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Article

Smart Homes and Families to Enable Sustainable Societies: A Data-Driven Approach for Multi-Perspective Parameter Discovery using BERT Modelling

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Abstract: Technological advancements and innovations have profoundly changed the lives of people giving rise to smart environments, cities, and societies. As homes are the building block of cities and societies, smart homes are critical to establishing smart living and are expected to play a key role in enabling smart cities and societies. The current academic literature and commercial advancements on smart homes have mainly focused on developing and providing smart functions for homes to provide security management and facilitate the residents in their various activities such as ambiance management. Homes are much more than physical structures, buildings, appliances, operational machines, and systems. Homes are composed of families and are inherently complex phenomena underlined by humans and their relationships with each other, subject to individual, intragroup, intergroup, and intercommunity goals. There is a clear need to understand, define, consolidate existing research, and actualize the overarching roles of smart homes, the roles of smart homes that would serve the needs of future smart cities and societies. This paper introduces our data-driven parameter discovery methodology and uses it to provide, for the first time, an extensive, rather fairly comprehensive, analysis of the families and homes landscape seen through the eyes of academics and the public using over a hundred thousand research papers and nearly a million tweets. We develop a methodology using deep learning, natural language processing (NLP), and big data analytics methods and apply it to automatically discover parameters that capture a comprehensive knowledge and design space of smart families and homes comprising social, political, economic, environmental, and other dimensions. The 66 discovered parameters and the knowledge space comprising 100s of dimensions are explained by reviewing and referencing over 300 articles from the academic literature and tweets. The knowledge and parameters discovered in this paper can be used to develop a holistic understanding of matters related to families and homes facilitating the development of better, community-specific, policies, technologies, solutions, and industries for families and homes, leading to strengthening families and homes, and in turn, empowering sustainable societies across the globe.

Keywords: Smart Families; Smart Homes; Sustainable Societies; Smart Cities; Deep Learning; Natural Language Processing (NLP); Social Sustainability; Environmental Sustainability; Economic Sustainability; Bidirectional Encoder Representations from Transformers (BERT); Triple Bottom Line (TBL); Internet of Things (IoT)

1. Introduction

1.1. *Home Sweet Home*

The advancements in information and communication technologies (ICTs) and the consequent innovations have profoundly changed the lives of people in recent years giving rise to smart environments, cities, and societies [1]–[4]. Technologies such as artificial intelligence (AI) and the Internet of Things (IoT) enhance quality of life for us by monitoring our environments and making decisions to achieve desirable outcomes. As homes are the building block of cities and societies, smart homes are critical to establishing smart living and are expected to play a key role in enabling smart cities and societies.

Homes, as is the case with many concepts, are interpreted differently by individuals. Després [5] discussed ten different meanings of homes, Gram-Hanssen and Darby [6] combined those ten meanings of homes into four categories, namely home as a place for "security and control", "activity", "relationships and continuity", and "identity and values". Mitty and Flores [7] defined homes as a physical location, a geographical location, or a place where meaningful relationships can be formed. Some see homes as places where control is important in determining the relationship between its members and their ability to make decisions [8]. Homes, therefore, may sound like a simple concept but the varying definitions of homes and the discussions around its various concepts show the complexity of the meanings of and concepts around homes.

A smart home is envisaged to consist of multiple network-connected devices, such as remote-controlled lighting, heating, kitchen, multimedia, and electronics appliances, usually integrated with sensors [9], [10], [11], [12]. These sensors produce a large volume of data that is continuously analysed to allow people to monitor and engage with the environment and make intelligent decisions about their, safety, comfort, efficiency, etc. There is no universally agreed-upon definition of smart homes, however, there is a general understanding that smart homes are homes where various home-related functions are automated and enhanced through ICT technologies including IoT and AI. Homes are said to be 'smartened', or transformed into smart homes, by their automation through ICT technologies.

Considering the recent emphasis on sustainability and ethics in AI, we define smart homes as "homes that provide comfort, security, and other desirable features and meanings of homes and make socially, environmentally, and economically sustainable and equitable decisions by using cutting-edge technologies, e.g., the internet of Things (IoT), big data, artificial intelligence, and large-scale distributed cloud, fog, and edge computing". So, by this definition, smart homes provide various desirable features and meanings of homes, and in doing so, they make sustainable decisions that are regulated by the triple bottom line (TBL), i.e., the decisions are made to ensure social, environmental, and economic sustainability. We used the term 'equitable' in the definition to emphasize an important aspect of sustainability that concerns equity, explainability, ethics, and greening of AI, required to make equitable decisions [13], [14]. In the past, heavy processing for smart homes was done in the cloud, causing long delays in making decisions by the system. With the rise of fog and edge computing, a large part of computing has moved close to homes (edge and fog) and this has reduced response time delays [15], [16].

The current academic literature and commercial advancements on smart homes have mainly focused on developing and providing smart functions for homes to facilitate the residents in their various activities including ambiance management [17], energy management [18], smart appliance control [19], security management [20], and healthcare [9]. The fact that smart homes to date have focused on a limited set of home-related activities and functions could be seen in the findings of several recent literature reviews on smart homes; see e.g., [12], [21]–[26]. For instance, our observation is confirmed by Gram-Hanssen and Darby [6] when they note, "The concept of home is largely absent from the thousands of papers in which building functions are analysed and modelled and the 'behaviours' of occupants are dissected and discussed".

It is clear that the current efforts on smart home research and products are limited in their scope and do not consider the concept of home, particularly its social dimensions.

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Homes need to be seen as fundamental units and beacons of society. An individual's character is defined by the values they hold. Society is comprised of individuals and, therefore, an individual's character determines the social character. The roles homes need to play in societies must be investigated and defined such that smart home technologies prioritize nurturing at home human values of sincerity, honesty, integrity, courage, determination, tolerance, compassion, generosity, loyalty, humility, modesty, and democracy, etc. These values should be nurtured in homes, the places that could have, and should have, the highest capacity for positive influence on its inhabitants, as well as the society. Thereby, homes should be developed as a place of love, trust, tolerant relationships, learning, and value building, a beacon of good and repellant of vice.

While it is important that the research on smart homes continues to develop technologies in their current domains of activities, it is vital, even more so, that smart homes research is guided through a holistic understanding of home meanings and functions and is aligned with the discrete and broad smart society objectives. There is a clear gap in understanding, defining, and actualization of the overarching roles of smart homes, the roles of smart homes that would serve the needs of future smart cities and societies.

1.2. *This Work*

This paper introduces our data-driven parameter discovery methodology and uses it to provide, for the first time, an extensive, rather fairly comprehensive, analysis of the families and homes landscape seen through the eyes of academics and the public using over a hundred thousand research papers and nearly a million tweets.

We combine deep learning, big data, and other technologies to create a complete machine learning pipeline for discovering parameters for families and homes from two different perspectives using two different types of data sources, namely academic literature on families and homes from the Scopus database and the public view from Twitter. The two types of data sources provide two distinct views of the families and homes domain, one from academics and researchers and the other from the general public. These points of view are not mutually exclusive, and they influence each other to some extent, but they represent distinct perspectives with significant differences.

The purpose is to understand homes extensively, rather comprehensively and holistically, and use this understanding and knowledge to create awareness of critical and other issues and drive future research on this topic using cutting-edge technologies. The parameters discovered and the knowledge gained in this research about families and homes could be used to direct smart homes research in areas that are important and have been neglected, fully or partially, in the past, leading to the enrichment of smart homes research and development of new technologies and industries. The ultimate aim is to develop theory and practice that will lead to the development of smarter families and homes enabling sustainable future societies.

The Scopus database was used to create the academic-view dataset that we utilised to discover parameters for the academia-focused aspects of families and homes. We collected 104,018 research article abstracts with titles and keywords in English from a variety of academic disciplines including Social Science, Computer Science, Art and Humanities, and Multidisciplinary. The articles that we have collected were for the publishing period beginning from 2015 to the present. We discovered 44 parameters related to families and homes from the academic dataset and organized them into five macro-parameters, viz. Nurturing Families, Health & Lifestyles, Communities & Nations, Resources & Management, and Technologies.

The Twitter dataset that provides a public view of families and homes was collected for a period of six months, January to June 2022. A total of 930,110 tweets were retrieved. The data was limited to Saudi Arabia because we aimed to understand local issues related to families and homes and compare them with the international academic perspectives.

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We discovered 22 parameters and grouped them into three macro-parameters namely, Nurturing Families, Resources & Management, and Challenges.

We implemented the proposed data-driven approach for families & homes into a software tool. The tool consists of four software components: Data Collection, Pre-processing, Parameter Modelling & Discovery, and Validation & Visualisation. The tool can discover parameters related to families and homes using the datasets described above. The two datasets were collected and pre-processed to generate data in a form that the machine learning processing engine can process. We used a pre-trained BERT word embedding model, Bidirectional Encoder Representations from Transformers [27]. Subsequently, the Uniform Manifold Approximation and Projection (UMAP) [28] algorithm is used as a method for reducing dimensions, and Hierarchical Density-based Spatial Clustering of Applications with Noise (HDBSCAN) [29] is applied as a clustering algorithm. Moreover, the class-based TF-IDF score (term frequency-inverse document frequency) is used to cluster documents automatically in datasets [30]. We extracted two taxonomies from academic and public perspectives on families & homes. A range of quantitative methods was then used to analyze each dataset in order to discover families & homes parameters and macro-parameters, including similarity metrics [31], hierarchical clustering [32], term score [33], keyword score [34], and an intertopic distance map [35]. The datasets, document clusters, and parameters were explored using various visualization methods, such as histograms [36], taxonomies, similarity matrices, temporal progression plots, and word clouds.

Error! Reference source not found. shows a multi-perspective (academic and public) view of families and homes comprising social, political, economic, environmental, and other issues discovered using Scopus and Twitter data. The figure exhibits the macro-parameters and parameters, laid out at the first branch level and the second branch level, respectively. The figure shows that the parameters discovered from the Scopus dataset provide a fairly comprehensive academic view of families & homes. The learned parameters capture and bring together, structurally, such wide-ranging issues including, among others, family roles and issues surrounding children women, and the elderly, specific physical and psychological diseases, addictions, House Pricing & Affordability, Architecture & Heritage, Work & Employment, Family Businesses, Farming, Animal Farms, Tourism, Energy Management, Water Management, pandemics and disasters, technologies for remote, rehabilitation, and wearable-based healthcare, and assistive robots, and issues specific to various political affiliations, races, communities, and nations from Canada, Europe, Asia, and America. The parameters detected by the Twitter data show a very local and public Saudi view of families with parameters such as an emphasis on Nurturing Family Values, Family Cohesion, Good Companionship, Gatherings with Grandmothers, House Financing & Affordability, Work & Indolence, Sleeping Habits, and Socioeconomic Challenges for Women. None of the earlier works have provided such an extensive view of families and homes captured systematically from academic and public perspectives. These could be used for instance by academia to focus on problems that are more important for public and specific cultures, communities, and societies.

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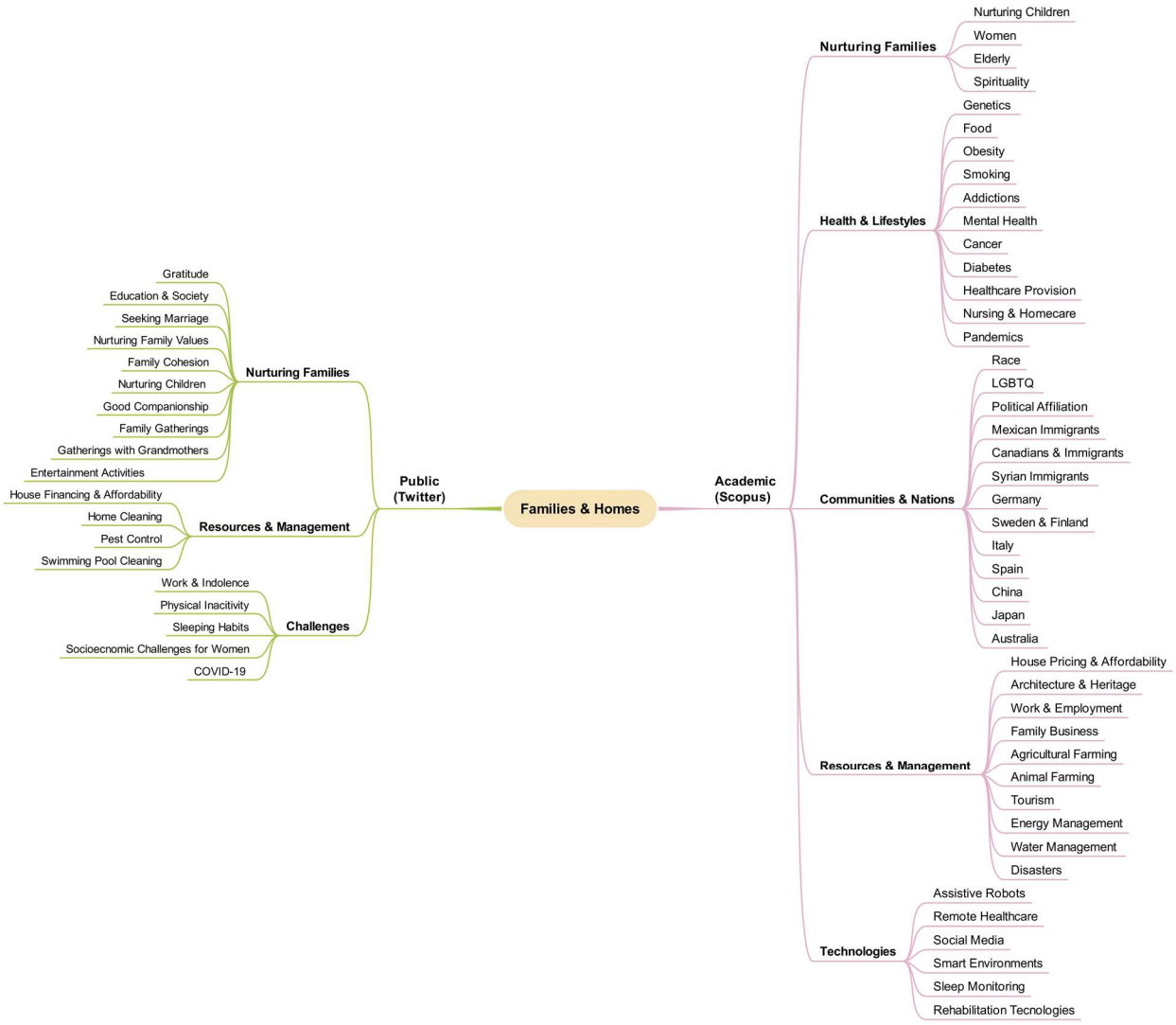

Figure 1 A multi-perspective taxonomy of Families & Homes.

