Case Study of the Academic Journal Papers. *Sustainability* **2022**, *14*, 4053. [CrossRef]
55. Yas, H.; Jusoh, A.; Abbas, A.; Abbas, M.; Nor, K. A Review and Bibliometric Analysis of Service Quality and Customer Satisfaction by Using Scopus Database. *Int. J. Manag.* **2020**, *11*, 459–470.
56. Ozyurt, O.; Ayaz, A. Twenty-Five Years of Education and Information Technologies: Insights from a Topic Modeling Based Bibliometric Analysis. *Educ. Inf. Technol.* **2022**, *27*, 11025–11054. [CrossRef]
57. Sassanelli, C.; Pezzotta, G.; Pirola, F.; Sala, R.; Margarito, A.; Lazoi, M.; Corallo, A.; Rossi, M.; Terzi, S. Using Design Rules to Guide the PSS Design in an Engineering Platform Based on the Product Service Lifecycle Management Paradigm. *Int. J. Prod. Lifecycle Manag.* **2018**, *11*, 91–115. [CrossRef]
58. Pezzotta, G.; Sassanelli, C.; Pirola, F.; Sala, R.; Rossi, M.; Fotia, S.; Koutoupes, A.; Terzi, S.; Mourtzis, D. The Product Service System Lean Design Methodology (PSSLDM): Integrating Product and Service Components along the Whole PSS Lifecycle. *J. Manuf. Technol. Manag.* **2018**, *29*, 1270–1295. [CrossRef]
59. Sassanelli, C.; Rossi, M.; Pezzotta, G.; de Jesus Pacheco, D.A.; Terzi, S. Defining Lean Product Service Systems Features and Research Trends through a Systematic Literature Review. *Int. J. Prod. Lifecycle Manag.* **2019**, *12*, 37–61. [CrossRef]
60. Alomari, E.; Katib, I.; Albeshri, A.; Yigitcanlar, T.; Mehmood, R. Iktishaf+: A Big Data Tool with Automatic Labeling for Road Traffic Social Sensing and Event Detection Using Distributed Machine Learning. *Sensors* **2021**, *21*, 2993. [CrossRef] [PubMed]
61. Suma, S.; Mehmood, R.; Albeshri, A. Automatic Detection and Validation of Smart City Events Using HPC and Apache Spark Platforms. In *Smart Infrastructure and Applications: Foundations for Smarter Cities and Societies*; Springer: Berlin/Heidelberg, Germany, 2020; pp. 55–78.
62. Alomari, E.; Katib, I.; Albeshri, A.; Mehmood, R. Covid-19: Detecting Government Pandemic Measures and Public Concerns from Twitter Arabic Data Using Distributed Machine Learning. *Int. J. Environ. Res. Public Health* **2021**, *18*, 282. [CrossRef] [PubMed]
63. Alswedani, S.; Mehmood, R.; Katib, I. Sustainable Participatory Governance: Data-Driven Discovery of Parameters for Planning Online and In-Class Education in Saudi Arabia During COVID-19. *Front. Sustain. Cities* **2022**, *4*, 97. [CrossRef]
64. Alotaibi, S.; Mehmood, R.; Katib, I.; Rana, O.; Albeshri, A. Sehaa: A Big Data Analytics Tool for Healthcare Symptoms and Diseases Detection Using Twitter, Apache Spark, and Machine Learning. *Appl. Sci.* **2020**, *10*, 1398. [CrossRef]
65. Zhan, Y.; Han, R.; Tse, M.; Ali, M.H.; Hu, J. A Social Media Analytic Framework for Improving Operations and Service Management: A Study of the Retail Pharmacy Industry. *Technol. Forecast. Soc. Chang.* **2021**, *163*, 120504. [CrossRef]
66. Lee, H.J.; Lee, M.; Lee, H.; Cruz, R.A. Mining Service Quality Feedback from Social Media: A Computational Analytics Method. *Gov. Inf. Q.* **2021**, *38*, 101571. [CrossRef]
67. Ibrahim, N.F.; Wang, X. A Text Analytics Approach for Online Retailing Service Improvement: Evidence from Twitter. *Decis. Support Syst.* **2019**, *121*, 37–50. [CrossRef]
68. Tian, X.; He, W.; Tang, C.; Li, L.; Xu, H.; Selover, D. A New Approach of Social Media Analytics to Predict Service Quality: Evidence from the Airline Industry. *J. Enterp. Inf. Manag.* **2019**, *33*, 51–70. [CrossRef]
69. Rahimi, M.M.; Naghizade, E.; Stevenson, M.; Winter, S. Service Quality Monitoring in Confined Spaces through Mining Twitter Data. *J. Spat. Inf. Sci.* **2020**, *21*, 229–261. [CrossRef]
70. He, W.; Tian, X.; Hung, A.; Akula, V.; Zhang, W. Measuring and Comparing Service Quality Metrics through Social Media Analytics: A Case Study. *Inf. Syst. E-bus. Manag.* **2018**, *16*, 579–600. [CrossRef]

71. Singh, A.; Shukla, N.; Mishra, N. Social Media Data Analytics to Improve Supply Chain Management in Food Industries. *Transp. Res. Part E Logist. Transp. Rev.* **2018**, *114*, 398–415. [CrossRef]
72. Singh, R.K.; Verma, H.K. Influence of Social Media Analytics on Online Food Delivery Systems. *Int. J. Inf. Syst. Model. Des.* **2020**, *11*, 1–21. [CrossRef]
73. Singh, P.; Dwivedi, Y.K.; Kahlon, K.S.; Sawhney, R.S.; Alalwan, A.A.; Rana, N.P. Smart Monitoring and Controlling of Government Policies Using Social Media and Cloud Computing. *Inf. Syst. Front.* **2020**, *22*, 315–337. [CrossRef]
74. Khatoon, S. Real-Time Twitter Data Analysis of Saudi Telecom Companies for Enhanced Customer Relationship Management. *Int. J. Comput. Sci. Netw. Secur.* **2017**, *17*, 141–147.
75. Devlin, J.; Chang, M.W.; Lee, K.; Toutanova, K. BERT: Pre-Training of Deep Bidirectional Transformers for Language Understanding. In Proceedings of the NAACL HLT 2019—2019 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies, Minneapolis, MN, USA, 2–7 June 2019; Association for Computational Linguistics (ACL): Kerrville, TX, USA, 2019; Volume 1, pp. 4171–4186.
76. McInnes, L.; Healy, J.; Melville, J. UMAP: Uniform Manifold Approximation and Projection for Dimension Reduction. *arXiv* **2018**, arXiv:1802.03426.