The validation of our findings can be internal or external. Internal validation is carried out by determining whether the articles and documents associated with a specific parameter are related to the subject and dimensions of the parameter. We have provided discussions on many articles in each dataset about how those articles relate to the parameters. External validation is carried out by comparing parameters, keywords, and quantitative metrics between the two perspectives, academic and public, to see how academic views compare to public views and vice versa. External validation is also carried out by utilizing sources other than the two dataset sources. Furthermore, the illustrations produced by various visualisation methods are used for both internal and external validation. Additional explanations of the methodology and design and the tool are presented in Section 3.

1.3. Novelty and Contributions

This paper's accomplishments are as follows.

1. We develop a methodology using deep learning, natural language processing (NLP), and big data analytics methods and apply it to automatically discover pa-

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rameters that capture a comprehensive knowledge and design space of smart families and homes comprising social, political, economic, environmental, and other dimensions.

2. The discovered parameters and the knowledge space are explained by reviewing and referencing in this paper over 300 articles from the academic literature and tweets.
3. We discovered 44 parameters and 5 macro-parameters for families and homes from an academic perspective using one of the largest databases of scientific literature, Scopus. These parameters provide comprehensive structural knowledge and design space of families and homes that could be used to extend smart homes research and practice.
4. We discovered 22 parameters and 6 macro-parameters for families and homes from the public perspective using Twitter data. This knowledge space could be used to develop culture and community-focused research and products.
5. We compare the academic and public perspectives of families and homes, highlight the gaps and propose a framework that discovers the knowledge and design space of families and homes, identifies parameters including opportunities, challenges, methods, solutions, and objectives and uses them to nurture better families and homes to enable smarter and sustainable societies.
6. We built two datasets specifically for the work presented in this paper, first from Scopus comprising 104,018 research articles in English, and second containing 930,110 tweets in the Arabic language. These datasets will be made available to the public for further research and development.
7. We created a complete big data analytics tool from the ground up for this purpose. The tool is general in nature and can be applied to other datasets, knowledge domains, and industrial sectors.
8. We provided an extensive analysis of the families and homes space using a range of metrics and data visualisation methods including similarity metrics, hierarchical clustering, term score, keyword score, intertopic distance map, histograms, taxonomies, similarity matrices, temporal progression plots, and word clouds.
9. The methodology and analysis developed in this work are extensible and applicable to other subjects and topics and the possibilities are endless.

The overarching goal of our research is to look into how ICT technologies can be used to solve pressing problems in smart cities and societies. Within the specific focus of this paper, we introduced in [37] the concept of Deep Journalism and discovered public, academic, and industry perspectives on transportation using The Guardian, Web of Science, and Traffic Technology International Magazine, respectively. We have also discovered parameters for education and learning during the COVID-19 pandemic [38] and healthcare services for cancer [39]. The work presented in this paper is novel for several reasons.

The current academic literature and commercial advancements on smart homes have mainly focused on developing and providing smart functions for homes to provide security management and facilitate the residents in their various activities such as ambiance management. It is clear that the current efforts on smart home research and products are limited in their scope and do not consider the concept of home, particularly its social dimensions. There is a clear gap in understanding, defining, and actualization of the overarching roles of smart homes, the roles of smart homes that would serve the needs of future smart cities and societies. This paper provides new approaches, methods, and findings and thereby fills in the above-mentioned gaps. None of the earlier works have provided such an extensive view of families and homes captured systematically from data bringing wide-ranging issues together. The novelty will be established further in Section 2 where we present the related works.

1.4. Utilisation

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The knowledge and parameters discovered in this paper can be used to develop a holistic understanding of matters related to families and homes allowing academics, governments, industry, social enterprises, and other organisations to develop better policies, technologies, solutions, and industries that will encompass important matters for families and homes leading to strengthening families and homes, that in turn will strengthen societies across the globe embedding equity, sustainability, resilience, empowering sustainable societies. The parameters detected by the Twitter data show a very local national view of families with parameters such as an emphasis on good companionship, gatherings with grandmothers, and indolence. These could be used to study and develop families and homes that incorporate culture-specific, intercultural, and intercommunal norms, traditions, and sensitivities. There are many works that relate to families and homes and are being carried out under different research umbrellas. Our approach could help consolidate and streamline those efforts to produce better sustainable technologies for smart homes and societies.

Our work was developed on Google Colab and Anaconda platforms. For data preprocessing and model training, we used python as the programming language along with libraries such as BERTopic [30], UMAP [28], HDBSCAN [29], Pandas [40], NumPy [41], NLTK [42], Scikit-Learn [43], and Gensim [44]. For data visualization, we used libraries such as Seaborn [45], Plotly [46], Matplotlib [47], and SciPy [48].

The remainder of the paper is organized as follows. Section 2 discusses the works relevant to this paper and identifies the research gap. Section 3 describes the methodology of this work, which includes determining parameters for families and homes using Scopus and Twitter data, as well as the design of our tool. Section 4 explains and analyzes the parameters discovered from Scopus data, offering an academic perspective on families and homes. Section 5 expands on the parameters discovered from Twitter data that provide a public view of families and homes. Section 7 contains a discussion, and Section 8 concludes with recommendations for future work.

2. Related Works

In this section, we discuss works related to our proposed work. We conducted an extensive review of research on the use of AI and data analytics to understand families and homes and their related issues. We did not find any work directly related to the work proposed in this paper. The home is a very broad concept and is a transdisciplinary area of research, therefore, it is intricate to build a broad understanding of such a topic. However, to present the case of this work in the context of the overall body of works in this area, we present here related works from three areas: the meanings and concepts of homes, smart homes (technological aspects), and social media analytics (these works on social media are relevant because we use Twitter data to capture parameters for families and homes).

Firstly, we discuss the works on the meanings of home. Gram-Hanssen and Darby [6] have discussed the concept of smart homes from a broader view (meanings and concepts) and noticed the difference between the technical and conceptual literature on smart homes. Typically, technical research literature focuses on devices, tools, and technologies such as IoT and AI to provide a place for residents' activities, data security, and household control. However, the home meaning goes beyond the walls and roof of a building and some activities to deeper aspects related to relations, values, identities, etc. which must be considered. They combined ten meanings of homes proposed by Després [5] into four categories, namely home as a place for "security and control", "activity", "relationships and continuity", and "identity and values". Gram-Hanssen and Darby [6] identified differences between the concepts of 'home' and 'smart home' in literature but their main focus was on energy management research. Mitty and Flores [7] defined homes as a physical location, a geographical location, or a place where meaningful relationships can be formed. Some see homes as places where control is important in determining the relationship between its members and their ability to make decisions [8].

Other studies have looked at the meaning of home for specific age groups (elderly, children, etc.) or specific cases (immigrants, some health conditions, etc.). For example, Hatcher et al. [49] focused on how older adults conceptualize home in light of age-related lifestyle changes. Four major categories are identified to define the meaning of home for this age group: anchoring self, enabling freedom, being comfortable, and staying in touch. Alternatively, Lewin [50] explored the meaning of home for elderly immigrants and stressed the importance of considering age, gender, and cultural background.

Regarding smart home studies, where researchers focus on the technological aspect of smart homes, multiple existing review papers discussed smart home literature from different perspectives [12], [21]–[26]. Regarding smart home definitions and characteristics, Marikyan et al. [22] suggested that the best way to facilitate the implementation and adoption of smart home technology would be by analysing the user's perspective and the current state. DeFrancoa and Kassaba [23] constructed a taxonomy for smart home research and noted that existing research avenues related to the concept of the smart home have not reached a consensus. Pira [24] discussed the social issues of smart homes and identified four main social barriers namely trust in controlling devices, service satisfaction, reliability of services, and privacy and security. Li et al. [12] concluded that the main research areas in smart homes are Information and Communication Technologies (ICT) for home automation, home information management, AI for home automation, domestic energy management, and home-based health care.

For the smart Internet of Things (SHIoT) research, Choi et al. [21] identified the key dimensions as household, systems, network, and security. Topics under each of these dimensions were identified, for instance, the household dimension includes home automation, energy efficiency, domestic appliances, and intelligent buildings. Singh et al. [25] specifically explored the home health and internet of health things (IoHT) research and identified the assisted living of elderly patients using health monitoring devices as a key theme in this area. Two key themes are identified by Li et al. [26] for smart building research which are: (1) IoT, cloud computing, and wireless sensor network (WSN) for automation control and (2) balancing energy efficiency and human comfort using machine learning and continuous monitoring.

The power of Twitter as an information source cannot be overstated. Many studies have used Twitter data in their research. For instance, researchers have conducted a thematic analysis of Twitter data in various study domains. For example, Alotaibi [1] introduced Sehaa, an Arabic-language big data analytics tool for healthcare in Saudi Arabia. A big data tool developed over Apache Spark, called Iktishaf, was proposed by Alomari [51], [52] for detecting traffic-related events in Saudi Arabia based on Twitter data. Saurs et al. [53] used data mining techniques to identify the main security concerns in smart living environments. Many research have done on discovering COVID-19 issues using Twitter data analytics [54], [55]. For instance, Su et al. [56] used to investigate the spatial-temporal factors and socioeconomic disparities that shaped U.S. residents' responses to COVID-19. An analysis of the sentiment and topics extracted from the COVID-19 tweets was conducted by Abdulaziz et al. [57]. Furthermore, Alswedani et al. [38] provided a comprehensive understanding of governance parameters related to the education sector using data-driven discovery tools developed for Twitter. Many other studies are available on the use of social media analytics on various topics [58]–[62]. However, as far as we know there is no study related to families & homes of a similar nature using Twitter data analytics in Arabic or other languages.

2.1. *Research Gap*

Looking at the literature, we note that the current research and development on smart homes have mainly focused on developing and providing smart functions for homes to provide security management and facilitate the residents in their various activities such as ambiance management. It is clear that the current efforts on smart home research and

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products are limited in their scope and do not consider the concept of home, particularly its social dimensions. There is a clear gap in understanding, defining, and actualization of the overarching roles of smart homes, the roles of smart homes that would serve the needs of future smart cities and societies. This paper provides new approaches, methods, and findings and thereby fills in the above-mentioned gaps. None of the earlier works have provided such an extensive view of families and homes captured systematically from data bringing wide-ranging issues together. The novelty will be established further in Section 2 where we present the related works.

3. Methodology & Design

This section explains the methodology and design of the proposed system architecture. Our software architecture is outlined in Figure 2, which consists of four software components that will be discussed in the following sections. Section 3.1 discusses the methodology overview, including the master algorithm. Sections 3.2 to 3.10 explain data collection, the data sources we used in this research (Scopus and Twitter), pre-processing, parameter modelling, parameter discovery & quantitate analysis, validation, and visualization, respectively.

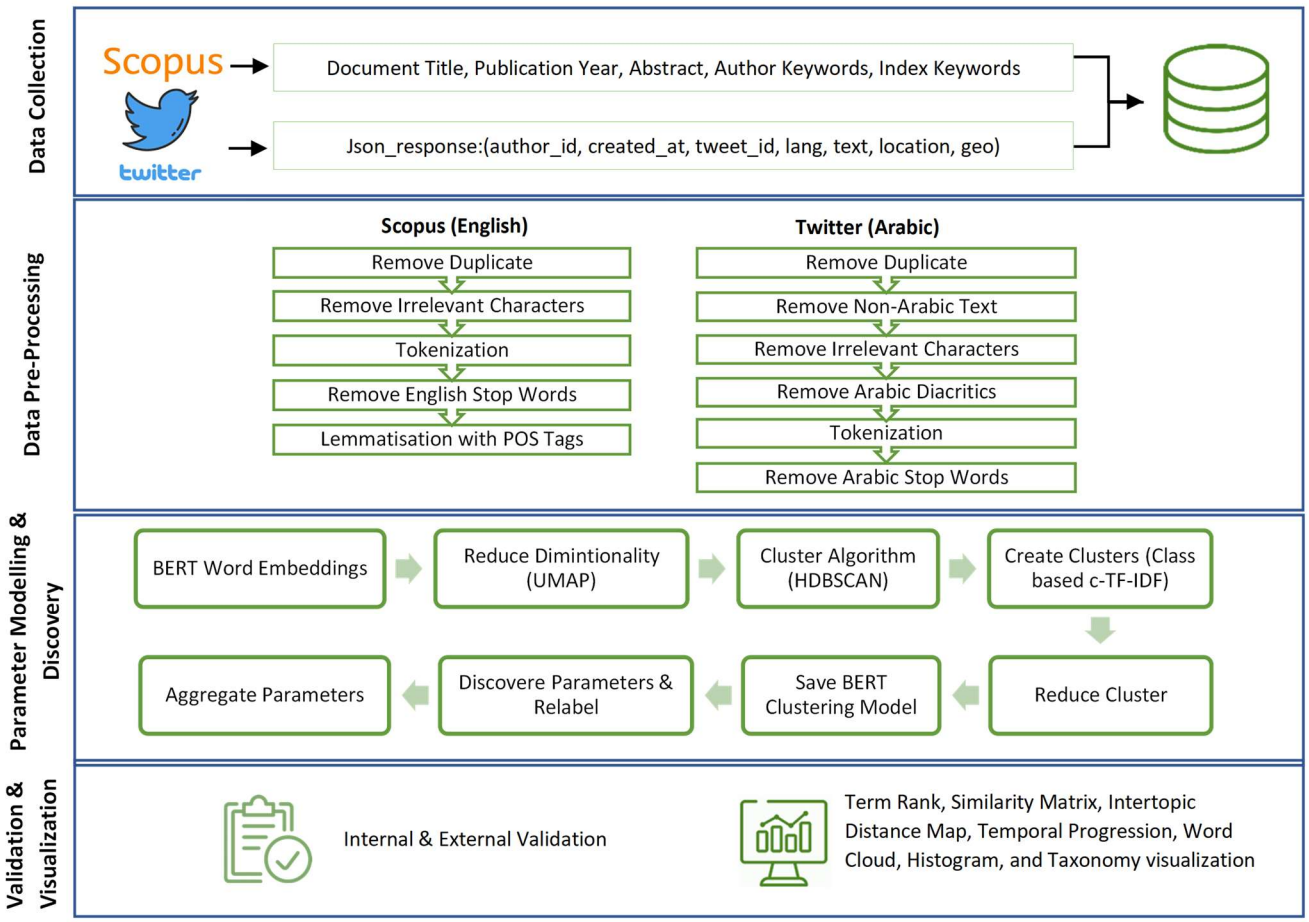

Figure 2 System Architecture.