77. McInnes, L.; Healy, J.; Astels, S. Hdbscan: Hierarchical Density Based Clustering. *J. Open Source Softw.* **2017**, *2*, 205. [CrossRef]
78. Suwais, K.; Alshahrani, A. The Impact of Virtual Classes on Students' Performance in Open Learning Environments: The Case of Arab Open University, Saudi Arabia. *J. Comput. Sci.* **2018**, *14*, 14–22. [CrossRef]
79. Sholikah, M.A.; Sutirman, S. How Technology Acceptance Model (TAM) Factors of Electronic Learning Influence Education Service Quality through Students' Satisfaction. *TEM J.* **2020**, *9*, 1221–1226. [CrossRef]
80. Mehmood, R.; Alam, F.; Albogami, N.N.; Katib, I.; Albeshri, A.; Altowaijri, S.M. UTiLearn: A Personalised Ubiquitous Teaching and Learning System for Smart Societies. *IEEE Access* **2017**, *5*, 2615–2635. [CrossRef]
81. Tan, C.; Lin, J. A New QoE-Based Prediction Model for Evaluating Virtual Education Systems with COVID-19 Side Effects Using Data Mining. *Soft Comput.* **2021**, *27*, 1699–1713. [CrossRef] [PubMed]
82. El-Sofany, H.F.; El-Haggar, N. The Effectiveness of Using Mobile Learning Techniques to Improve Learning Outcomes in Higher Education. *Int. J. Interact. Mob. Technol.* **2020**, *14*, 4–18. [CrossRef]
83. Hershkovitz, A.; Abu Elhija, M.; Zedan, D. Whatsapp Is the Message: Out-of-Class Communication, Student-Teacher Relationship, and Classroom Environment. *J. Inf. Technol. Educ. Res.* **2019**, *18*, 73–95. [CrossRef] [PubMed]
84. Baytiyeh, H. Social Media Tools for Educational Sustainability in Conflict-Affected Regions. *Educ. Sci.* **2021**, *11*, 662. [CrossRef]
85. Mehrotra, A.; Giang, C.; El-Hamamsy, L.; Guinchard, A.; Dame, A.; Zahnd, G.; Mondada, F. Accessible Maker-Based Approaches to Educational Robotics in Online Learning. *IEEE Access* **2021**, *9*, 96877–96889. [CrossRef]
86. Maraza-Quispe, B.; Alejandro-Oviedo, O.M.; Choquehuanca-Quispe, W.; Hurtado-Mazeyra, A.; Fernandez-Gambarini, W. E-Learning Proposal Supported by Reasoning Based on Instances of Learning Objects. *Int. J. Adv. Comput. Sci. Appl.* **2019**, *10*, 252–258. [CrossRef]
87. Peechapol, C.; Na-Songkhla, J.; Sujiva, S.; Luangsodsai, A. Development of Smartphone Application Based on the Theory of Planned Behaviour to Enhance Self-Efficacy for Online Learning. *Int. J. Interact. Mob. Technol.* **2018**, *12*, 135–151. [CrossRef]
88. Rahman, M.M.; Sharker, M.; Paudel, R. Impact of Infusing Interactive and Collaborative Learning in Teaching Introductory Programming in a Dynamic Class. In Proceedings of the SIGCSE'20: The 51st ACM Technical Symposium on Computer Science Education, New York, NY, USA, 11–14 March 2020; p. 1315. [CrossRef]
89. Baryshev, R.A.; Verkhovets, S.V.; Babina, O.I. The Smart Library Project: Development of Information and Library Services for Educational and Scientific Activity. *Electron. Libr.* **2018**, *36*, 535–549. [CrossRef]
90. Schöpfel, J. Smart Libraries. *Infrastructures* **2018**, *3*, 43. [CrossRef]
91. Malheiros, T.M.; Da Cunha, M.B. Libraries as Facilitators in Access to Information by Visually Impaired Users. *Rev. Digit. Bibliotecon. Cienc. Inf.* **2018**, *16*, 146–170. [CrossRef]
92. Hjelt, M.; Saarti, J. Implementing Library Strategies and Values as a Part of the Workplace Information Literacy. *Commun. Comput. Inf. Sci.* **2018**, *810*, 11–20. [CrossRef]
93. Borrego, Á.; Anglada, L. Research Support Services in Spanish Academic Libraries: An Analysis of Their Strategic Plans and of an Opinion Survey Administered to Their Directors. *Publications* **2018**, *6*, 48. [CrossRef]
94. McCready, K.; Molls, E. Developing a Business Plan for a Library Publishing Program. *Publications* **2018**, *6*, 42. [CrossRef]
95. Nurse, R.; Baker, K.; Gambles, A. Library Resources, Student Success and the Distance-Learning University. *Inf. Learn. Sci.* **2018**, *119*, 77–86. [CrossRef]
96. Serholt, S.; Eriksson, E.; Dalsgaard, P.; Bats, R.; Ducros, A. Opportunities and Challenges for Technology Development and Adoption in Public Libraries. In Proceedings of the 10th Nordic Conference on Human-Computer Interaction, Oslo, Norway, 29 September–3 October 2018; pp. 311–322. [CrossRef]
97. Howard, H.; Huber, S.; Carter, L.; Moore, E. Academic Libraries on Social Media: Finding the Students and the Information They Want. *Inf. Technol. Libr.* **2018**, *37*, 8–18. [CrossRef]
98. Chisita, C.T.; Dick, A. Library Cooperation in Zimbabwe: In Search of a Suitable Model to Underpin National Development. *Electron. Libr.* **2018**, *36*, 633–649. [CrossRef]
99. Al-Ani, M.; Abdulrazzaq, A. The Feasibility of Implementing Augmented Reality Technology for Delivering Library Services: A Case Study at the University of Bahrain. *Int. J. Comput. Digit. Syst.* **2019**, *8*, 367–373. [CrossRef]

100. Tsekea, S.; Chigwada, J.P. COVID-19: Strategies for Positioning the University Library in Support of e-Learning. *Digit. Libr. Perspect.* **2021**, *37*, 54–64. [CrossRef]
101. Ma, X.; Wang, Z.; Zhou, S.; Wen, H.; Zhang, Y. Intelligent Healthcare Systems Assisted by Data Analytics and Mobile Computing. In Proceedings of the 2018 14th International Wireless Communications & Mobile Computing Conference (IWCMC), Limassol, Cyprus, 25–29 June 2018; pp. 1317–1322. [CrossRef]
102. Rezaeiaghdam, A.; Watson, J.; Ziaimatin, H. Online Value Co-Creation in the Healthcare Service Ecosystem: A Review. In Proceedings of the 29th Australasian Conference on Information Systems, Sydney, Australia, 3 December 2018.
103. Russo, G.; Tartaglione, A.M.; Cavacece, Y. Empowering Patients to Co-Create a Sustainable Healthcare Value. *Sustainability* **2019**, *11*, 1315. [CrossRef]
104. Bisceglia, M.; Cellini, R.; Grilli, L. Quality Competition in Healthcare Services with Regional Regulators: A Differential Game Approach. *Dyn. Games Appl.* **2019**, *9*, 1–23. [CrossRef]
105. Harerimana, G.; Jang, B.; Kim, J.W.; Park, H.K. Health Big Data Analytics: A Technology Survey. *IEEE Access* **2018**, *6*, 65661–65678. [CrossRef]
106. Sirilak, S.; Muneesawang, P. A New Procedure for Advancing Telemedicine Using the HoloLens. *IEEE Access* **2018**, *6*, 60224–60233. [CrossRef]
107. Paganelli, A.I.; Velmovitsky, P.E.; Miranda, P.; Branco, A.; Alencar, P.; Cowan, D.; Endler, M.; Morita, P.P. A Conceptual IoT-Based Early-Warning Architecture for Remote Monitoring of COVID-19 Patients in Wards and at Home. *Internet Things* **2022**, *18*, 100399. [CrossRef]
108. Saminathan, S.; Geetha, K. Real-Time Health Care Monitoring System Using IoT. *Int. J. Eng. Technol.* **2018**, *7*, 484–488. [CrossRef]
109. Alswedani, S.; Mehmood, R.; Katib, I.; Altowaijri, S.M. Psychological Health and Drugs: Data-Driven Discovery of Causes, Treatments, Effects, and Abuses. *Toxics* **2023**, *11*, 287. [CrossRef] [PubMed]
110. Alswedani, S.; Katib, I.; Abozinadah, E.; Mehmood, R. Discovering Urban Governance Parameters for Online Learning in Saudi Arabia During COVID-19 Using Topic Modeling of Twitter Data. *Front. Sustain. Cities* **2022**, *4*, 1–24. [CrossRef]
111. Alam, F.; Almaghthawi, A.; Katib, I.; Albeshri, A.; Mehmood, R. IResponse: An AI and IoT-Enabled Framework for Autonomous COVID-19 Pandemic Management. *Sustainability* **2021**, *13*, 3797. [CrossRef]
112. Kim, S.; Lee, M.; Shin, C. IoT-Based Strawberry Disease Prediction System for Smart Farming. *Sensors* **2018**, *18*, 4051. [CrossRef]
113. Alberdi, A.; Weakley, A.; Schmitter-Edgecombe, M.; Cook, D.J.; Aztiria, A.; Basarab, A.; Barrenechea, M. Smart Home-Based Prediction of Multidomain Symptoms Related to Alzheimer's Disease. *IEEE J. Biomed. Health Inform.* **2018**, *22*, 1720–1731. [CrossRef]
114. Jnr, B.A. Applying Enterprise Architecture for Digital Transformation of Electro Mobility towards Sustainable Transportation. In Proceedings of the SIGMIS-CPR'20: 2020 on Computers and People Research Conference, Nuremberg Germany, 19–21 June 2020; pp. 38–46. [CrossRef]
115. Aqib, M.; Mehmood, R.; Alzahrani, A.; Katib, I.; Albeshri, A.; Altowaijri, S.M. Rapid Transit Systems: Smarter Urban Planning Using Big Data, In-Memory Computing, Deep Learning, and GPUs. *Sustainability* **2019**, *11*, 2736. [CrossRef]
116. Mehmood, R.; Meriton, R.; Graham, G.; Hennelly, P.; Kumar, M. Exploring the Influence of Big Data on City Transport Operations: A Markovian Approach. *Int. J. Oper. Prod. Manag.* **2017**, *37*, 75–104. [CrossRef]
117. Baldini, G.; Sportiello, L.; Chiaramello, M.; Mahieu, V. Regulated Applications for the Road Transportation Infrastructure: The Case Study of the Smart Tachograph in the European Union. *Int. J. Crit. Infrastruct. Prot.* **2018**, *21*, 3–21. [CrossRef]
118. Astarita, V.; Festa, D.C.; Giofrè, V.P.; Guido, G.; Vitale, A. The Use of Smartphones to Assess the Feasibility of a Cooperative Intelligent Transportation Safety System Based on Surrogate Measures of Safety. *Procedia Comput. Sci.* **2018**, *134*, 427–432. [CrossRef]
119. Aqib, M.; Mehmood, R.; Alzahrani, A.; Katib, I.; Albeshri, A.; Altowaijri, S.M. Smarter Traffic Prediction Using Big Data, In-Memory Computing, Deep Learning and GPUs. *Sensors* **2019**, *19*, 2206. [CrossRef] [PubMed]
120. Alam, F.; Mehmood, R.; Katib, I.; Altowaijri, S.M.; Albeshri, A. TAAWUN: A Decision Fusion and Feature Specific Road Detection Approach for Connected Autonomous Vehicles. *Mob. Netw. Appl.* **2019**, *28*, 636–652. [CrossRef]
121. Hussain, S.A.; Yusof, K.M.; Hussain, S.M.; Singh, A.V. A Review of Quality of Service Issues in Internet of Vehicles (IoV). In Proceedings of the 2019 Amity International Conference on Artificial Intelligence (AICAI), Dubai, United Arab Emirates, 4–6 February 2019.
122. Zhao, W.; Zhou, B.; Zhang, C. Heterogeneous Social Linked Data Integration and Sharing for Public Transportation. *J. Adv. Transp.* **2022**, *2022*, 6338365. [CrossRef]
123. Hu, X.; Deng, Z. Research on Perception Bias of Implementation Benefits of Urban Intelligent Transportation System Based on Big Data. *EURASIP J. Wirel. Commun. Netw.* **2019**, *2019*, 116. [CrossRef]
124. Du, J.; Qiao, F.; Yu, L. Improving Bus Transit Services for Disabled Individuals: Demand Clustering, Bus Assignment, and Route Optimization. *IEEE Access* **2020**, *8*, 121564–121571. [CrossRef]
125. Alic, A.S.; Almeida, J.; Aloisio, G.; Andrade, N.; Antunes, N.; Ardagna, D.; Badia, R.M.; Basso, T.; Blanquer, I.; Braz, T.; et al. BIGSEA: A Big Data Analytics Platform for Public Transportation Information. *Futur. Gener. Comput. Syst.* **2019**, *96*, 243–269. [CrossRef]
126. Wang, X.; Jiang, H.; Tang, T.; Zhao, H. The Qos Indicators Analysis of Integrated Euht Wireless Communication System Based on Urban Rail Transit in High-Speed Scenario. *Wirel. Commun. Mob. Comput.* **2018**, *2018*, 2359810.

127. Li, W.; Peng, Q.; Wen, C.; Li, S.; Yan, X.; Xu, X. Integrated Optimization on Energy Saving and Quality of Service of Urban Rail Transit System. *J. Adv. Transp.* **2020**, *2020*, 3474020. [CrossRef]
128. Chen, Z.; Zhang, Z.; Zhao, J.; Wu, B.; Huang, X. An Analysis of the Charging Characteristics of Electric Vehicles Based on Measured Data and Its Application. *IEEE Access* **2018**, *6*, 24475–24487. [CrossRef]
129. Alkhayat, G.; Hasan, S.H.; Mehmood, R. SENERGY: A Novel Deep Learning-Based Auto-Selective Approach and Tool for Solar Energy Forecasting. *Energies* **2022**, *15*, 6659. [CrossRef]
130. Lai, Z.; Li, S. On-Demand Valet Charging for Electric Vehicles: Economic Equilibrium, Infrastructure Planning and Regulatory Incentives. *Transp. Res. Part C Emerg. Technol.* **2022**, *140*, 103669. [CrossRef]
131. Luo, C.; Huang, Y.-F.; Gupta, V.; Luo, C.; Huang, Y.-F.; Gupta, V. Stochastic Dynamic Pricing for EV Charging Stations with Renewables Integration and Energy Storage. *IEEE Trans. Smart Grid* **2018**, *9*, 1494–1505. [CrossRef]
132. Mehrabi, A.; Siekkinen, M.; Yla-Jaaski, A.; Aggarwal, G. Mobile Edge Computing Assisted Green Scheduling of On-Move Electric Vehicles. *IEEE Syst. J.* **2022**, *16*, 1661–1672. [CrossRef]
133. Zenginis, I.; Vardakas, J.; Zorba, N.; Verikoukis, C. Performance Evaluation of a Multi-Standard Fast Charging Station for Electric Vehicles. *IEEE Trans. Smart Grid* **2018**, *9*, 4480–4489. [CrossRef]
134. Sanchez, F.; Gonzalez-Lonzatt, F.; Rueda, J.L.; Palensky, P. Impact of Electric Vehicle Charging Control on the Frequency Response: Study of the Gb System. In Proceedings of the 2018 IEEE PES Innovative Smart Grid Technologies Conference Europe (ISGT-Europe), Sarajevo, Bosnia and Herzegovina, 21–25 October 2018; pp. 3–8. [CrossRef]
135. Andersen, P.B.; Sousa, T.; Thingvad, A.; Berthou, L.S.; Kulahci, M. Added Value of Individual Flexibility Profiles of Electric Vehicle Users for Ancillary Services. In Proceedings of the 2018 IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm), Aalborg, Denmark, 29–31 October 2018; pp. 1–6. [CrossRef]
136. Mottola, L.; Whitehouse, K. Fundamental Concepts of Reactive Control for Autonomous Drones. *Commun. ACM* **2018**, *61*, 96–104. [CrossRef]
137. Calle, M.; Andrade-Pineda, J.L.; González, P.L.R.; Leon-Blanco, J.M.; Ortiz, D.C. A Tandem Drone-Ground Vehicle for Accessing Isolated Locations for First Aid Emergency Response in Case of Disaster. In Proceedings of the International Joint Conference on Computational Intelligence, Dhaka, Bangladesh, 14–15 December 2018; pp. 289–296. [CrossRef]
138. Crişan, G.C.; Nechita, E. On a Cooperative Truck-and-Drone Delivery System. *Procedia Comput. Sci.* **2019**, *159*, 38–47. [CrossRef]
139. Syd Ali, B. Traffic Management for Drones Flying in the City. *Int. J. Crit. Infrastruct. Prot.* **2019**, *26*, 100310. [CrossRef]
140. Gan, K.B.; Mohd, S.A.; Ng, T.Y. Apps-Based Temperature Monitoring System with Location Services for Medical Needs Delivery Using Drone. *Int. J. Interact. Mob. Technol.* **2021**, *15*, 103–117. [CrossRef]
141. Hunukumbure, M.; Tsoukaneri, G. Cost Analysis for Drone Based 5G EMBB Provision to Emergency Services. 2019 IEEE Globecom Work. In Proceedings of the 2019 IEEE Globecom Workshops (GC Wkshps), Waikoloa, HI, USA, 9–13 December 2019. [CrossRef]
142. Liang, M.; Delahaye, D. *Drone Fleet Deployment Strategy for Large Scale Agriculture and Forestry Surveying*; Institute of Electrical and Electronics Engineers Inc.: New York, NY, USA; School of Engineering, University of South Australia: Adelaide, Australia, 2019; pp. 4495–4500.
143. Afghah, F.; Razi, A.; Chakareski, J.; Ashdown, J. *Wildfire Monitoring in Remote Areas Using Autonomous Unmanned Aerial Vehicles*; Institute of Electrical and Electronics Engineers Inc.: New York, NY, USA; School of Informatics, Computing and Cyber Systems, Northern Arizona University: Flagstaff, AZ, USA, 2019; pp. 835–840.