3.1. Methodology Overview

Algorithm 1 provides a high-level master algorithm of our system. We built our dataset based on a specified search query then stored the results in a CSV file. Afterward, the CSV file is loaded and pre-processed using Pandas. The contextual relationships be-

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tween words are then captured with a pre-trained BERT word embedding model (Bidirectional Encoder Representations from Transformers) [27]. Subsequently, the UMAP (Uniform Manifold Approximation and Projection) [28] algorithm is used as a technique for reducing dimensions, and HDBSCAN (Hierarchical Density-based Spatial Clustering of Applications with Noise) is applied as a clustering algorithm [29]. Moreover, we merged similar clusters to reduce the number of clusters. Then we saved the clustering model. Based on the domain knowledge, similarity matrices, hierarchical clustering, and other quantitative analyses, the clusters are renamed as parameters, and ultimately the parameters are grouped into macro-parameters. Finally, we visualized the parameters and macro-parameters. In addition, we validated these parameters using two techniques, which are external and internal validation.

Algorithm 1: Master

Input: Search Query

Output: The discovered Parameters & their Visualization

1. Collect data using the Search Query and Save to the Database
2. Read the saved data using Pandas Data Frame (data could be the English articles or the Arabic tweets)
3. Pre-process the Pandas DataFrame and return the Processed DataFrame
4. Train BERT model with the Processed DataFrame and generate the Word Embeddings
5. Reduce the dimensionality of the generated Word Embeddings using the UMAP algorithm
6. Cluster the Word Embeddings into groups of similar embeddings using the HDBSCAN algorithm
7. Extract Topics based on c-TF-IDF
8. Reduce the number of extracted Topics
9. Save the BERT model
10. Relabel the Topics as Parameters
11. Visualise the Parameters

3.2. Data Collection

During our research, we used two data sources: Scopus (academic perspectives) and Twitter (public perspectives). Scopus is an indexing database of academic research and therefore we consider that it provides an academic view of families and homes. Academic articles could be written to describe public perspectives and situations; however, these perspectives could be considered academics because these are perceived and expressed by academics (we understand that it depends on particular issues and situations and requires further elaborations). Twitter is a popular microblogging social media platform and we used it to understand the public view of families and homes. Twitter could include posts from governments, industries and other stakeholders and hence could be used understand other perspectives though tweets generated by various stakeholders are generally used to engage with the public. The Scopus datasets were downloaded from the Scopus website in the CSV format. Twitter dataset was acquired using the Twitter API. Sections **Error! Reference source not found.** and **Error! Reference source not found.** discuss the data collection for Scopus and Twitter, respectively.

3.3. Dataset (Scopus: English)

We obtained the most relevant documents from Scopus, one of the largest abstract databases covering a variety of scientific journals, conference proceedings, and books in various disciplines. The document types were limited to proceedings papers, articles, and

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reviews. We collected 104,018 research articles by using "Home", "House", and "Family" keywords with the OR logical relation from several different subject areas in Scopus: Social Science, Computer Science, Art and Humanities, and Multidisciplinary. Furthermore, we have narrowed our search filtering option to the English language and due to the large number of papers limited the publishing years to be between 2015 until the latest publication years (the latest publication dates could be 2023 or later years). Additionally, we utilized advanced search and selected the "Topic Search" option, which yielded results from the document title, year, abstract, author keywords, and index keywords columns. Once the dataset had been collected under each subject area, we combined all the CSV files into a single final CSV file. Any duplicate academic articles were removed before passing the final CSV file to the next stage (pre-processing).

An overview of Scopus academic research is shown in **Error! Reference source not found.**. The x-axis represents the number of academic research papers, and the y-axis represents the number of words per research abstract. The maximum number of words in the research abstracts is 2277. The average abstract length of academic research abstracts is around 700 words. A relatively small number of research articles contained 700 or more words, the majority had words less than 700.

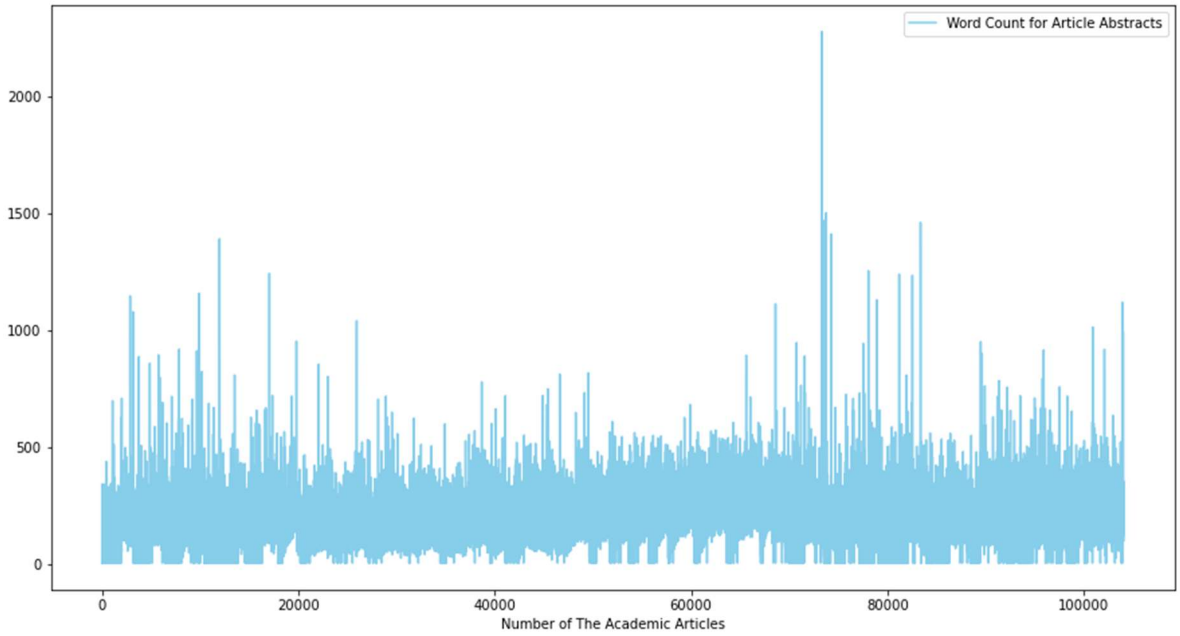

Figure 3 Histogram (Data Source: Scopus).

3.4. *Dataset (Twitter: Arabic)*

Twitter API V2 was used to collect the dataset during the period from January 2022 to June 2022. The total number of retrieved tweets is approximately 930110. Initially, the tweets were acquired by using keywords and hashtags related to families & homes, such as "بيت" (Home), "منزل" (Manzel), "عائلة" (Family), "#بيت", "#منزل", and "#عائلة", and others. Using geolocation filtering, we obtained only tweets posted from Saudi Arabia because we aimed to find major families & homes issues related to the Saudi society. Our collected Arabic tweets were retrieved from Twitter in JavaScript Object Notation (JSON) format. Each tweet includes several attributes such as "created_at" and "text", "geo" and "place" and others. Subsequently, we extracted and stored these attributes in a CSV file.

The histogram of Arabic tweets is shown in **Error! Reference source not found.**. The x-axis shows the number of tweets and the y-axis, shows the number of words in the tweet text. Tweets are commonly less than 60 words long. There are relatively few tweets with more than 50 words in them. Only a small number of tweets have a maximum of 90 words.

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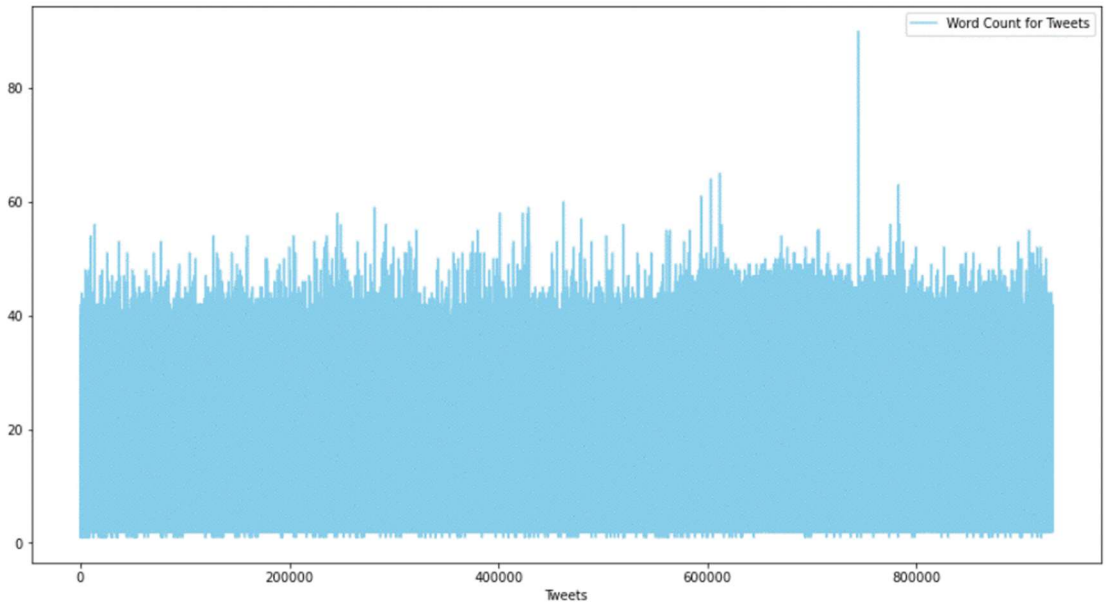

Figure 4 Histogram (Data Source: Twitter).

3.5. *Data Pre-Processing*

Data pre-processing is a crucial part of data analytics. In our research, we have used two types of data sources. A Scopus dataset contains English academic articles, while a Twitter dataset contains Arabic tweets. Due to the different languages used in these datasets, Scopus and Twitter cannot be pre-processed using the same algorithm. Sections 3.6 and 3.6 discuss the data pre-processing steps for each Scopus and Twitter, respectively.

3.6. *Pre-Processing (Scopus: English)*

As part of the pre-processing step, we remove duplicate articles, irrelevant characters, tokenisation, remove English stop word, then lemmatisation with POS tags is performed. Initially, the CSV file is read by Pandas, a Python package, and saved in a data frame. Secondly, we encountered with duplicate articles thus we eliminated them. Thirdly, we removed all irrelevant characters, including several Unicode characters. The step follow that involved tokenizing the texts using the "Spacy" engine. Then, removed the English stop words from the articles using Natural Language Toolkit (NLTK) predefined list of stop words. As a final step, we lemmatized the data using the WordNetLemmatizer, which allows nouns, verbs, adjectives, and adverbs to be used as parts of speech. As a result of the pre-processing step, we obtained the cleaned articles and saved it in a CSV file that were used for parameter modelling and discovery.

3.7. *Pre-Processing (Twitter: Arabic)*

Our main pre-processing steps for Twitter dataset as follows: remove duplicate tweets, non-Arabic languages that use Arabic script, irrelevant characters, Arabic diacritics, tokenization, remove Arabic stop-words, then save cleaned tweets in a CSV file.

In the initial step, the CSV file loaded in a data frame. Then, the duplicate tweets are removed using the Pandas package. Tweets written in non-Arabic languages that use Arabic scripts such as Urdu (ur), Persian (fa), and Central Kurdish (ckb) are also excluded. All English letters, numbers, mentions, and punctuation are removed. We also remove links and Arabic punctuation, including Arabic semicolons (؛) and The Arabic question mark (؟). In addition, Arabic diacritics have been removed where it categorized as a vowel, nunation, and shadda diacritics. The Arabic diacritics for short vowels include Fatha (◌َ), Damma (◌ُ), and Kasra (◌ِ), as well as Sukun diacritics (◌ْ), which indicate the absence of vowels. Arabic nunation diacritics represent the doubled versions of short vowels such as Fathatan (◌ً), Dammatan (◌ٌ), and Kasratan (◌ٍ). Shadda is the last form of diacritics (◌ّ) which can be combined with diacritics from the previous two types to create

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a new diacritic. NLTK stop-words as well as dialectical Arabic stop-words are excluded. Next, the Normalizer is used to normalize the words (tokens) that contain different forms of Alif (آ,إ,أ), Taa Marbutah (ة), and Yaa (ي) into the basic form. All these letters are replaced with the based form, such as Alif is replaced by bare Alif (ا), Taa Marbutah is replaced by haa (ه), while Yaa is replaced by dotless Yaa (ى). Tokenizing the text is the next step using the Spacy package.

3.8. Parameter Modelling

As the first step to parameter modelling, we developed a word embedding model using a technique developed by Google called BERT (Bidirectional Encoder Representations from Transformers) [27]. Textual data is analysed using BERT to extract features, including word embeddings and sentence embeddings. Our paper used the pre-trained "distilbert-base-nli-mean-tokens" model, which is a model of sentence-transformers. It can be used for tasks like clustering or semantic search by mapping sentences and paragraphs into a dense vector space with 768 dimensions. In terms of performance, it offers a nice balance between speed and efficiency. In addition, there are several multilingual models available in the package. For keeping maximum information in a lower dimension, we implemented a dimensional reduction algorithm called UMAP. It has several parameters, but the most important are n_neighbors and n_components. The n_neighbors parameter controls how UMAP balances local and global data structures. In addition, it defines the neighbourhood size, low-value focus locally and high-value focus globally. The n_components parameter controls the dimensionality to find the embed data. There are no obvious ways to choose the best values, depending on the situation. According to Angelov's paper [63], the best is n_neighbors = 15 and n_components = 5. We grouped similar articles to define a cluster or parameter using HDBSCAN algorithm. The most important HDBSCAN parameters are min_cluster_size and min_sample. The min_cluster_size parameter controls the smallest cluster. The min_sampling parameter controls the cluster size, when min_sample is smaller than min_cluster_size, it will merge that article to the same cluster. More articles are discarded when the min_sampling is high. Since UMAP retains local structures at lower dimensions, HDBSCAN complements UMAP effectively and does not force outlier articles to cluster.

Additionally, TF-IDF scores (Term Frequency-Inverse Document Frequency) are used to calculate words' importance. It determines the frequency and prominence of a word in a given document so that it can be used to evaluate word relevance across documents. TF-IDF can be used to achieve significant scores for individual words. Nevertheless, if we consider all the documents of a cluster as a single whole document and then running TF-IDF on it, we will be able to obtain a significant score for each word inside the cluster. A parameter becomes more representative as the number of significant words within a cluster increase. Consequently, we can get the keyword-based description of each parameter. A c-TF-IDF score is calculated using Equation 1 [34], where f = the word frequency is derived for each class c and divided by the number of words w. The total number of un-joined documents (d) is then divided by the total frequency of words (f) throughout all classes (cc).

$$\mathrm{c-TF-}IDF_C = \frac{\mathrm{f_c}}{w_c} \times \log \frac{\mathrm{d}}{\sum_{\mathrm{p}}^{\mathrm{cc}} \mathrm{f}_p} \qquad (1)$$

Predicting how many parameters will be extracted from our documents is difficult before training our model. Therefore, BERTopic was trained on our documents, which resulted in several parameters. After knowing how many parameters were created, we decided and specified a reasonable number of parameters using parameter reduction. After that, all parameters were assigned to the articles, and the model was saved.

Originally, the parameter was represented as an integer number, we use our domain knowledge and quantitative analysis methods to re-label and aggregate it into macro-parameters. We discuss this in the following section.

3.9. Parameter Discovery & Quantitative Analysis

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To get a good understanding of the topics that were extracted, we can iteratively go through perhaps a hundred topics after training our BERTopic model. Nonetheless, this takes a considerable amount of time and does not offer a global view. A better approach would be to visualize the topics that were generated using quantitative analysis methods. Therefore, we were able to determine and understand the parameters and macro-parameters for this study from quantitative analysis methods and our domain knowledge, such as term scores, intertopic distances, keyword scores, and hierarchical clustering.

3.9.1. Term Score

It is not easy to express the context of a parameter based on a list of keywords (terms). Our first step in finding a parameter is determining how many keywords are needed and the starting and ending positions of significant keywords. The keywords c-TF-IDF score for each parameter is visualized by sorting them in decreasing order. This term score visualization greatly influences parameter identification [30].

3.9.2. Intertopic Distance Map

The intertopic distance map represents the parameters in a two-dimensional way, represented by parameter circles whose size corresponds to the number of words used in the dictionary to describe that parameter. A MinMaxScaler algorithm is used to form the circles. The parameters closer together share more words [30].

3.9.3. Keyword Score

BERT parameter models generate a list of keywords that describe a parameter, each having an importance score or c-TF-IDF (see Section 3.8) for contextualizing the parameter [30].

3.9.4. Hierarchical Clustering

Clusters are systematically paired to create hierarchical clusters using the cosine similarity matrices between the parameter embeddings [30]. Starting with the correlation matrix in each phase all possible pairs of clusters are tried, and the pair with the largest average correlation within the experimental cluster is chosen as the new unique cluster.

3.9.5. Similarity Matrix

Plotly, a Python library is used to visualize the similarity matrix between parameters based on the cosine similarity matrix [30]. We calculated the cosine similarity score between the parameters embedding to show the relationship between the parameters. According to Plotly "BnGu" (green to blue), the dark blue colour represents the highest relationship between parameters, and the light green colour represents the lowest similarity relationship.

3.10. Validation & Visualization

Results can be validated internally and externally. An internal validation of a parameter involves the investigation and discussion of the documents related to the parameter. In our research, documents could be the academic articles or tweets. We discussed how we perceived the correlation between the documents and the parameters in most of the documents in our dataset. External validation is done by comparing parameters, keywords, and metric metrics across the two datasets. For the visualization, various visualization methods are used for the internal and external validation. Many visualization methods are used to describe the datasets, the clusters of documents, and the parameters that have been discovered. Among these are dataset histograms [36], taxonomies, similarity matrices [64], Term Rank, Similarity Matrix, Intertopic Distance Map, temporal progression plots, and word clouds. These visualizations are created using several Python libraries, including Seaborn, Plotly, and Matplotlib.

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4. Parameter Discovery for Families & Homes (Academia: Scopus)

This section discusses the parameters detected by our BERT model from the Scopus dataset. Section 4.1 provides an overview of the parameters and macro-parameters. In Section 4.2, we provide quantitative analysis of the clustering characteristics and discovered parameters. In the subsequent sections, Sections 4.3 – **Error! Reference source not found.**, we discuss each individual macro-parameter in detail. The temporal analysis of the parameters and macro-parameters is presented in Section 4.8.

4.1. Overview and Taxonomy

The modelling process detected a total of 50 clusters from the Scopus dataset using the BERT modelling algorithm. We excluded six parameters from the original clustering results as they were irrelevant to the topic of this work. Four clusters captured parameters related to the families of Animals (Clusters 12 and 40) and Plants (Clusters 11 and 32) due to the keyword "families" in the article search. Software Development (Cluster 1) and Miscellaneous (Cluster 6) were the other two irrelevant characters. Note that our approach in this paper is to cluster the data and then remove irrelevant clusters. Another approach could be to filter irrelevant data before clustering. Yet another approach could be to find irrelevant clusters, use them to filter the dataset and perform clustering again on the filtered data. These alternative approaches will be investigated in the future.

The remaining 44 clusters, called as parameters, were grouped into five macro-parameters based on the domain knowledge, similarity matrix, hierarchical clustering, and other quantitative methods. The methodology and process used to discover parameters and group them into macro-parameters has already been described in Section **Error! Reference source not found.**.

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Table 1 lists some information about these parameters. The parameters, their numbers in the clustering model, and macro-parameters are listed in Columns 1 to 3, respectively. Some of the parameters have been merged. The percentage of the articles for each parameter are listed in Columns 4 and 5. Our BERT model labelled 47.01% of the articles with the outlier cluster and therefore the total percentage of articles listed in the table is 52.99%. The sixth column shows the top 20 keywords associated with each parameter sorted according to their importance score.

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Table 1 Macro-Parameters and Parameter for Families & Homes (Data Source: Scopus).

Macro	Parameter	ID	%	Keywords
Nurturing Families	Nurturing Children	0	8.33	child, student, parent, school, family, study, education, teacher, language, learn, home, social, research, parental, experience, educational, academic, year, relationship, literacy
	Women	4	4.24	woman, gender, mother, health, female, pregnancy, family, work, study, social, maternal, article, birth, child, adult, violence, life, contraceptive, home, research
	Elderly	7	1.23	old, elderly, old adult, home, live, adult, old people, health, life, social, elderly people, fall, daily, study, support, sensor, caregiver, aged, home care, base
	Spirituality	23	0.40	religious, religion, church, spirituality, christian, chaplain, spiritual care, muslim, prayer, faith, theology, community, study, protestant, theological, catholic, law, secular, patient, marriage
Health & Lifestyles	Genetics	16	0.52	mutation, genetic, gene, protein, disease, pedigree, phenotype, patient, study, exome sequence, female, clinical, nucleotide, autosomal, male, dna, genotype, protein human, polymorphism, novel
	Food	15	0.58	food, eat, meal, nutrition, food waste, household, restaurant, study, school, consumer, diet, dietary, health, vegetable, grocery, food insecurity, nutritional, food consumption, cooking, food security
	Obesity	49	0.19	obesity, overweight, overweight obesity, body mass, weight, childhood obesity, mass, prevalence, health, mass index, index, obese, adult, age, female, physical, family, high, male, adolescent
	Smoking	41	0.23	smoking, tobacco, cigarette, smoker, smoke free, tobacco product, smoking cessation, adolescent, quit, study, adult, tobacco use, nicotine, home, health, secondhand, shs exposure, passive smoking, female, free
	Addictions	44	0.22	alcohol, drink, gambling, drinking, drug, overdose, opioid, adolescent, naloxone, alcohol use, consumption, cocaine, male, study, alcohol consumption, female, family, alcoholic, health, disorder
	Mental Health	30	0.33	dementia, caregiver, people dementia, live, alzheimer, dementia care, live dementia, home, dementia family, family, patient, person dementia, disease, health, family caregiver, aged, nursing, staff, alzheimer disease cognitive,
	Cancer	3	4.49	protein, cell, cancer, gene, mouse, tumour, animal, receptor, kinase, molecular, drug, enzyme, family, cell line, breast, genetic, domain, gene expression, acid, DNA
	Diabetes	38	0.26	diabetes, type diabetes, glucose, insulin, patient, blood, diabetic, study, health, diabete, insulin dependent, disease, dependent diabetes, adult, risk factor, family history, female, non insulin, male, history
	Healthcare Provision	46	0.19	student, medical, nursing, medical student, education, nursing student, clinical, undergraduate, patient, medical education, health, nurse, medical school, medicine, education medical, practice, nursing education, study education nursing, interprofessional,
	Nursing & Homecare	9	1.02	patient, hospital, study, nurse, death, home, health care, nursing, aged, clinical, healthcare, medical, female, disease, medication, tuberculosis, physician, nursing home, article, family
	Pandemics	22	0.40	vaccine, covid, infection, virus, disease, vaccination, coronavirus, pandemic, influenza, viral, epidemic, spread, respiratory, study, outbreak, infant, model, patient, pneumonia, social
Communities & Nations	Race	14	0.62	black, racial, race, african, racism, family, health, hispanic, social, black woman, american, woman, slavery, segregation, child, black, white, african american, racial ethnic, black family, research
	LGBTQ	28	0.37	gay, transgender, bisexual, sex, male, heterosexual, lesbian, homosexuality, parent, adult, health, gay bisexual, gay man, social, study, queer, sexual gender, female, youth, father
	Political Affiliations	17	0.51	party, election, political, vote, electoral, voter, presidential, candidate, house, partisan, president, parliamentary, voting, parliament, democracy, congressional, democratic, trump, legislator, political party
	Mexican Immigrants	48	0.19	mexican, mexican origin, immigrant, parent, adolescent, migrant, migration, study, mother, familism, health, mexican immigrant, female, experience, social, transnational, human, adult, policy, mexican american
	Canadians & Immigrants	20	0.44	canadian, family, study, child, social, indigenous, policy, community, health care, research, home care, practice, mental, adult, article, life, patient, physician, mental health, immigrant
	Syrian Immigrants	45	0.22	refugee, syrian, immigration, deportation, asylum, syrian refugee, migration, migrant, family, country, resettlement, displacement, camp, child, detention, mental health, home, asylum seeker, interview, article
	Germany	25	0.39	german, family, war, home, study, article, social, life, history, germany, child, work, research, author, migration, country, century, health, refugee, memory
	Sweden & Finland	29	0.37	swedish, sweden, finland, finnish, home, family, child, study, social, second home, article, health, parent, life, policy, language, school, home care, education, parental

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	Italy	31	0.32	italian, family, social, study, work, child, migrant, language, article, history, parent, home, migration, house, immigrant, lockdown, gender, economic, life, author
	Spain	39	0.25	spanish, english, bilingual, spanish english, family, vocabulary, spanish speak, study, heritage, speaker, literacy, home, parent, home language, proficiency, linguistic, read, dual language, social, learner
	China	19	0.44	chinese, family, child, study, social, housing, chinese family, home, market, parent, policy, culture, immigrant, migrant, filial, firm, government, economic, relationship, research
	Japan	42	0.22	japanese, care, language, family, study, home, child, work, caregiver, culture, article, life, health, survey, medical, student, old, house, adult, social
	Australia	8	1.16	australian, australia, homelessness, housing, homeless, home, health, social, study, parent, young, research, mental, community, aboriginal, work, policy, article, school, interview
Resources & Management	House Pricing & Affordability	18	0.48	price, house price, housing, house, market, real estate, estate, housing price, model, housing market, hedonic, prediction, urban, price prediction, mortgage, datum, residential, land, income, buyer
	Architecture & Heritage	21	0.44	century, house, archaeological, date, late, neolithic, excavation, early, bronze, pottery, bronze age, burial, evidence, medieval, history, archaeology, ancient, chronology, radiocarbon, iron
	Work & Employment	26	0.39	work, employee, work family, job, family, family conflict, worker, work home, workplace, job satisfaction, study, life, stress, relationship, resource, organizational, work life, supervisor, employment, home
	Family Business	34	0.28	business, family firm, family, family business, corporate, company, governance, non family, social responsibility, corporate governance, corporate social, family ownership, ceo, study, social, financial, sustainability, firm performance, relationship, innovation
	Agricultural Farming	24	0.40	farmer, farm, agricultural, land, family farm, agriculture, farming, food, rural, crop, household, smallholder, economic, market, labor, sustainable, study, adoption, local, climate
	Animal Farming	13	0.63	dog, home range, range, habitat, pet, chicken, cat, poultry, bird, specie, pig, home, wild, female, male, meat, owner, article, house, animal
	Tourism	33	0.28	tourism, tourist, hotel, travel, guest, holiday, tourist destination, family, sustainable, airbnb, research, cruise, accommodation, social, second home, local, house, tourism industry, heritage, business
	Energy Management	5	3.09	energy, grid, electric, management, electricity, building, solar, energy management, air, appliance, renewable, residential, house, home energy, thermal, battery, indoor, heating, renewable energy, energy consumption
	Water Management	37	0.26	water, water supply, drinking water, sanitation, water quality, household, drinking, supply, water consumption, urban, water treatment, drink water, rainwater, water source, water use, water management, sensor, wash, household water, toilet
	Disasters	27	0.38	flood, disaster, earthquake, hurricane, evacuation, coastal, landslide, community, tsunami, flooding, flood risk, impact, event, natural disaster, recovery, household, study, storm, housing, resilience
Technologies	Assistive Robots	10	0.88	robot, robotic, home, human robot, robot interaction, design, service robot, environment, mobile robot, user, mobile, social robot, assistive, base, social, machine, propose, intelligent, paper, technology
	Remote Healthcare	47	0.19	health, patient, healthcare, medical, internet, datum, sensor, internet thing, monitor, remote, health monitoring, security, wearable, network, health care, home, cloud, technology, mobile, privacy
	Social Media	43	0.22	social medium, twitter, facebook, online, user, networking, social networking, tweet, social network, network, news, networking online, youtube, friend, online social, broadband, internet, study, digital, video
	Smart Environments	2	6.27	home, smart home, internet, network, security, internet thing, sensor, automation, wireless, base, technology, intelligent, propose, malware, datum, detection, home automation, attack, paper, mobile
	Sleep Monitoring	35	0.28	sleep, apnea, sleep quality, sleep apnea, sleep stage, night, polysomnography, sleep disorder, disorder, sleep duration, stage, study, home, sleep, sleep research, wake, adolescent, patient, sleep monitor, male
	Rehabilitation Technologies	36	0.27	rehabilitation, exercise, patient, parkinson, parkinson disease, game, stroke, training, disease, home, base, therapy, motor, virtual, home base, pd, week, feedback, wearable, upper limb

Figure 5 provides a taxonomy of Families & Homes domain extracted from academia. The taxonomy is created using the parameters and macro-parameters discovered from the Scopus dataset. The macro-parameters are shown on the first level of branches, the discovered parameters are shown on the second level of branches.