144. Hiebert, B.; Nouvet, E.; Jeyabalan, V.; Donelle, L. The Application of Drones in Healthcare and Health-Related Services in North America: A Scoping Review. *Drones* **2020**, *4*, 30. [CrossRef]
145. Grote, M.; Cherrett, T.; Oakey, A.; Royall, P.G.; Whalley, S.; Dickinson, J. How Do Dangerous Goods Regulations Apply to Uncrewed Aerial Vehicles Transporting Medical Cargos? *Drones* **2021**, *5*, 38. [CrossRef]
146. González Jorge, H.; Miguel González de Santos, L.; Fariñas Álvarez, N.; Martínez Sánchez, J.; Navarro Medina, F. Operational Study of Drone Spraying Application for the Disinfection of Surfaces against the COVID-19 Pandemic. *Drones* **2021**, *5*, 18. [CrossRef]
147. Iqbal, A.; Olariu, S. A Survey of Enabling Technologies for Smart Communities. *Smart Cities* **2020**, *4*, 54–77. [CrossRef]
148. Mehmood, R.; Corchado, J.M.; Yigitcanlar, T. Developing Smartness in Emerging Environments and Applications with a Focus on the Internet of Things. *Sensors* **2022**, *22*, 8939. [CrossRef]
149. Polese, F.; Botti, A.; Monda, A.; Grimaldi, M. Smart City as a Service System: A Framework to Improve Smart Service Management. *J. Serv. Sci. Manag.* **2019**, *12*, 121001. [CrossRef]
150. Serrano, W. Digital Systems in Smart City and Infrastructure: Digital as a Service. *Smart Cities* **2018**, *1*, 134–154. [CrossRef]
151. Mehmood, R.; Sheikh, A.; Catlett, C.; Chlamtac, I. Editorial: Smart Societies, Infrastructure, Systems, Technologies, and Applications. *Mob. Netw. Appl.* **2022**, *28*, 598–602. [CrossRef]
152. Magdalena, M.; Almira, M. Water Governance in the Smart City. *WIT Trans. Built Environ.* **2018**, *179*, 13–22. [CrossRef]
153. Tcholtchev, N.; Schieferdecker, I. Sustainable and Reliable Information and Communication Technology for Resilient Smart Cities. *Smart Cities* **2021**, *4*, 156–176. [CrossRef]
154. D'Amico, G.; L'Abbate, P.; Liao, W.; Yigitcanlar, T.; Ioppolo, G. Understanding Sensor Cities: Insights from Technology Giant Company Driven Smart Urbanism Practices. *Sensors* **2020**, *20*, 4391. [CrossRef] [PubMed]

155. Ma, H. The Construction Path and Mode of Public Tourism Information Service System Based on the Perspective of Smart City. *Complexity* **2020**, *2020*, 8842061. [CrossRef]
156. Nguyen, L.V.; Nguyen, T.H.; Jung, J.J. Tourism Recommender System Based on Cognitive Similarity between Cross-Cultural Users. In *Intelligent Environments 2021*; Ambient Intelligence and Smart Environments; IOS Press: Amsterdam, The Netherlands, 2021; Volume 29, pp. 225–232. [CrossRef]
157. Boulaalam, O.; Aghoutane, B.; El Ouadghiri, D.; Moumen, A.; Cheikh Malinine, M.L. Proposal of a Big Data System Based on the Recommendation and Profiling Techniques for an Intelligent Management of Moroccan Tourism. *Procedia Comput. Sci.* **2018**, *134*, 346–351. [CrossRef]
158. Nusraningrum, D.; Pratama, A. The Tourism Development through Creative Economy. *Int. J. Eng. Adv. Technol.* **2019**, *8*, 300–308. [CrossRef]
159. Li, H. Study on the Development Model of Rural Smart Tourism Based on the Background of Internet of Things. *Wirel. Commun. Mob. Comput.* **2022**, *2022*, 9688023. [CrossRef]
160. Khrais, L.T.; Alghamdi, A.M. The Role of Mobile Application Acceptance in Shaping E-Customer Service. *Futur. Internet* **2021**, *13*, 77. [CrossRef]
161. Khan, E.A.; Shambour, M.K.Y. An Analytical Study of Mobile Applications for Hajj and Umrah Services. *Appl. Comput. Informatics* **2018**, *14*, 37–47. [CrossRef]
162. Zimmer, F.; Scheibe, K.; Zhang, H. Gamification Elements on Social Live Streaming Service Mobile Applications. In *Social Computing and Social Media. Design, Ethics, User Behavior, and Social Network Analysis: Proceedings of the 12th International Conference, SCSM 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, 19–24 July 2020*; Lecture Notes in Computer Science; Springer: Berlin/Heidelberg, Germany, 2020; Volume 12194, pp. 184–197. [CrossRef]
163. Çelik, S.; Baran, E.; Sert, O. The Affordances of Mobile-App Supported Teacher Observations for Peer Feedback. *Int. J. Mob. Blended Learn.* **2018**, *10*, 36–49. [CrossRef]
164. Ren, B.; Liu, C.; Cheng, B.; Hong, S.; Guo, J.; Chen, J. EasyPrivacy: Context-Aware Resource Usage Control System for Android Platform. *IEEE Access* **2018**, *6*, 44506–44518. [CrossRef]
165. Didik Madyatmadja, E.; Abdurachman, E.; Gaol, F.L.; Pudjianto, B.W.; Hapsara, M. Potential Impact of Social Media to Support Government Services in Jakarta Smart City. In Proceedings of the 2018 International Conference on Information Management and Technology (ICIMTech), Jakarta, Indonesia, 3–5 September 2018; pp. 534–538. [CrossRef]
166. Chen, J.; Becken, S.; Stantic, B. Sentiment Analytics of Chinese Social Media Posts. In Proceedings of the 8th International Conference on Web Intelligence, Mining and Semantics, Novi Sad, Serbia, 25–27 June 2018. [CrossRef]
167. Sangam, S.; Shinde, S. Sentiment Classification of Social Media Reviews Using an Ensemble Classifier. *Indones. J. Electr. Eng. Comput. Sci.* **2019**, *16*, 355–363. [CrossRef]
168. Tusar, M.; Islam, M.T. A Comparative Study of Sentiment Analysis Using NLP and Different Machine Learning Techniques on US Airline Twitter Data. In Proceedings of the 2021 International Conference on Electronics, Communications and Information Technology (ICECIT), Khulna, Bangladesh, 14–16 September 2021.
169. Jain, P.K.; Pamula, R. A Systematic Literature Review on Machine Learning Applications for Consumer Sentiment Analysis Using Online Reviews. *Comput. Sci. Rev.* **2021**, *41*, 100413. [CrossRef]
170. Barros, A.; Sindhgatta, R.; Nili, A. Scaling up Chatbots for Corporate Service Delivery Systems. *Commun. ACM* **2021**, *64*, 88–97. [CrossRef]
171. Nawaz, N.; Gomes, A.M. Artificial Intelligence Chatbots Are New Recruiters. *Int. J. Adv. Comput. Sci. Appl.* **2020**, *10*, 1–5. [CrossRef]
172. Svenningsson, N.; Faraon, M. Artificial Intelligence in Conversational Agents: A Study of Factors Related to Perceived Humanness in Chatbots. In Proceedings of the 2019 2nd Artificial Intelligence and Cloud Computing Conference, Kobe, Japan, 21–23 December 2019; pp. 151–161. [CrossRef]
173. Følstad, A.; Nordheim, C.B.; Bjørkli, C.A. What Makes Users Trust a Chatbot for Customer Service? An Exploratory Interview Study. In *Internet Science: Proceedings of the 5th International Conference, INSCI 2018, St. Petersburg, Russia, 24–26 October 2018*; Lecture Notes in Computer Science; Springer: Berlin/Heidelberg, Germany, 2018; Volume 11193, pp. 194–208. [CrossRef]
174. Daniel, F.; Matera, M.; Zaccaria, V.; Dell'orto, A. Toward Truly Personal Chatbots: On the Development of Custom Conversational Assistants. In Proceedings of the 1st International Workshop on Software Engineering for Cognitive Services, Gothenburg, Sweden, 28–29 May 2018; pp. 31–36. [CrossRef]
175. Yang, S.; Evans, C. Opportunities and Challenges in Using AI Chatbots in Higher Education. In Proceedings of the 2019 3rd International Conference on Education and E-Learning, Barcelona, Spain, 5–7 November 2019; pp. 79–83. [CrossRef]
176. Yang, S.; Stansfield, K. AI Chatbot for Educational Service Improvement in the Post-Pandemic Era: A Case Study Prototype for Supporting Digital Reading List. In Proceedings of the 2022 13th International Conference on E-Education, E-Business, E-Management, and E-Learning, Tokyo, Japan, 14–17 January 2022; pp. 24–29. [CrossRef]
177. Fröhlich, K.; Nieminen, M.; Peters, A.; Pinomaa, A. Considerations for Co-Designing e-Government Services in under-Served Rural Communities. In Proceedings of the Second African Conference for Human Computer Interaction: Thriving Communities, Windhoek, Namibia, 3–7 December 2018; pp. 204–207. [CrossRef]

178. Alavesa, P.; Pakanen, M.; Niemelä, A.; Huang, W.; Väinämö, S.; Haukipuro, L.; Arhippainen, L.; Ojala, T.; Väinömö, S.; Ojala, T. 2018 Mobile Augmented Reality Client as a UX Method for Living Lab's User Involvement Tool. In Proceedings of the 22nd International Academic Mindtrek Conference, Tampere, Finland, 10–11 October 2018; pp. 135–142. [CrossRef]
179. Gombolay, M.; Yang, X.J.; Hayes, B.; Seo, N.; Liu, Z.; Wadhwania, S.; Yu, T.; Shah, N.; Golen, T.; Shah, J. Robotic Assistance in the Coordination of Patient Care. *Int. J. Robot. Res.* **2018**, *37*, 1300–1316. [CrossRef]
180. Holland, J.; Kingston, L.; McCarthy, C.; Armstrong, E.; O'dwyer, P.; Merz, F.; McConnell, M. Service Robots in the Healthcare Sector. *Robotics* **2021**, *10*, 47. [CrossRef]
181. Ramalingam, B.; Yin, J.; Elara, M.R.; Tamilselvam, Y.K.; Rayguru, M.M.; Muthugala, M.A.V.J.; Gómez, B.F. A Human Support Robot for the Cleaning and Maintenance of Door Handles Using a Deep-Learning Framework. *Sensors* **2020**, *20*, 3543. [CrossRef]
182. Kim, J.; Cauli, N.; Vicente, P.; Damas, B.; Cavallo, F.; Santos-Victor, J. "ICub, Clean the Table!" A Robot Learning from Demonstration Approach Using Deep Neural Networks. In Proceedings of the 2018 IEEE International Conference on Autonomous Robot Systems and Competitions (ICARSC), Torres Vedras, Portugal, 25–27 April 2018; BioRobotics Institute, Scuola Superiore sant'Anna: Pisa, Italy, 2018; pp. 3–9.