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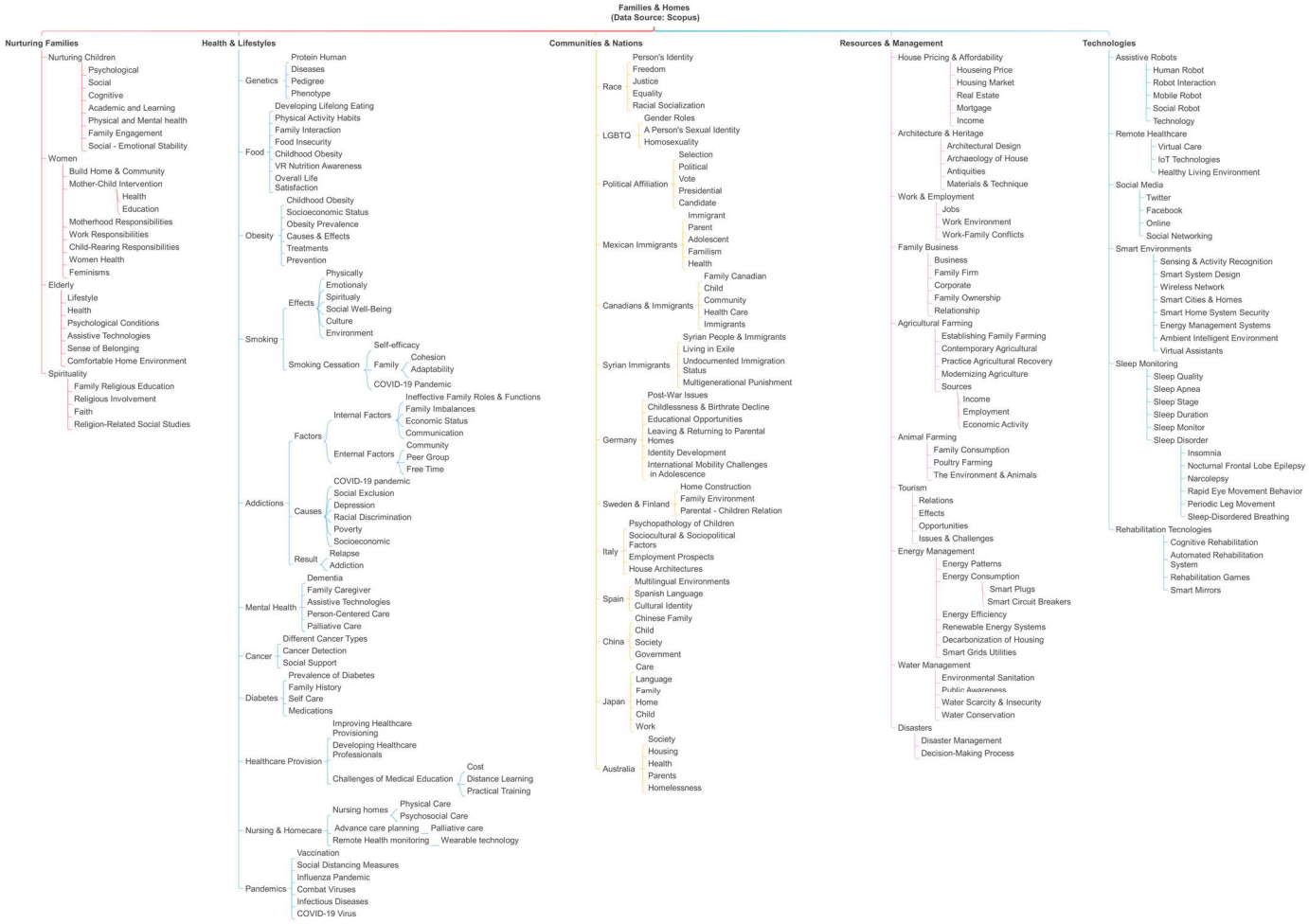

Figure 5 A Taxonomy of Families and Homes Extracted from the Scopus Dataset.

4.2. *Quantitative Analysis*

This section discusses term and word scoring, intertopic distance mapping, hierarchical clustering, and similarity matrices. A group of keywords represents almost all parameters; not all of them are equally descriptive. Figure 6 indicates the number of keywords needed to describe a parameter and at what point the benefit of adding more keywords diminishes (see Section 3.9). Only the top seven to ten terms in each parameter accurately describe that parameter. Since all the other probabilities are close to each other, it makes no sense to rank them. Therefore, to label the parameter, we focused on the top seven to ten keywords of that parameter.

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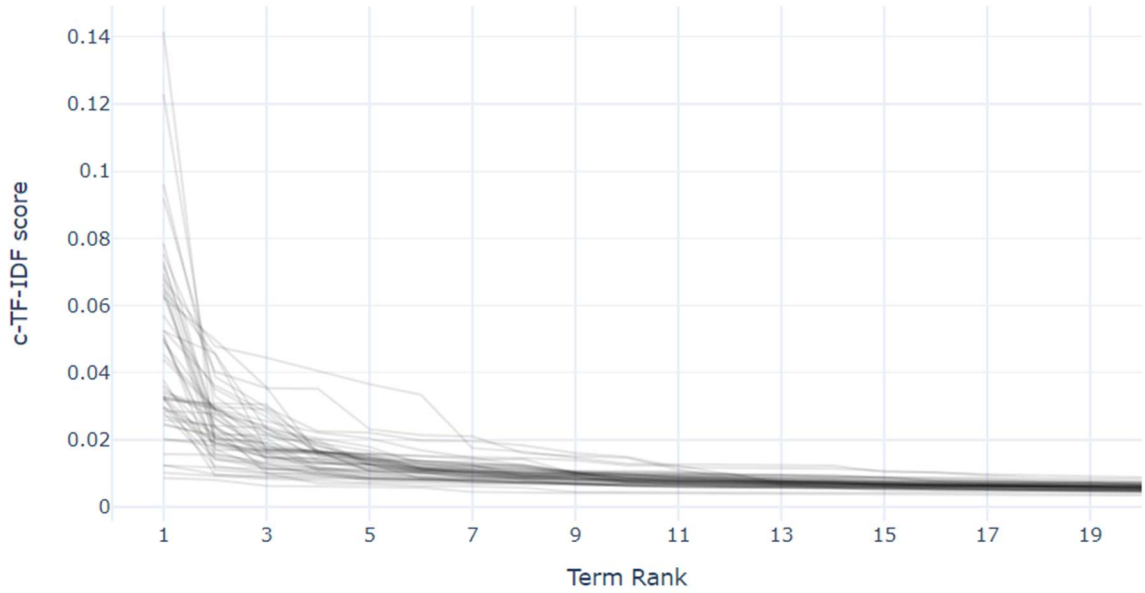

Figure 6 Term Rank (Data Source: Scopus).

The top ten keywords for each parameter are shown inFigure 7 Families and Homes Parameters with Keywords c-TF–IDF Score Figure 7 and Figure 8. The importance score c-TF-IDF is used to order the keywords (see Section 3.9). There are 44 bar charts, where the horizontal line indicates the importance score, and the vertical line indicates the parameter keywords.

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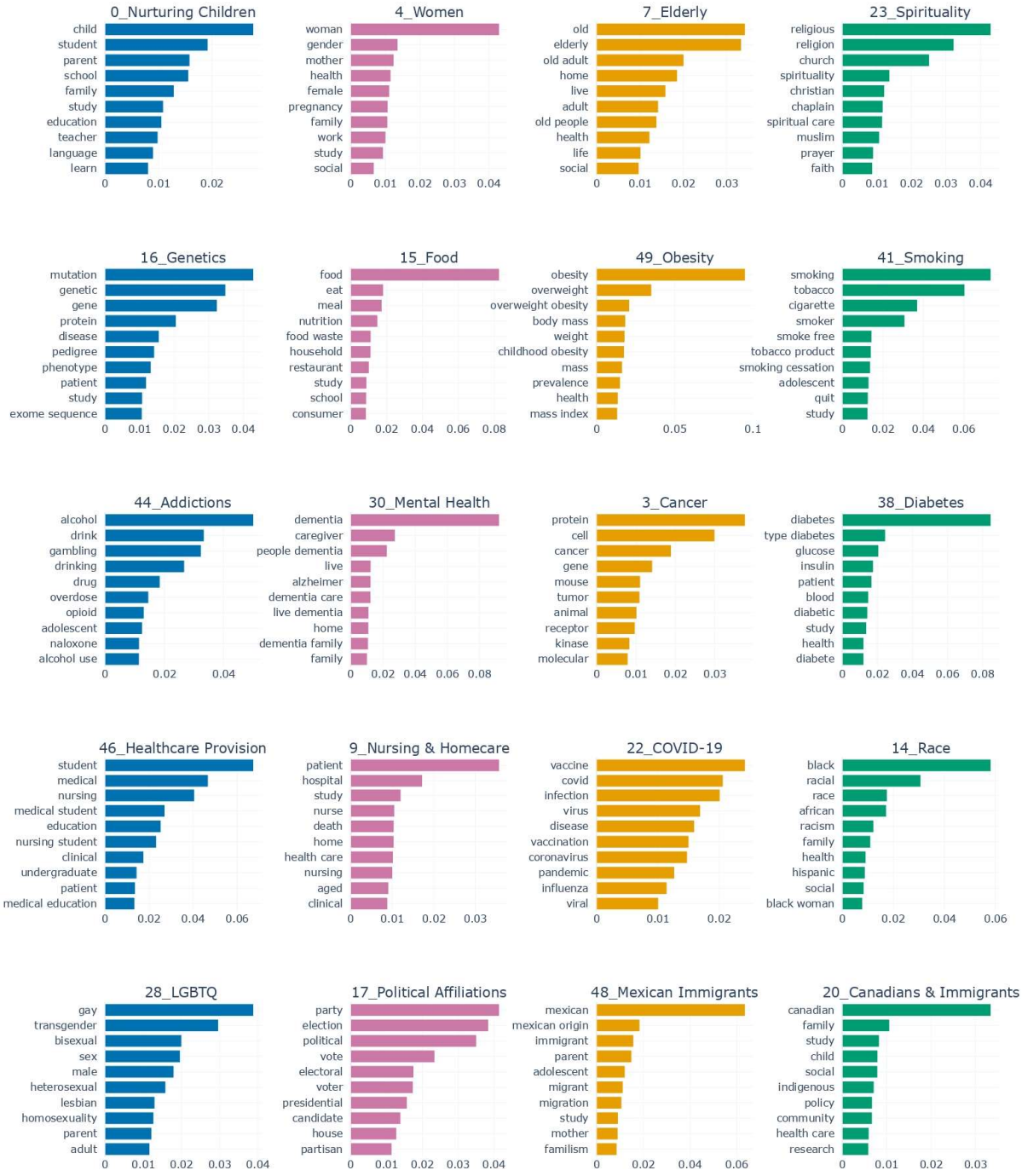

Figure 7 Families and Homes Parameters with Keywords c-TF–IDF Scores (Data Source: Scopus) (Part A).

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Figure 8 Families and Homes Parameters with Keywords c-TF–IDF Scores (Data Source: Scopus) (Part B).

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Figure 9 shows the intertopic distance map, where eleven groups of parameters are clearly identified (see Section 3.9). The BERT model names each by the first few keywords and these are not necessarily representative of the clusters. Therefore, we labelled them using our domain knowledge and quantitative analysis information. Manually grouping the parameters into five macro-parameters is also performed.

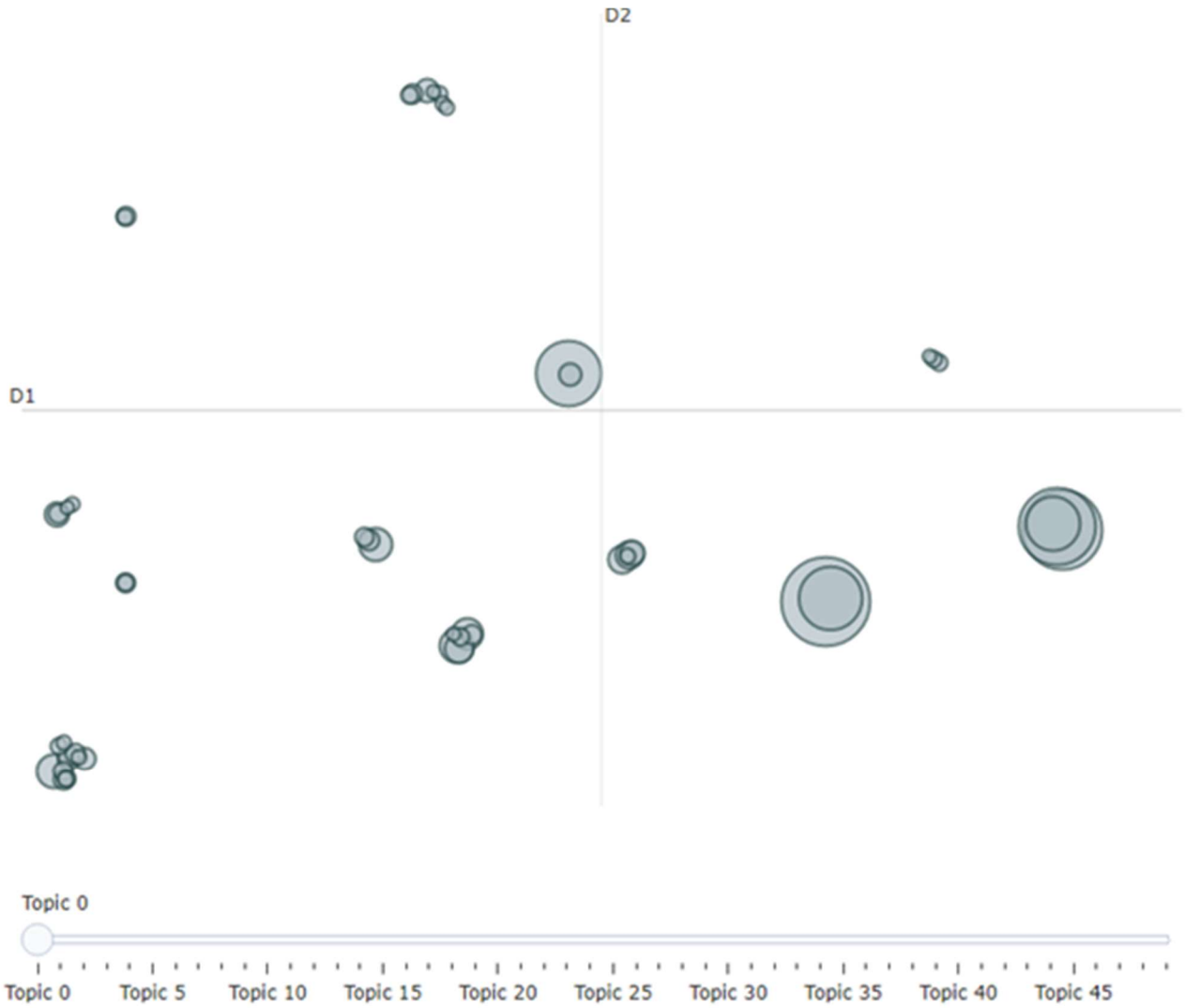

Figure 9 Intertopic distance map (Data Source: Scopus).

Figure 10 describes the automated hierarchical clustering of the 50 clusters. It systematically pairs them based on the cosine similarity matrix (see Section 3.9).

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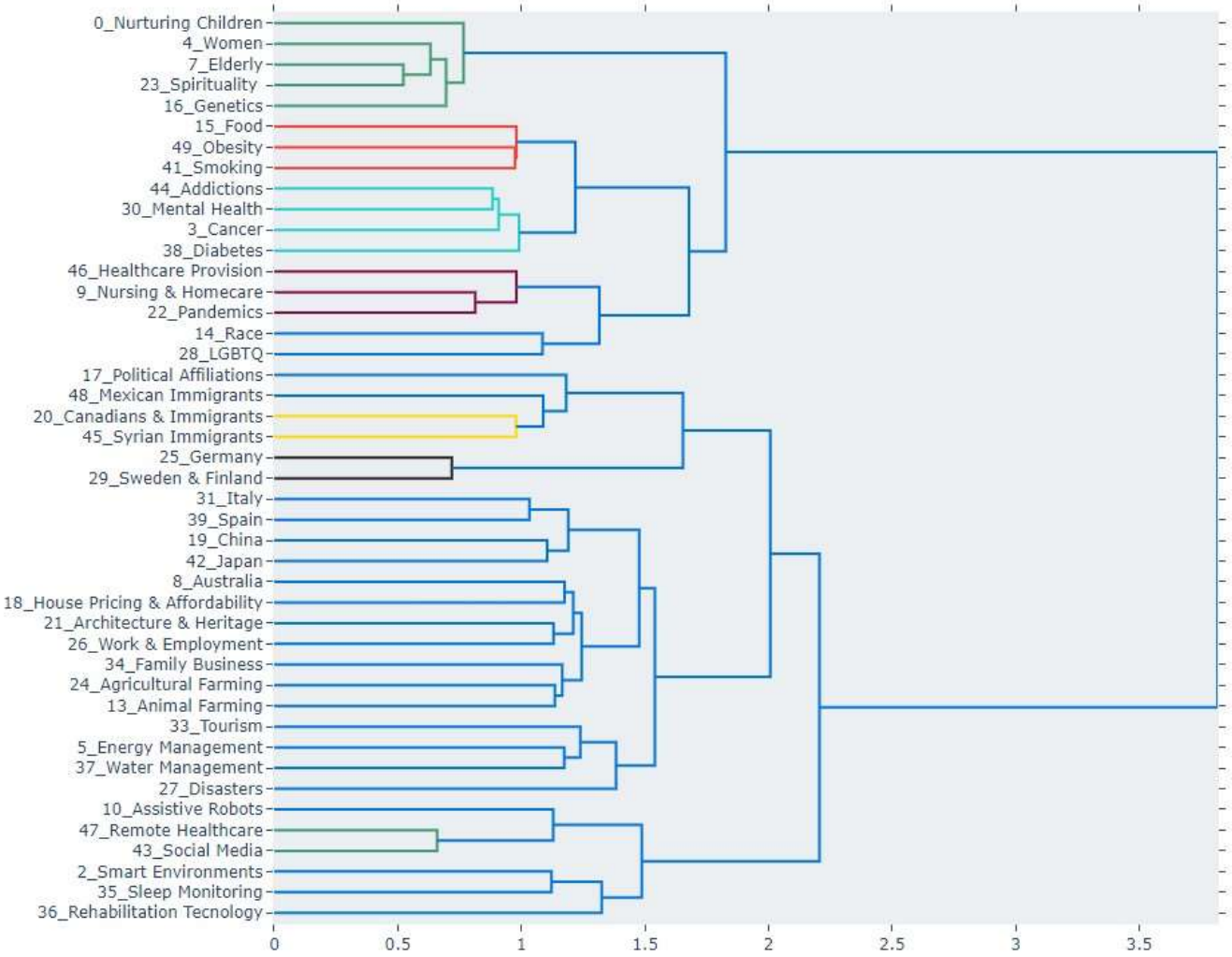

Figure 10 Hierarchical Clusters (Data Source: Scopus).

Figure 11 visualizes the similarity matrix among the parameters (see Section 3.9). The dark blue colour represents the highest similarity between parameters, whereas light green represents the lowest similarity. For example, Cluster 10, labelled as Assistive Robots, and Cluster 47, labelled as Remote Healthcare, have high similarity scores as they are both important technologies that focus on caring for the patient; robotics can be used to provide high-quality patient care in the healthcare field.

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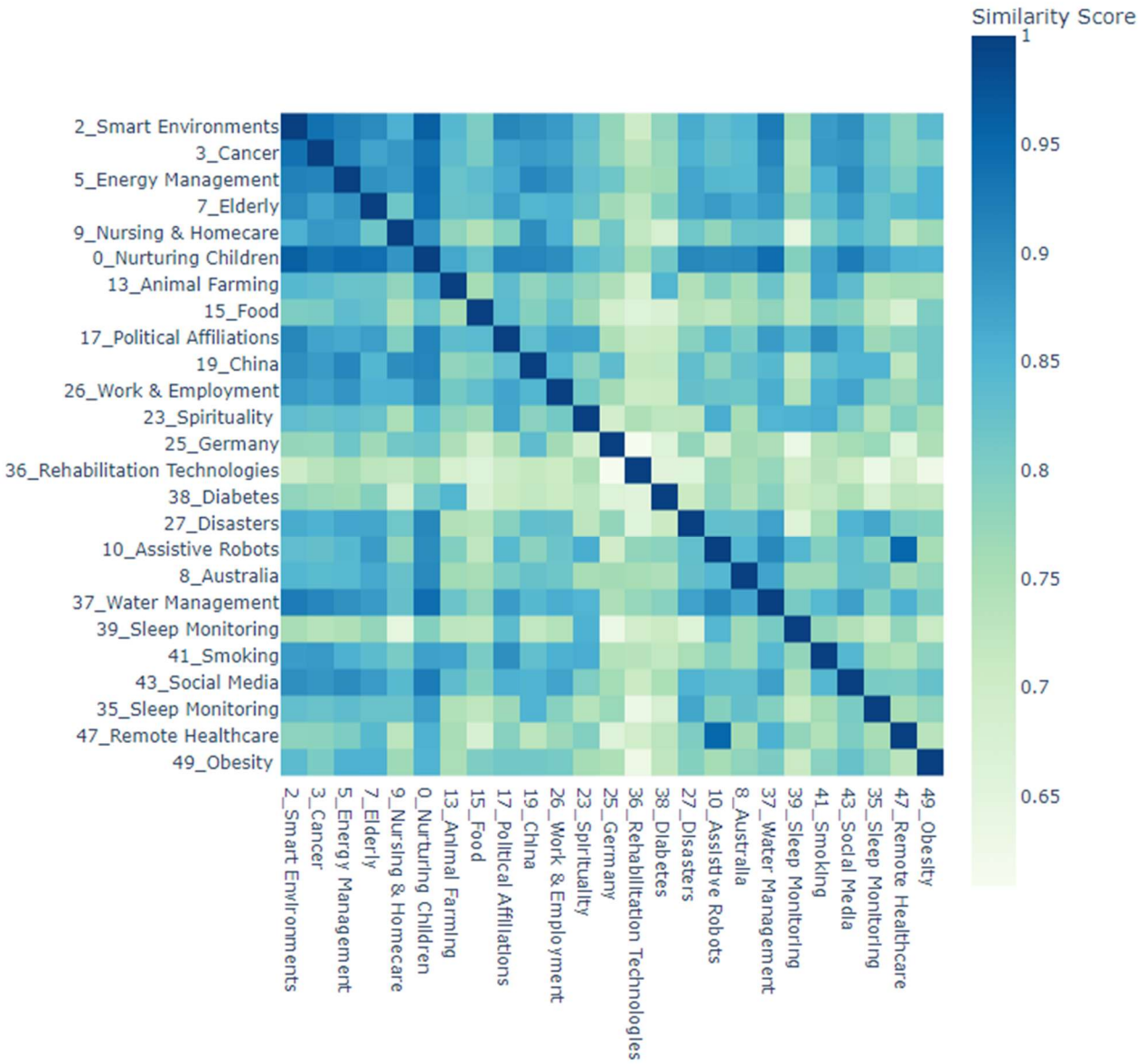

Figure 11 Similarity matrix (Data Source: Scopus).

4.3. *Nurturing Families*

The Nurturing Families macro-parameter concerns about strengthening families and homes and the associated challenges. It comprises four parameters, namely, Nurturing Children, Woman, Elderly, and Spirituality.

4.3.1. Nurturing Children

The Nurturing Children parameter focuses on the development of children's academic abilities and social skills, among other issues, along with the involvement of parents and teachers. The keywords that were detected by our model include child, student, parent, school, family, study, education, teacher, language, learn, home, social, research, parental, experience, educational, academic, relationship, and literacy. Taking a look at the academic articles that relate to this parameter, we were able to find a number of topics that describe various dimensions of this parameter. The topics and dimensions include psychological [65]–[67], social [68], cognitive [69], physical and mental health development [70]–[72], family engagement [73]–[75], behaviour change [76], [77], and education [68], [78]–[80].

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Children's psychological development -- including their cognitive, intellectual, social, and emotional capabilities -- is affected by many factors related to their families and homes. Arranz-Freijo and Barreto-Zarza [65] advocated the use of an epigenetic approach to better understand the effects of family structure and parenting quality on the psychological development of children. Solsona et al. [81] noticed the concept of family has grown to be broader and more complex. It was no longer necessary to own a home to form a family, nor did living together imply a lack of close relationships, stability, or emotional bonds. The placement of adopters and scrutiny of potential adopters are important considerations emphasized by Dalton et al. [66]. Consequently, adoptees and foster children can form secure attachments with their foster parents and other adults when they are placed in a sensitive and well-organized environment. Aguayo and Salomonsson [76] focused on understanding the infant's behaviour and emotions and various approaches adopted to understand the infant's psyche. Keijsers [82] reviewed the evidence regarding the effectiveness of parental monitoring in preventing adolescent delinquency within a family. No causal processes were operating within families, but rather stable differences between individuals. Jamis [77] stated that there is a multiscale relationship between state violence and domestic violence among low-income families. They understood the violence as an act of care meant to correct inappropriate behaviour from the point of care perspective.

The level and quality of family and parent's engagement and involvement in their children's life influence different aspects of their children's development such as language development [69], [74], academic and learning development [78], interest and study choice [80], and socio-economic success [68]. Mehus et al. [73] explain that children's lives are most significantly influenced by their parents, and parenting practices can help moderate the relationship between risks of the environmental factors and child outcomes. Fathers, therefore, have three primary responsibilities: to provide for their children, educate their children, and to create a stable and peaceful home. Hosseinpour et al. [31] found that the parents' involvement and attitude were really important to their children's language development. This means that the more they get involved in and the more positive attitude they have to their children's language acquisition, the more their children will achieve academically. And also, that parents' level of education and income have a big influence on their children's language development. Hoxha and Sumner [69] explained that the cognitive, motivational, and environmental factors influence the development and enhancement of reading and writing performance for children who speak English as a first or additional language. Ying and Warschauer [68] emphasized families should engage in a highly routinized activity of reading together. The relationship between literacy practices and children's identities is fundamental to those practices across the home and college domains which support their academic learning and social success. Pereira et al. [78] noticed that the family environment resources and family-school relations play a significant role in influencing the academic and learning development of children. Akkerman and Bakker [80] acknowledged that students' multiple and diverging interests are influenced by several factors, including school, family, work, and peers. Bahna [83] discussed the influence of families with high cultural capital and/or economic capital on international student mobility, their study choices, and postgraduation returns. An analysis of foreign students studying in German universities and their subsequent academic migration was discussed by Strenger et al. [79]. Chang et al. [67] found a relationship between parents' education and first-generation college students' ability to deal with academic, financial, and psychological challenges.