183. Rubio, F.; Valero, F.; Llopis-Albert, C. A Review of Mobile Robots: Concepts, Methods, Theoretical Framework, and Applications. *Int. J. Adv. Robot. Syst.* **2019**, *16*, 1729881419839596. [CrossRef]
184. Coro, G.; Bjerregaard Walsh, M. An Intelligent and Cost-Effective Remote Underwater Video Device for Fish Size Monitoring. *Ecol. Inform.* **2021**, *63*, 101311. [CrossRef]
185. Liu, T.; Wu, F. A Sensor-Based IoT Data Collection and Marine Economy Collaborative Innovation Method. *Comput. Intell. Neurosci.* **2022**, *2022*, 3421999. [CrossRef]
186. Sathya, P.; Sengottuvelan, P. Energy Efficient and Quality-of-Service Aware Routing Using Underwater Wireless Sensor Networks. *Int. J. Adv. Comput. Sci. Appl.* **2022**, *13*, 468–474.
187. Cannata, M.; Strigaro, D.; Lepori, F.; Capelli, C.; Rogora, M.; Manca, D. FOSS4G Based High Frequency and Interoperable Lake Water-Quality Monitoring System. *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.* **2021**, *46*, 25–29. [CrossRef]
188. Konaté, J.; Diarra, A.G.; Diarra, S.O.; Diallo, A. SyrAgri: A Recommender System for Agriculture in Mali. *Information* **2020**, *11*, 561. [CrossRef]
189. Umar, R.; Fahana, J.; Triyono, A. Development of E-Marketplace in Department of Agriculture Food Crops and Horticulture as a Means to Expand the Market of Processed Food. In Proceedings of the 2018 12th International Conference on Telecommunication Systems, Services, and Applications (TSSA), Yogyakarta, Indonesia, 4–5 October 2018. [CrossRef]
190. Wisnubhadra, I.; Suhana Kamal Baharin, S.; Suryana Herman, N. Open Spatiotemporal Data Warehouse for Agriculture Production Analytics. *Int. J. Intell. Eng. Syst.* **2020**, *13*, 419–431. [CrossRef]
191. Corista, P.; Ferreira, D.; Giao, J.; Sarraipa, J.; Goncalves, R.J. An IoT Agriculture System Using FIWARE. In Proceedings of the 2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC), Stuttgart, Germany, 17–20 June 2018; p. 8436381. [CrossRef]
192. Placidi, P.; Morbidelli, R.; Fortunati, D.; Papini, N.; Gobbi, F.; Scorzoni, A. Monitoring Soil and Ambient Parameters in the IoT Precision Agriculture Scenario: An Original Modeling Approach Dedicated to Low-Cost Soil Water Content Sensors. *Sensors* **2021**, *21*, 5110. [CrossRef] [PubMed]
193. Edwin, B.; Veemaraj, E.; Parthiban, P.; Devarajan, J.P.; Mariadhas, V.; Arumuganainar, A.; Reddy, M. Smart Agriculture Monitoring System for Outdoor and Hydroponic Environments. *Indones. J. Electr. Eng. Comput. Sci.* **2022**, *25*, 1679–1687. [CrossRef]
194. Soeparno, H.; Samsinga Perbangsa, A.; Pardamean, B. Best Practices of Agricultural Information System in the Context of Knowledge and Innovation. In Proceedings of the 2018 International Conference on Information Management and Technology (ICIMTech), Jakarta, Indonesia, 3–5 September 2018.
195. Zhang, C.; Liu, Z. Application of Big Data Technology in Agricultural Internet of Things. *Int. J. Distrib. Sens. Netw.* **2019**, *15*, 1550147719881610. [CrossRef]
196. Jung, Y.; Mallari, T.; Hattman, E. DRMACert: Certification for Disaster Response Mobile Applications. In Proceedings of the 4th International Conference on Computer Science and Software Engineering, New York, NY, USA, 22–24 October 2021; pp. 195–199. [CrossRef]
197. Chao, M.; Chenji, H.; Yang, C.; Stoleru, R.; Nikolova, E.; Altaweel, A. EAR: Energy-Aware Risk-Averse Routing for Disaster Response Networks. *Ad Hoc Netw.* **2020**, *103*, 102167. [CrossRef]
198. Verma, R.; Karimi, S.; Lee, D.; Gnawali, O.; Shakery, A. Newswire versus Social Media for Disaster Response and Recovery. In Proceedings of the 2019 Resilience Week (RWS), San Antonio, TX, USA, 4–7 November 2019; pp. 132–141. [CrossRef]
199. Doxani, G.; Siachalou, S.; Mitraka, Z.; Patias, P. Decision Making on Disaster Management in Agriculture with Sentinel Applications. *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.* **2019**, *42*, 121–126. [CrossRef]
200. Ramli, S.; Mohamed, Z.A. Understanding of CSFs in the Application of Public-Private Partnership (PPP) Toll Expressways in Malaysia. *Int. J. Innov. Technol. Explor. Eng.* **2019**, *9*, 2082–2087. [CrossRef]
201. Voorwinden, A. The Privatised City: Technology and Public-Private Partnerships in the Smart City. *Law Innov. Technol.* **2021**, *13*, 439–463. [CrossRef]
202. Wang, S.; Fang, J.; Liu, L.; Wu, H. Study on an Intelligent Prediction Method of Ticket Price in a Subway System with Public-Private Partnership. *Complexity* **2021**, *2021*, 6623485. [CrossRef]

203. Smith, G.; Sandberg, J. Barriers to Innovating with Open Government Data: Exploring Experiences across Service Phases and User Types. *Inf. Polity* **2018**, *23*, 249–265. [CrossRef]
204. NEL, D. Allocation of Risk in Public Private Partnerships in Information and Communications Technology. *Int. J. Ebus. Egovernment Stud.* **2020**, *12*, 17–32. [CrossRef]
205. Anthony, B.; Petersen, S.A.; Helfert, M. Digital Transformation of Virtual Enterprises for Providing Collaborative Services in Smart Cities. *IFIP Adv. Inf. Commun. Technol.* **2020**, *598*, 249–260. [CrossRef]
206. Guzmán-Ortiz, C.V.; Navarro-Acosta, N.G.; Florez-Garcia, W.; Vicente-Ramos, W. Impact of Digital Transformation on the Individual Job Performance of Insurance Companies in Peru. *Int. J. Data Netw. Sci.* **2020**, *4*, 337–346. [CrossRef]
207. Reid, T.G.R.; Chan, B.; Goel, A.; Gunning, K.; Manning, B.; Martin, J.; Neish, A.; Perkins, A.; Tarantino, P.; Reid, T.G.R.; et al. Satellite Navigation for the Age of Autonomy. *arXiv* **2020**, arXiv:2005.09144. [CrossRef]
208. Parker, J.J.K.; Bauer, F.H.; Ashman, B.W.; Miller, J.J.; Enderle, W.; Blonski, D. Development of an Interoperable GNSS Space Service Volume. In Proceedings of the 31st International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2018), Miami, FL, USA, 24–28 September 2018; pp. 1246–1256. [CrossRef]
209. Laha, A.K.; Putatunda, S. Real Time Location Prediction with Taxi-GPS Data Streams. *Transp. Res. Part C Emerg. Technol.* **2018**, *92*, 298–322. [CrossRef]
210. Ge, Y.; Qin, W.J.; Cao, X.; Zhou, F.; Wang, S.; Yang, X. Consideration of GLONASS Inter-Frequency Code Biases in Precise Point Positioning (PPP) International Time Transfer. *Appl. Sci.* **2018**, *8*, 1254. [CrossRef]
211. Yayla, G.; Van Baelen, S.; Peeters, G.; Afzal, M.R.; Catoor, T.; Singh, Y.; Slaets, P. Accuracy Benchmark of Galileo and EGNOS for Inland Waterways. In Proceedings of the International Ship Control Systems Symposium (iSCSS), Delft, The Netherlands, 6–8 October 2020.
212. Li, R.; Zheng, S.; Wang, E.; Chen, J.; Feng, S.; Wang, D.; Dai, L. Advances in BeiDou Navigation Satellite System (BDS) and Satellite Navigation Augmentation Technologies. *Satell. Navig.* **2020**, *1*, 12. [CrossRef]
213. Geng, J.; Yang, S.; Guo, J. Assessing IGS GPS/Galileo/BDS-2/BDS-3 Phase Bias Products with PRIDE PPP-AR. *Satell. Navig.* **2021**, *2*, 17. [CrossRef]
214. Zuo, W.; Guo, C.; Liu, J.; Peng, X.; Yang, M. A Police and Insurance Joint Management System Based on High Precision BDS/GPS Positioning. *Sensors* **2018**, *18*, 169. [CrossRef]
215. Dari, Y.E.; Suyoto, S.; Pranowo, P. Pranowo CAPTURE: A Mobile Based Indoor Positioning System Using Wireless Indoor Positioning System. *Int. J. Interact. Mob. Technol.* **2018**, *12*, 61–72. [CrossRef]
216. Imran, S.; Ko, Y.B. A Novel Indoor Positioning System Using Kernel Local Discriminant Analysis in Internet-of-Things. *Wirel. Commun. Mob. Comput.* **2018**, *2018*, 2976751. [CrossRef]
217. Liu, F.; Liu, J.; Yin, Y.; Wang, W.; Hu, D.; Chen, P.; Niu, Q. Survey on WiFi-Based Indoor Positioning Techniques. *IET Commun.* **2020**, *14*, 1372–1383. [CrossRef]
218. Khanh, T.T.; Nguyen, V.D.; Pham, X.Q.; Huh, E.N. Wi-Fi Indoor Positioning and Navigation: A Cloudlet-Based Cloud Computing Approach. *Hum.-Centric Comput. Inf. Sci.* **2020**, *10*, 32. [CrossRef]
219. Stavrou, V.; Bardaki, C.; Papakyriakopoulos, D.; Pramatari, K. An Ensemble Filter for Indoor Positioning in a Retail Store Using Bluetooth Low Energy Beacons. *Sensors* **2019**, *19*, 4550. [CrossRef]
220. Busaeed, S.; Katib, I.; Albeshri, A.; Corchado, J.M.; Yigitcanlar, T.; Mehmood, R. LidSonic V2.0: A LiDAR and Deep-Learning-Based Green Assistive Edge Device to Enhance Mobility for the Visually Impaired. *Sensors* **2022**, *22*, 7435. [CrossRef]
221. Taki, S.U.; Chakrabarty, A.; Piran, M.J.; Pham, Q.V.; Suh, D.Y. An Indoor Positioning and Navigation System Using Named Data Networking. *IEEE Access* **2020**, *8*, 196408–196424. [CrossRef]
222. NonAlinsavath, K.; Nugroho, L.; Widyawan, W.; Hamamoto, K. Integration of Indoor Localization System Using Wi-Fi Fingerprint, Bluetooth Low Energy Beacon and Pedometer Based on Android Application Platform. *Int. J. Intell. Eng. Syst.* **2020**, *13*, 171–181. [CrossRef]
223. Hussain, G.; Jabbar, M.; Cho, J.; Bae, S. Indoor Positioning System: A New Approach Based on Lstm and Two Stage Activity Classification. *Electronics* **2019**, *4*, 375. [CrossRef]
224. Yu, C.H.; Tsai, C.C.; Wang, Y.; Lai, K.K.; Tajvidi, M. Towards Building a Value Co-Creation Circle in Social Commerce. *Comput. Hum. Behav.* **2020**, *108*, 105476. [CrossRef]
225. Dospinescu, O.; Dospinescu, N.; Bostan, I. Determinants of E-Commerce Satisfaction: A Comparative Study between Romania and Moldova. *Kybernetes* **2021**, *51*, 1–17. [CrossRef]
226. Shi, M.; Yuan, H. Impact of E-Commerce Website Usability on User Satisfaction. *J. Adv. Comput. Intell. Intell. Inform.* **2019**, *23*, 91–96. [CrossRef]
227. Abdullah, R.; Sarno, R. Aspect Based Sentiment Analysis for Explicit and Implicit Aspects in Restaurant Review Using Grammatical Rules, Hybrid Approach, and SentiCircle. *Int. J. Intell. Eng. Syst.* **2021**, *14*, 294–305. [CrossRef]
228. Gupta, V.; Khanna, V.; Sahoo, B.M. Analysis of Shopping Trends Employing E-Commerce Applications: A Comparative Case Study. *Procedia Comput. Sci.* **2018**, *132*, 1728–1738. [CrossRef]
229. Olaleye, S.A.; Sanusi, I.T.; Salo, J. Sentiment Analysis of Social Commerce: A Harbinger of Online Reputation Management. *Int. J. Electron. Bus.* **2018**, *14*, 85–102. [CrossRef]
230. Nguyen, B.; Nguyen, V.-H.; Ho, T. Sentiment Analysis of Customer Feedbacks in Online Food Ordering Services. *Bus. Syst. Res. Int. J. Soc. Adv. Innov. Res. Econ.* **2021**, *12*, 46–59. [CrossRef]

231. Naidu, A.; Rajagopal, K.; Sinha, M.; Mahajan, V. Car Sharing versus Car Ownership: An Exploratory Examination in India. *Int. J. Innov. Technol. Explor. Eng.* **2019**, *8*, 541–547. [CrossRef]
232. Al-Adwan, A.S. Revealing the Influential Factors Driving Social Commerce Adoption. *Interdiscip. J. Inf. Knowl. Manag.* **2019**, *14*, 295–324. [CrossRef]
233. Muhammed, T.; Mehmood, R.; Albeshri, A.; Katib, I. UbeHealth: A Personalized Ubiquitous Cloud and Edge-Enabled Networked Healthcare System for Smart Cities. *IEEE Access* **2018**, *6*, 32258–32285. [CrossRef]
234. Janbi, N.; Mehmood, R.; Katib, I.; Albeshri, A.; Corchado, J.M.; Yigitcanlar, T. Imtidad: A Reference Architecture and a Case Study on Developing Distributed AI Services for Skin Disease Diagnosis over Cloud, Fog and Edge. *Sensors* **2022**, *22*, 1854. [CrossRef] [PubMed]
235. Janbi, N.; Katib, I.; Albeshri, A.; Mehmood, R. Distributed Artificial Intelligence-as-a-Service (DAIaaS) for Smarter IoE and 6G Environments. *Sensors* **2020**, *20*, 5796. [CrossRef] [PubMed]
236. Jiang, C.; Qiu, Y.; Gao, H.; Fan, T.; Li, K.; Wan, J. An Edge Computing Platform for Intelligent Operational Monitoring in Internet Data Centers. *IEEE Access* **2019**, *7*, 133375–133387. [CrossRef]
237. Zhang, C.; Zhao, H.; Deng, S. A Density-Based Offloading Strategy for IoT Devices in Edge Computing Systems. *IEEE Access* **2018**, *6*, 73520–73530. [CrossRef]
238. Chen, L.; Zhou, P.; Gao, L.; Xu, J.; Chen, L.; Xu, J.; Zhou, P.; Gao, L. Adaptive Fog Configuration for the Industrial Internet of Things. *IEEE Trans. Ind. Inform.* **2018**, *14*, 4656–4664. [CrossRef]
239. Deng, S.; Xiang, Z.; Yin, J.; Taheri, J.; Zomaya, A.Y. Composition-Driven IoT Service Provisioning in Distributed Edges. *IEEE Access* **2018**, *6*, 54258–54269. [CrossRef]
240. Mohammed, T.; Albeshri, A.; Katib, I.; Mehmood, R. UbiPriSEQ—Deep Reinforcement Learning to Manage Privacy, Security, Energy, and QoS in 5G IoT Hetnets. *Appl. Sci.* **2020**, *10*, 7120. [CrossRef]
241. Lee, Y.J.; Chae, H.S.; Lee, K.W. Countermeasures against Large-Scale Reflection DDoS Attacks Using Exploit IoT Devices. *Autom. Čas. Autom. Mjer. Elektron. Račun. Komun.* **2021**, *62*, 127–136. [CrossRef]
242. Dao, N.-N.; Phan, T.V.; Sa, U.; Kim, J.; Member, S.; Bauschert, T.; Do, D.-T.; Cho, S. Securing Heterogeneous IoT with Intelligent DDoS Attack Behavior Learning. *IEEE Syst. J.* **2021**, *16*, 1974–1983. [CrossRef]
243. Bojjagani, S.; Denslin Brabin, D.R.; Saravanan, K. Early DDoS Detection and Prevention with Traced-Back Blocking in SDN Environment. *Intell. Autom. Soft Comput.* **2022**, *34*, 805–819. [CrossRef]
244. Dat-Thinh, N.; Xuan-Ninh, H.; Kim-Hung, L. MidSiot: A Multistage Intrusion Detection System for Internet of Things. *Wirel. Commun. Mob. Comput.* **2022**, *2022*, 9173291. [CrossRef]
245. Al-Akhras, M.; Alawairdhi, M.; Alkoudari, A.; Atawneh, S. Using Machine Learning to Build a Classification Model for Iot Networks to Detect Attack Signatures. *Int. J. Comput. Netw. Commun.* **2020**, *12*, 99–116.