The children's health is an important aspect of their development including their physical and mental development. A variety of influences on children's health are identified such as nurturing, early diagnosis, environmental stimulation, and specific pandemic (e.g. COVID-19). Jopkiewicz et al. [71] described that the family socioeconomic status influences the child's academic preparation. Thus, their physical and mental development levels differ significantly from those of other children. Children were exposed to a broad

range of harmful health effects, which may have a negative long-term effect on their development and education. Hair et al. [72] addressed how family income affects children's brain development. Physical and mental health problems, behavioural problems, and low academic achievement are among the effects of living in poverty on children's development. Avants et al. [75] pointed out that parents' nurturing and environmental stimulation play imperative roles in shaping lifelong children's brain development. Moroe et al. [70] focused on the importance of early diagnosis of deafblind children as deaf blindness is often underdiagnosed or misdiagnosed which affects their development as children and their families.

The impact of the COVID-19 pandemic on teachers, students, and families is evaluated and the pandemic practices are suggested. MacDonald and Hill [84] emphasised the importance of good communication and health, care, and educational practices that address social-emotional wellness, to the populations. Penuel [85] suggested that assessment practices for educational purposes should continue and schools must use student work as evidence of learning, reflecting their culture, and as a way to establish connections with families and the community.

4.3.2. Woman

The Woman parameter covers different roles women play in the families & homes, challenges, issues, advice, and technological enablers while developing, maintaining, and taking care of their families. In addition, documents under this parameter discussed some social movements related to women such as feminism. The keywords that were detected by our model include woman, gender, mother, health, female, pregnancy, family, work, study, social, maternal, article, birth, child, adult, violence, life, contraceptive, home, and research.

Tara Beagan in her book “Honour Beat” described the mother as the home and community and stated that they are synonymous [86]. Shai [87] stated that in order to strengthen women's roles in the household, young women in communities need to be protected from violence and discussed family-centered intervention methods to prevent violence against girls and women. Smith [88] focused on the eighteenth century and affirmed the important role that women played in Britain's elite imperial families in home building in terms of organizing and completing the work.

Kozlowskiet al. [89] expressed that feminist movements have had a profound effect on women's and men's daily lives in Argentina, changing family structures, child-rearing, and the manner in which clothes and goods are consumed. Due to these changes, values and cultural practices became more diverse and respectful, resulting in a society where women are no longer treated as objects and have full autonomy over their lives and professions.

Several documents put the light on the struggles mothers face to balance their work and motherhood responsibilities. Zhou [90] explained that in the process of becoming mothers, women realize that employment and child-rearing responsibilities are incompatible. This reshapes women's gender attitudes toward their roles. Nancy Huston wrote a novel where a dancer mother abandons her family eventually because she struggles to balance her career and motherhood [91]. Singh et al. [92] focused on mothers of children with Down syndrome or cerebral palsy and stressed that they must identify which behaviours of their children are communicative and maintain reciprocal interaction with those behaviours. Some other documents discussed women health related issues. For example, Bennani et al. [93] discussed the prevalence and incidence of active syphilis in adult women focusing on Moroccan woman cases.

Technology affects virtually every aspect of society. Technology enables female adolescents to develop secure relationships with their families and friends and create attachments in a variety of ways. Levine et al. [94] extend this discussion and studied the amplification of technology on young girls existing relationships positively and negatively.

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Vaiara et al. [95] exploited chatbot systems powered by artificial intelligence to help families with young children, pregnant women, and mothers by giving them advice and instructions as needed.

4.3.3. Elderly

The Elderly parameter is regarding elderly care and health. It is represented by keywords, detected by our model, such as old, elderly, old adult, home, live, adult, old people, health, life, social, elderly people, fall, daily, study, support, sensor, caregiver, aged, home care, and base. This parameter captured some concerns related to elderly people's lifestyle, health, psychological conditions at care homes, and assistive technologies. For example, Cook et al. [96] noticed that moving to a care home for the first time compromises an older person's sense of security that comes from their own 'home'. After some time, they have developed a sense of belonging to a care home as "home" and prefer 'living with care' rather than 'existing in care'. Henkel et al. [97] emphasized the importance of connecting with others and one's own personal past. They considered this valuable for many older adults living in long-term care facilities as it serves different psychosocial functions in various settings to reflect on the past and share recollections with others. On the other hand, Roh et al. [98] discovered that seniors living with families in South Korea had significantly higher life satisfaction than those living alone. Further, individuals who maintained both their social and physical activities and their economic profile showed higher levels of life satisfaction than their counterparts. Kaudki et al. [99] explained that health experts consider falls as one of the greatest risks facing older and handicapped adults. One of the advices is to use RFID technology to detect human falls. This can be used to identify elder people's movements. Macik et al. [100] suggested that ageing adults who are blind or visually impaired can benefit from information and communication technology (ICT). Janssens et al. [101] explored how staircase designs can contribute to creating a healthier and more comfortable home environment for older adults.

4.3.4. Spirituality

The Spirituality parameter captures various aspects of the family spirituality including religion, faith, religious education, and religion-related social studies. It is represented by the following keywords: religious, religion, church, spirituality, Christian, chaplain, spiritual care, Muslim, prayer, faith, theology, community, study, protestant, theological, catholic, law, secular, patient, and marriage. Some examples articles from this parameter are discussed as follows. Thanissaro [102] studied and evaluated the attitude towards Buddhism in adolescents and teenagers in the UK. The involvement in religiosity was measured through temple attendance, scripture reading, meditation, spiritual experiences, and religious style. Peri-Rotem [103] discussed religion and fertility and tried to understand the changing relationships between religion, childbearing, and family formation patterns in Britain, France and the Netherlands. In family religious education, Setran [104] believes that teaching children how to pray is a prophetic role for parents. Dhuhri [105] showed different types of living images, which are included in Islamic arts and are used in traditional houses. Østebø et al. [106] explored the responses of different religions to the COVID-19 pandemic in Ethiopia. They found that, according to Christians and Muslims in Ethiopia alike, the pandemic was a punishment for sins. As a result, prayer, fasting, and gathering around houses of worship became more prominent.

4.4. Health & Lifestyle

This macro-parameter concerns health and lifestyle touching upon lifestyles, diseases and provision of healthcare. It captures the following parameters: Genetic, Food, Obesity, Smoking, Addictions, Mental Health, Cancer, Diabetes, Healthcare Provision, Nursing & Homecare, and Pandemics.

4.4.1. Genetics

This parameter captures the effects of genetic characteristics on families and homes. This parameter explores the following keywords mutation, genetic, gene, protein, disease,

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pedigree, phenotype, patient, study, exome sequence, female, clinical, nucleotide, autosomal, male, dna, genotype, protein human, polymorphism, and novel. Genetics is believed to be responsible for many developmental abnormalities. For example, NOG-related symphalangism spectrum disorder (NOG-SSD), intellectual disability and other developmental abnormalities have been reported by Pang et al. [107] as a result of microdeletions in chromosome 17q22, where the NOG gene resides [108]. Similarly, Toyoda et al. [107] studied a case of childhood-onset hyperuricemia and early-onset gout caused by dysfunctional ABCG2. Kertesz et al. [109] studied the relationship between proximal genetic abnormality and pathogenic pathways in families. Zhao et al. [110] conducted a genome-wide association study on eight different ovary syndrome in families and discovered eight new risk loci independently associated with PCOS. Moreover, they found that Polycystic Ovary Syndrome (PCOS) is an endocrine disorder that may be family inherited. The genotype-phenotype correlation of NR2E3 has been studied in autosomal dominant Retinitis Pigmentosa by Blanco-Kelly et al. [111].

4.4.2. Food

This parameter captures issues related to the family's and home's food consumption and eating habits. The keywords that were detected by our model include food, eat, meal, nutrition, food waste, household, restaurant, study, school, consumer, diet, dietary, health, vegetable, grocery, food insecurity, nutritional, food consumption, cooking, and food security.

An analysis of food-related life satisfaction by Schnettler et al. [112] found that health, family, and eating are factors that contribute to overall life satisfaction, and family interaction that occurs while eating may play an important role in overall life satisfaction. Similarly, Jackson et al. [113] explained how family homes are considered a key setting for developing lifelong eating and physical activity habits and how family home nutrition and physical activity environments influence food insecurity and childhood obesity. Lambert et al. [114] found that dinner conversations and settings are among the best times to discuss hard issues with family and friends. For example, the topic of death could be communicated via humour types over dinner conversations, and they specified six different types of humour that can be used in conversations about death: entertaining humour, gallows humour, tension-relieving humour, confused/awkward laughter, and group humour/narrative chaining. As health is affected by food choices therefore Mills et al. [115] studied the impact of food preparation methods on diet and health and discovered many factors that influence food preferences, such as identity, cooking process, and resources, including money, time, and facilities. The virtual reality nutrition awareness learning system is considered by Karkar et al. [116] as the most effective and attractive way to motivate children as interacting directly with healthy food enhances children's learning skills and keeps them engaged.

4.4.3. Obesity

This parameter focuses on obesity prevalence, causes, effects, treatments, and prevention in families including children and adolescents. It is represented by the keywords such as obesity, overweight, childhood obesity, prevalence, health, adult, age, female, physical, family, high, male, and adolescent.

Childhood obesity is highly influenced by the family and home environment, according to Knowlden et al. [117]. As the global obesity epidemic affects children today and some of these children also have other disease-related problems, such as diabetes type II, Rio et al. [118] studied the impact of a gamified educational program on patients with obesity and diabetes, resulting in positive changes to their medical records and health habits. Around the world, obesity has been on the rise among children and adolescents. Socioeconomic status plays an important role in adolescents' risk of obesity, as Ni et al. [119] stated. They investigated the role of socioeconomic status on weight gain among adolescents exposed to economic and social transitions. Mosha et al. [120] observed the prevalence of childhood overweight and obesity in urban and private schools in low- and

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middle-income countries. Thus, it is important to ensure that there are playgrounds at schools and to encourage children to participate in physical activities. Noonan and Turchi [121] conducted a study and mentioned that children who live in two-parent families are less likely to be obese compared to those who live in single-parent families. They examined differences in obesity rates for young children from single-father and single-mother families and found that in their study the father had a higher income and a healthier home, but the mothers do not. There is a similar level of obesity in these two types of single-parent families. Bejster et al. [122] urged that children's obesity must be viewed from a multifaceted perspective and partnerships must be developed to expand health outreach and promote community capacity.

4.4.4. Smoking

The Smoking parameter is regarding smoking's effects on families, homes, health, culture, and environment. It is represented by keywords (detected by our model) such as smoking, tobacco, cigarette, smoker, smoke free, tobacco product, smoking cessation, adolescent, quit, study, adult, tobacco use, nicotine, home, health, secondhand, shs exposure, passive smoking, female, and free.

According to Golestan et al. [123], around the world, cigarette smoking is not considered as dangerous as narcotic drugs, since there is no country in which adolescents do not smoke. However, cigarette smoking among adolescents is considered a global and complex public health problem as it affects the development of a person's physical, emotional, spiritual, and social well-being. Therefore, they believe that families and self-efficacy are crucial in preventing young children from smoking. Leite et al [124] stressed on that the use of tobacco can cause cancer and affect the microbiota of the oral, fecal, duodenal mucosa, and bowel luminal microbiome. Mbongwe et al. [125] noticed that the effects of culture and environment on smoking among adolescents were greater in boys than in girls and peer and social acceptance were strong predictors of smoking among boys. As an alternative to cigarettes, Patel et al. [126] referred to the electronic nicotine delivery system called JUUL for current adult smokers. It helps them to quit smoking. Furthermore, they mentioned the importance of cessation intervention efforts and policy development to assist smokers in quitting. Sun et al. [127] discovered that there was a decline in tobacco use in Hong Kong after the first two COVID-19 outbreaks and cigarette users decreased their usage more than tobacco or e-cigarette users. Lidón-Moyano et al. [128] found that smoking bans in Spain did not shift tobacco consumption from public places (such as workplaces) to private ones (such as homes) as Spain's implementation of smoke-free regulations in public and workplaces was accompanied by an increase in voluntary smoke-free rules in homes.

4.4.5. Addictions

This parameter describes by the following keywords: alcohol, drink, gambling, drinking, drug, overdose, opioid, adolescent, naloxone, alcohol use, consumption, cocaine, male, study, alcohol consumption, female, family, alcoholic, health, and disorder.

Factors influencing the recurrence of drug abuse include internal factors such as ineffective family roles and functions, family imbalances, economic status, and communication and external factors, including environmental and peer group variables, as well as free time [129]. Raharni et al. [129] stressed that friends played a very dominant role in causing relapse and external factors such as social pressures and the environment was more likely to lead to relapse. Moreover, drug types also affected the likelihood of relapse. Therefore, they affirmed on importance of social support for recovering from drug addiction. According to Cordova et al. [130] eco-developmental factors, including family and community, play a significant role in alcohol and drug use. Gajewski et al. [131] noticed that a significant number of people with depression and substance abuse disorder have comorbid substance abuse and addiction and they are more likely to have a worse quality of life and commit suicide. A link between alcohol use and anxiety issues among women with HIV is observed by Ge et al. [132]. Foster et al. [133] found that drinking at home has

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become more prevalent in the United Kingdom than outside the home. A study of the COVID-19 pandemic effect on drinking behaviour conducted by Vanherle et al. [134] found that the pandemic has affected students' drinking behaviour, especially drinking at home which may have resulted in problematic drinking among students. Moreover, social isolation and the increase in the use of social networking sites have been linked to increased alcohol consumption.

4.4.6. Mental Health

People's and family mental health issues are captured by this parameter. The following keywords were detected by our model: dementia, caregiver, people dementia, live, alzheimer, dementia care, live dementia, home, dementia family, family, patient, person dementia, disease, health, family caregiver, aged, nursing, staff, and alzheimer disease cognitive. This parameter discovered research focused on supporting and dealing with family members that suffer from mental conditions and their caregivers including getting family help, care at the organizational level, establishing trust with caregivers, everyday conversation, and assistive technologies. For example, Berry et al. [135] noticed that people with dementia seemed to be aware when their condition was declining and frequently asked their families for help. As a result, families need to consider the functional abilities of demential elders and manage their involvement in activities. The person-centered care at the organizational level is believed to be a possible supporting way for the quality of life of people with dementia [136]. As people with dementia tend to have a decline in their ability to engage in everyday conversation, Sluis et al. examined the use of conversational analysis to improve communication between people with dementia in residential care and their caregivers [137]. In addition, people with dementia and the elderly can benefit from assistive technology (AT) that provides appropriate and personalized support for time-related activities, sensory awareness, communication, and entertainment, and in this way, boredom, loneliness, and social isolation can be reduced [138]. Since nursing home health professionals should be trusted for their experiences as caregivers by family caregivers, Boogaard et al. [139] argued that improved communication and information exchange can increase family caregivers' trust in nursing home health professionals and as a result, optimal palliative care could be provided for those with advanced dementia.