246. Wang, Z.; Ma, Z.; Luo, S.; Gao, H. Enhanced Instant Message Security and Privacy Protection Scheme for Mobile Social Network Systems. *IEEE Access* **2018**, *6*, 13706–13715. [CrossRef]
247. Lei, C.; Chuang, Y. Privacy Protection for Telecare Medicine Information Systems with Multiple Servers Using a Biometric-Based Authenticated Key Agreement Scheme. *IEEE Access* **2019**, *7*, 186480–186490. [CrossRef]
248. Cerf, S.; Ben Mokhtar, S.; Bouchenak, S.; Marchand, N.; Robu, B. Dynamic Modeling of Location Privacy Protection Mechanisms. In *Distributed Applications and Interoperable Systems: Proceedings of the 18th IFIP WG 6.1 International Conference, DAIS 2018, Held as Part of the 13th International Federated Conference on Distributed Computing Techniques, DisCoTec 2018, Madrid, Spain, 18–21 June 2018*; Lecture Notes in Computer Science; Springer: Berlin/Heidelberg, Germany, 2018; Volume 10853, pp. 26–39. [CrossRef]
249. Sheng, L. User Privacy Protection Scheme Based on Verifiable Outsourcing Attribute-Based Encryption. *Secur. Commun. Netw.* **2021**, *2021*, 6617669. [CrossRef]
250. Chen, G.; Zhao, J.; Jin, Y.; Zhu, Q.; Jin, C.; Shan, J. Certificateless Deniable Authenticated Encryption for Location-Based Privacy Protection. *IEEE Access* **2019**, *7*, 101704–101717. [CrossRef]
251. Zhang, Y.; Deng, R.; Han, G.; Zheng, D. Secure Smart Health with Privacy-Aware Aggregate Authentication and Access Control in Internet of Things. *J. Netw. Comput. Appl.* **2018**, *123*, 89–100. [CrossRef]
252. Freitag, M.; Wiesner, S. Smart Service Lifecycle Management: A Framework and Use Case. *IFIP Adv. Inf. Commun. Technol.* **2018**, *536*, 97–104.
253. Arunachalam, K.; Thangamuthu, S.; Shanmugam, V.; Raju, M.; Premraj, K. Deep Learning and Optimisation for Quality of Service Modelling. *J. King Saud Univ.-Comput. Inf. Sci.* **2022**, *34*, 5998–6007. [CrossRef]
254. Sasanuma, K.; Hampshire, R.; Scheller-Wolf, A. Controlling Arrival and Service Rates to Reduce Sensitivity of Queueing Systems with Customer Abandonment. *Results Control Optim.* **2022**, *6*, 100089. [CrossRef]
255. Sivakami Sundari, M.; Yamini, S.; Rath, K.; Senthil Kumar, K.; Palaniammal, S. Artificial Neural Network Simulation for Markovian Queuing Models in a Busy Airport. In Proceedings of the 2020 International Conference on Computer Science, Engineering and Applications (ICCSEA), Gunupur, India, 13–14 March 2020. [CrossRef]
256. Legros, B.; Jouini, O. On the Scheduling of Operations in a Chat Contact Center. *Eur. J. Oper. Res.* **2019**, *274*, 303–316. [CrossRef]
257. Karamanis, R.; Angeloudis, P.; Sivakumar, A.; Stettler, M. Dynamic Pricing in One-Sided Autonomous Ride-Sourcing Markets. In Proceedings of the 2018 21st International Conference on Intelligent Transportation Systems (ITSC), Maui, HI, USA, 4–7 November 2018.

258. Niu, C.; Zheng, Z.; Wu, F.; Tang, S. Online Pricing with Reserve Price Constraint for Personal Data Markets. *IEEE Trans. Knowl. Data Eng.* **2020**, *34*, 1928–1943.
259. Key, P.; Steinberg, R. Pricing, Competition and Content for Internet Service Providers. *IEEE/ACM Trans. Netw.* **2020**, *28*, 2285–2298. [CrossRef]
260. Arbib, C.; Pınar, M.; Tonelli, M. Competitive Location and Pricing on a Line with Metric Transportation Costs. *Eur. J. Oper. Res.* **2020**, *282*, 188–200. [CrossRef]
261. Hossain, M.S.; Nayla, N.; Rassel, A.A. Product Market Demand Analysis Using Nlp in Banglish Text with Sentiment Analysis and Named Entity Recognition Recognition. In Proceedings of the 2022 56th Annual Conference on Information Sciences and Systems (CISS), Princeton, NJ, USA, 9–11 March 2022; pp. 166–171. [CrossRef]
262. Lee, I. Pricing and Profit Management Models for SaaS Providers and IaaS Providers. *J. Theor. Appl. Electron. Commer. Res.* **2021**, *16*, 859–873. [CrossRef]
263. Meziani, K.; Rahmoune, F.; Radjef, M.S. The Service Pricing Strategies and the Strategic Behavior of Customers in an Unobservable Markovian Queue with Unreliable Server. *RAIRO-Oper. Res.* **2022**, *56*, 213–237. [CrossRef]
264. Li, T.; Chen, Y.; Li, T. Pricing Strategies of Logistics Distribution Services for Perishable Commodities. *Algorithms* **2018**, *11*, 186. [CrossRef]
265. Sun, L.; Teunter, R.H.; Babai, M.Z.; Hua, G. Optimal Pricing for Ride-Sourcing Platforms. *Eur. J. Oper. Res.* **2019**, *278*, 783–795. [CrossRef]
266. Montero, R.; Pagès, A.; Agraz, F.; Spadaro, S. Supporting QoE/QoS-Aware End-to-End Network Slicing in Future 5G-Enabled Optical Networks. In *Metro and Data Center Optical Networks and Short-Reach Links II*; SPIE: Bellingham, WA, USA, 2019; Volume 10946, pp. 89–95. [CrossRef]
267. Prentkovskis, O.; Erceg, Ž.; Stević, Ž.; Tanackov, I.; Vasiljević, M.; Gavranović, M. A New Methodology for Improving Service Quality Measurement: Delphi-FUCOM-SERVQUAL Model. *Symmetry* **2018**, *10*, 757. [CrossRef]
268. Cheng, X.; Cao, Y.; Huang, K.; Wang, Y. Modeling the Satisfaction of Bus Traffic Transfer Service Quality at a High-Speed Railway Station. *J. Adv. Transp.* **2018**, *2018*, 7051789. [CrossRef]
269. Nabavi, S.R.; Osati Eraghi, N.; Akbari Torkestani, J. Intelligent Optimization of QoS in Wireless Sensor Networks Using Multiobjective Grey Wolf Optimization Algorithm. *Wirel. Commun. Mob. Comput.* **2022**, *2022*, 5385502. [CrossRef]
270. Sanusi, I.O.; Nasr, K.M.; Moessner, K. Radio Resource Management Approaches for Reliable Device-to-Device (D2D) Communication in Wireless Industrial Applications. *IEEE Trans. Cogn. Commun. Netw.* **2021**, *7*, 905–916. [CrossRef]
271. Lüftenegger, E. Co-Creating Service-Dominant Business Artifacts with Action Design Research: Towards Ambidextrous Business Process Management. *Rev. Inform. Teor. Apl.* **2021**, *28*, 63–77. [CrossRef]
272. Malekan, H.S.; Adamiak, K.; Afsarmanesh, H. A Systematic Approach for Business Service Consolidation in Virtual Organizations. *Serv. Oriented Comput. Appl.* **2018**, *12*, 41–57. [CrossRef]
273. Mu, W.; Benaben, F.; Pingaud, H. An Ontology-Based Collaborative Business Service Selection: Contributing to Automatic Building of Collaborative Business Process. *Serv. Oriented Comput. Appl.* **2018**, *12*, 59–72. [CrossRef]
274. Acar, H.; Benfenatki, H.; Gelas, J.P.; Da Silva, C.F.; Alptekin, G.I.; Benharkat, A.N.; Ghodous, P. Software Greenability: A Case Study of Cloud-Based Business Applications Provisioning. In Proceedings of the IEEE International Conference on Cloud Computing, CLOUD, San Francisco, CA, USA, 2–7 July 2018; IEEE Computer Society. Volume 2018, pp. 875–878.
275. Mishra, S.; Sree Devi, K.K.; Badri Narayanan, M.K. Technology Dimensions of Automation in Business Process Management Industry. *Int. J. Eng. Adv. Technol.* **2019**, *8*, 1919–1926. [CrossRef]
276. Ivančić, L.; Vukšić, V.B.; Spremić, M. Mastering the Digital Transformation Process: Business Practices and Lessons Learned. *Technol. Innov. Manag. Rev.* **2019**, *9*, 36–51. [CrossRef]
277. Jussila, J.; Raitanen, J.; Partanen, A.; Tuomela, V.; Siipola, V.; Kunnari, I. Rapid Product Development in University-Industry Collaboration: Case Study of a Smart Design Project. *Technol. Innov. Manag. Rev.* **2020**, *10*, 48–58. [CrossRef]
278. Zhang, H.; Zang, Z.; Zhu, H.; Uddin, M.I.; Amin, M.A. Big Data-Assisted Social Media Analytics for Business Model for Business Decision Making System Competitive Analysis. *Inf. Process. Manag.* **2022**, *59*, 102762. [CrossRef]
279. Arifiani, L.; Budiastuti, I.D.; Erika, W.K. The Effect of Disruption Technology, and the Future Knowledge Management toward Service Innovation for Telecommunication Industry 4.0 in Indonesia. *Int. J. Eng. Adv. Technol.* **2019**, *8*, 247–257. [CrossRef]
280. Simonsson, J.; Magnusson, M.; Johanson, A. Organizing the Development of Digital Product-Service Platforms. *Technol. Innov. Manag. Rev.* **2020**, *10*, 36–47. [CrossRef]
281. Ar, U.; Faruqi, A. Future Service in Industry 5.0. *J. Sist. Cerdas* **2019**, *2*, 67–79. [CrossRef]
282. Pezzotta, G.; Cavalieri, S.; Romero, D. Collaborative Product-Service Systems Engineering: Towards an Active Role of Customers and Stakeholders in Value Co-Creation. In Proceedings of the 2017 International Conference on Engineering, Technology and Innovation (ICE/ITMC), Madeira, Portugal, 27–29 June 2017; pp. 1247–1254. [CrossRef]
283. Hong, L.; Yu, H.; Yu, Y.; Liang, P.; Xu, J. The Role of Customer-Task Fit Between Service Interaction and Value Co-Creation: Evidence from China. *J. Glob. Inf. Manag.* **2021**, *29*, 1–15. [CrossRef]
284. Chen, S.C.; Yang, S.Y. A Web Services, Ontology and Big Data Analysis Technology-Based Cloud Case-Based Reasoning Agent for Energy Conservation of Sustainability Science. *Appl. Sci.* **2020**, *10*, 1387. [CrossRef]
285. Dølvik, J.E.; Waddington, J. Private Sector Services: Challenges to European Trade Unions. *Transf. Eur. Rev. Labour Res.* **2002**, *8*, 356–376. [CrossRef]

286. Li, C.; Mirosa, M.; Bremer, P. Review of Online Food Delivery Platforms and Their Impacts on Sustainability. *Sustainability* **2020**, *12*, 5528. [CrossRef]
287. Suhartanto, D.; Helmi Ali, M.; Tan, K.H.; Sjahroeddin, F.; Kusdibyo, L. Loyalty toward Online Food Delivery Service: The Role of e-Service Quality and Food Quality. *J. Foodserv. Bus. Res.* **2018**, *22*, 81–97. [CrossRef]
288. Vasić, N.; Kilibarda, M.; Andrejić, M.; Jović, S. Satisfaction Is a Function of Users of Logistics Services in E-Commerce. *Technol. Anal. Strateg. Manag.* **2020**, *33*, 813–828. [CrossRef]
289. Murfield, M.; Boone, C.A.; Rutner, P.; Thomas, R. Investigating Logistics Service Quality in Omni-Channel Retailing. *Int. J. Phys. Distrib. Logist. Manag.* **2017**, *47*, 263–296. [CrossRef]
290. Tirachini, A. Ride-Hailing, Travel Behaviour and Sustainable Mobility: An International Review. *Transportation* **2020**, *47*, 2011–2047. [CrossRef]
291. Mitra, S.K.; Bae, Y.; Ritchie, S.G. Use of Ride-Hailing Services among Older Adults in the United States. *Transp. Res. Rec.* **2019**, *2673*, 700–710. [CrossRef]
292. Gui, G.; Liu, M.; Tang, F.; Kato, N.; Adachi, F. 6G: Opening New Horizons for Integration of Comfort, Security, and Intelligence. *IEEE Wirel. Commun.* **2020**, *27*, 126–132. [CrossRef]
293. Abdullah, D.M.; Ameen, S.Y. Enhanced Mobile Broadband (EMBB): A Review. *J. Inf. Technol. Inform.* **2021**, *1*, 13–19.
294. Carter, L.; Weerakkody, V.; Phillips, B.; Dwivedi, Y.K. Citizen Adoption of E-Government Services: Exploring Citizen Perceptions of Online Services in the United States and United Kingdom. *Inf. Syst. Manag.* **2016**, *33*, 124–140. [CrossRef]
295. Xin, Y.; Dilanchiev, A.; Ali, M.; Irfan, M.; Hong, Y. Assessing Citizens’ Attitudes and Intentions to Adopt E-Government Services: A Roadmap toward Sustainable Development. *Sustainability* **2022**, *14*, 15183. [CrossRef]
296. van Dijck, J.; Jacobs, B. Electronic Identity Services as Sociotechnical and Political-Economic Constructs. *New Media Soc.* **2020**, *22*, 896–914. [CrossRef]
297. Kostopoulos, A.; Sfakianakis, E.; Chochliouros, I.; Pettersson, J.S.; Krenn, S.; Tesfay, W.; Migliavacca, A.; Hörandner, F. Towards the Adoption of Secure Cloud Identity Services. In Proceedings of the 12th International Conference on Availability, Reliability and Security, Reggio Calabria, Italy, 29 August–1 September 2017. Part F1305. [CrossRef]
298. Grassi, P.; Fenton, J.; Lefkovitz, N.; Danker, J.; Choong, Y.-Y.; Greene, K.; Theofanos, M. *Digital Identity Guidelines: Enrollment and Identity Proofing*; National Institute of Standards and Technology: Gaithersburg, MD, USA, 2017.
299. Joh, E.E. Policing the Smart City. *Int. J. Law Context* **2019**, *15*, 177–182. [CrossRef]
300. Ekaabi, M.A.; Khalid, K.; Davidson, R.; Kamarudin, A.H.; Preece, C. Smart Policing Service Quality: Conceptualisation, Development and Validation. *Policing* **2020**, *43*, 707–721. [CrossRef]
301. Machado, M.; Sousa, M.; Rocha, V.; Isidro, A. Innovation in Judicial Services: A Study of Innovation Models in Labor Courts. *Innov. Manag. Rev.* **2018**, *15*, 155–173. [CrossRef]
302. Preston, B.J. *The Judicial Development of Ecologically Sustainable Development*; Edward Elgar Publishing: Cheltenham, UK, 2022; ISBN 9781839108327.
303. Serova, D.S. Social Security in the Provision of Services to the Population. *Contemp. Probl. Soc. Work* **2016**, *2*, 73–80. [CrossRef]
304. Bhandari, K. Social Security System of Elderly Population in Nepal. *NUTA J.* **2019**, *6*, 18–24. [CrossRef]
305. Collins, M.E.; Spindle-Jackson, A.; Yao, M. Workforce Development Systems Efforts for System-Involved Youth: Opportunities and Challenges. *Child. Youth Serv. Rev.* **2021**, *128*, 106158. [CrossRef]
306. Blustein, D.L.; Connors-Kellgren, A.; Olle, C.; Diamonti, A.J. Promising Career and Workforce Development Programs and Services in Supporting the Needs of Unemployed Populations. In *The Handbook of Career and Workforce Development*; Routledge: London, UK, 2017; pp. 97–123. [CrossRef]
307. Zaki, M. Digital Transformation: Harnessing Digital Technologies for the next Generation of Services. *J. Serv. Mark.* **2019**, *33*, 429–435. [CrossRef]
308. World Bank. The World Bank in Saudi Arabia: Overview. Available online: https://www.worldbank.org/en/country/saudiarabia/overview (accessed on 2 April 2023).
309. LLoyds Bank. Foreign Direct Investment (FDI) in Saudi Arabia—International Trade Portal. Available online: https://www.lloydsbanktrade.com/en/market-potential/saudi-arabia/investment (accessed on 2 April 2023).
310. Saudi Ministry of Investment Home | Ministry of Investment. Available online: https://www.misa.gov.sa/en/ (accessed on 2 April 2023).
311. Alam, F.; Singh, H.P.; Singh, A. Economic Growth in Saudi Arabia through Sectoral Reallocation of Government Expenditures. *SAGE Open* **2022**, *12*, 21582440221127158. [CrossRef]
312. Brika, S.K.M.; Adli, B.; Chergui, K. Key Sectors in the Economy of Saudi Arabia. *Front. Public Health* **2021**, *9*, 952. [CrossRef]