4.4.7. Cancer

The Cancer parameter is regarding cancer patients of various ages, different cancer types, social support, and detection. It is represented by keywords (detected by our model) such as protein, cell, cancer, gene, mouse, tumour, animal, receptor, kinase, molecular, drug, enzyme, family, cell line, breast, genetic, domain, gene expression, acid, and DNA. Looking at the Scopus academic articles that belong to this parameter we were able to find a number of topics related to it. For example, Gage-Bouchard et al. [140] discussed different types of support the parents of children with cancer receive from a broad range of people (e.g. friends, family, neighbours, and health care professionals) including emotional support and information about health issues. Huang et al. [141] stressed on the role of family communication patterns, coping, and well-being as they found that it is essential to support and help cancer patients including breast, prostate, and mixed cancer types. Regarding breast cancer, as a significant health issue among women and early detection makes treatment easier and more effective, medical imaging has been used in a variety of ways to investigate breast cancer. Moreover, Melekoodappattu et al. [142] developed a computer-aided diagnostic (CAD) system to detect breast cancer by interpreting mammograms and identifying tumours with 99.33 % accuracy. On the other hand, Kim et al. [143] affirmed that patients suffering from breast cancer are less likely to become depressed if they have a lot of support from their families and the more family support they receive, the less depressed they will be. Sheth et al. [144] studied the relationship between Aspirin and colorectal cancer and found that taking Aspirin regularly may reduce the risk of colorectal cancer.

4.4.8. Diabetes

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The Diabetes parameter is represented by keywords including diabetes, type diabetes, glucose, insulin, patient, blood, diabetic, study, health, diabete, insulin dependent, disease, dependent diabetes, adult, risk factor, family history, female, non-insulin, male, and history. This parameter covers research related to diabetes such as self-care, family history, and medications. For example, Baig et al. [145] stressed on the importance of self-care in managing diabetes in adults and discovered that participation of family members in diabetes self-care has a positive impact on patient outcomes. Among the Chinese, Zhang et al. [146] investigated the possible association between family history risk and the prevalence of diabetes. Lan et al. [147] explained how family history of diabetes and hypertension were both significantly associated with an increased risk of metabolic syndrome (MS). As the prevalence of type 2 diabetes mellitus is increasing, Steadman et al. [148] found that oral medications were not effective in the first place, however, they may be used with glucagon-like peptide-1 receptor agonists.

4.4.9. Healthcare Provision

The Healthcare Provision parameter captures various dimensions of improving healthcare provisioning and developing healthcare professionals. The parameter's keywords include student, medical, nursing, medical student, education, nursing student, clinical, undergraduate, patient, medical education, health, nurse, medical school, medicine, education medical, practice, nursing education, study education nursing, and interprofessional. The dimensions covered by this parameter include the challenges of medical education including cost [149], distance learning [150] and practical training [151], how to improve family medicine [152], how to improve homecare and the nursing profession [153], how to improve medical education and profession [150], and simulations and other methods based on the emerging technologies to improve healthcare [154]. For example, for medical education, Walsh [149] stressed the importance to consider how to control costs or how to improve value for money as they believe it continues to be too expensive for students and their families to receive medical education. Bayoumi et al. [154] claimed that clinical simulation projects delivered in a well-planned and well-executed manner can enhance the clinical experiences of nurse practitioners in home-based primary care. Newcomb et al. [150] asserted that while telemedicine has great potential for future expansion, video-conferencing-specific communication skills are necessary to enable surgical teams to build rapport in this innovative form of consultation.

4.4.10. Nursing & Homecare

This parameter is about homecare where the services by healthcare professionals are made available to people at their homes as opposed to hospitals, nursing homes or elderly homes. These services could be tailored for people, elderly or young, who are ill, disabled, or waiting for their death due to their various diseases and health conditions. The parameter touches on various issues, diseases and stakeholders including patients, nursing and nurses, death, home, aged, clinical, healthcare, female, disease, medication, tuberculosis, physician, nursing home, and family. Examples of academic research under this parameter include ensuring the quality of life for the elderly through both physical and psychosocial care in nursing homes by offering a home-like environment, communication, conversations, and self-care, which are all considered high marks of a quality elder care program [155], ethics of families in healthcare decision making [156], the value of death conversations in the clinical setting and how conversations about death early on in life can be an effective way for doctors and patients to co-create more healthy lifestyles [157], the end-of-life care policy and how patients are encouraged to die at home, which most believe to be their preferred setting [158], and how in-home care using the remote monitoring and diagnostic system would provide a holistic view of the patient's health status and minimizes hospitalization times [159].

4.4.11. Pandemics

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This parameter captures the effects of Pandemics on families and homes across the world. The various dimensions captured include vaccine, infection, virus, influenza, viral epidemic, spread, respiratory, outbreak, infant, patient, pneumonia, and social aspects. Examples of studies under this parameter include how family resources during a pandemic are re-allocated as a result of a health shock to one child [160], the use of vaccination and social distancing measures to slow the spread of infectious diseases and the provided public support to enhance epidemic control [161], the behavioural measures (e.g. wearing face masks and keeping social distance from others) for combating Covid-19 in the absence of vaccines or causal therapies [162], how family violence during COVID-19 has led to a lockdown and long-term home isolation across China [163], early detection frameworks using smartphone sensors on individual smartphones globally to identifying the disease early, monitoring the users' current location, and taking protective measures [164], opportunities and benefits opened to those in need within society, the community, and the nation such as changes undergone to healthcare including teleconsultation, Internet use, and E-learning, and the effect on water sources, waste management systems, and conservation of natural resources [165].

4.5. Communities & Nations

This macro-parameter covers various dimensions of families and homes distinguished by different communities, countries, societies, or nations. It captures the following parameters: Race, LGBTQ, Political Affiliations, Mexican Immigrants, Canadian & Immigrants, Syrian Immigrants, Germany, Sweden & Finland, Italy, Spain, China, Japan, and Australia.

4.5.1. Race

The Race parameter captures the racial issues associated with families and homes. It includes the following keywords: black, racial, race, african, racism, family, health, hispanic, social, black woman, american, woman, slavery, segregation, child, black, white, african american, racial ethnic, black family, and research. The parameter discloses several important dimensions in academic literature including the person's identity and how it can be affected by the families and places they visit [166] [167], how freedom, justice, and equality are constrained by social and political conditions [168], family, friends, or members of the same racial group reporting racial discrimination incidents [169], racialized discrimination against multiracial families [170], racial socialization and how parents transmit race-related messages about race and racism to their children through racial socialization [171], the online genetic-genealogical networks and genetic relative match role in the reconstruction of historical and genetic connections between white and black families which could break racial barriers and help uncover the family history knowledge of slavery [172], and the school experience impact on blacks and their families [173].

4.5.2. LGBTQ

The lesbian, Gay, Bisexual, Transgender, and Questioning (LGBTQ) parameter captures the families and home issues associated with these distinct groups. The keywords that were detected by our model include gay, transgender, bisexual, sex, male, heterosexual, lesbian, homosexuality, parent, adult, health, gay bisexual, gay man, social, study, queer, sexual gender, female, youth, and father. Academic documents under this parameter discussed various issues related to LGBTQ including the behaviour of lesbian, gay, bisexual, and transgender couples alters gender roles in the home [174], the family role in the construction of a person's sexual identity in terms of acceptance and integration into familial roles [175], the public health concern of Sexually Transmitted Diseases (STDs) prevalence among heterosexual males [176], health and social care provision concerns related to LGBTQ individuals [177], and transgender youth and medical fertility preservation to avoid infertility or biological sterility [178].

4.5.3. Political Affiliations

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This parameter shows how the political candidate's identity is framed and which information is most valuable to voters in order to vote for him or her. The effects of socio-political change on family relationships, especially for LGBTQ individuals. As well as a political perspective on COVID-19. Our BERT model captured some keywords related to this parameter as party, election, political, vote, electoral, voter, presidential, candidate, house, partisan, president, parliamentary, voting, parliament, democracy, congressional, democratic, trump, legislator, and political party. Sclafani [179] explained political identities can be framed using inherited identities derived from family. Rugh [180] explored how migration, race, and class affect Latino household wealth. Finger et al. [181] argued that voters' evaluation of a politician is influenced by family composition, particularly parental status when supporting a candidate. Furthermore, their communities, the place of worship, and the schools their children attend all affect how voters perceive them. As a result of the COVID-19 public health crisis, Wang et al. [182] noticed that Democratic governors issued stay-at-home orders more quickly than Republican governors. On the other hand, Shepherd et al. [183] believe that the stay-at-home order assists researchers in understanding political beliefs and they examined the political worldviews that shaped their trust in public health institutions, their views about COVID-19, and their methods of prevention. Gonzalez et al. [184] asserted that families play an especially important role for LGBTQ people during times of socio-political change. In their study, they examined the impact of the 2016 US presidential election on LGBTQ people's relationships with their families and identified three distinct themes: family divisions, family cohesion, and no change.

4.5.4. Mexican Immigrants

This parameter covers issues related to families and homes that are specific to Mexico, Mexican people, and Mexican immigrants in the US. The keywords in this parameter include immigrant, parent, adolescent, migrant, migration, study, mother, familism, health, mexican immigrant, female, experience, social, transnational, human, adult, policy, and mexican american. For example, Fuller-Iglesias [185] believes that migration affects family members, especially the wives and children of migrants. Tsai et al. [186] explained the relationship between parental stress and adolescents' emotional support for family members. On days when parents were experiencing family stressors, adolescents were more likely to offer support to other family members than to their parents. For Mexican family constellations therapy, Duncan [187] claimed that non-native therapeutic practice may align with local cultural frameworks to promote new forms of therapeutic engagement and social interaction.

4.5.5. Canadian & Immigrants

This parameter includes keywords, Canadian, family, study, child, social, indigenous, policy, community, health care, research, home care, practice, mental, adult, article, life, patient, physician, mental health, and immigrant. The documents under this parameter captured some issues related to Canadian people & immigrants in general such as Schieman et al. [188] studied the influence of work-family multitasking on Canadian and American Workers and identified four main factors: Social status, employment type, work location, and schedule, and job demands and resources. Laplante [189] explained that families in Canada are at risk due to changes in values, gender relations, and the legal framework dealing with family life. These changes still affect many families today. As a result, Canadian society is moving toward immigration. Burrage et al. [190] focused on trauma healing in the Indian Residential School system of Canada and found that a strong sense of belonging to family, culture, and community is critical to helping and healing after being physically, psychologically, or sexually abused. Prentice [191] believes that the care of children is one of the biggest challenges facing Canadians. Rural families encounter inaccessible services, high fees, and a lack of qualified early childcare educators. The impact of this scenario is detrimental to all Canadians, but the impact on Aboriginal children and families is particularly grave. Considering language retention, Nault [192] attested

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that cultural factors including identity, consumption, and values play a crucial role in maintaining continuity.

4.5.6. Syrian Immigrants

This parameter explores the following keywords refugee, syrian, immigration, deportation, asylum, syrian refugee, migration, migrant, family, country, resettlement, displacement, camp, child, detention, mental health, home, asylum seeker, interview, and article. It captures issues related to Syrian people and immigrants such as how the home is associated with feelings of belonging and meaningful relationships [193], how the material and symbolic conditions of living in exile reshape the concept of home in long-term [193], how the refugee camps can be as "homes" in view of their persistence and resilience [194], risks and limitations children and their parents can be subject to due to undocumented immigration status [195], the concept of Multigenerational Punishment and how strong social ties, constant interaction, and connections make it common among families [195], trauma exposure and post-traumatic stress symptoms among Syrian youth refugee and the need for school- or family-based intervention to address this issue, in particular within a Syrian Muslim cultural context, to distinguish between the needs of girls and boys [196], psychosocial and environmental stressors as well as perceived barriers to health care the parents of Syrian refugee children face [197], and harm of the loss of educational opportunities causes by this kind of crisis to adolescents and its long-term devastating outcomes [198].

4.5.7. Germany

This parameter is represented by keywords including german, family, war, home, study, article, social, life, history, germany, child, work, research, author, migration, country, century, health, refugee, and memory. Several dimensions are captured by our model related to Germany including post-war issues, childlessness and birthrate decline, educational opportunities, leaving and returning to parental homes, and identity development and international mobility challenges in adolescence. For example, Mouton [199] discussed the great struggle to provide for the missing, lost, and displaced children who suffered in post-war Germany and how successful the efforts to care for these children were [199]. Hill [200] believes that childlessness has become a reality for more women in Germany as the birthrate declines. Consiglio et al. [201] observed that even though equal opportunities are a priority for German policymakers regardless of an individual's socioeconomic background, children from families without academic backgrounds continue to be disadvantaged in educational opportunities. Berngruber [202] noticed that young adults who are financially and socially independent are less likely to return to their families of origin. Further, growing up in a two-parent household in West Germany, as well as having a strong father-son bond, increases one's chances of returning to the parental home after moving away. Greischel et al. [203] found that international mobility affects adolescent identity development and changes in social relationships.

4.5.8.Sweden & Finland

This parameter covers concepts about home, family, child, parental, language, life, education, social, and health related to Sweden and Finland. Academic research under this parameter discussed various aspects including home construction, family theory, parental relation with their children, etc. For example, Yakovleva et al. [204] stated that in family theory, in the Finnish paremiologically, there are three main levels: Nuclear Family, Androcentric Family, and Affinal Family [204]. Edman [205] confirmed that culture played a significant role in constructing a home in Sweden. For the Russian-Swedish families, Abreu Fernandes [206] stressed the importance of embedding mother-child communication in mundane activities such as family activities and home language lessons. A study by Gauffin et al. [207] in Sweden found that a dysfunctional family environment can lead to an increased likelihood of adult alcohol-related illnesses for children. Further-

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more, growing up in a low socioeconomic position household will increase a child's vulnerability, including low school performance, low education levels, poorly-paid, stressful jobs, occupational hazards, and poor general health. Several studies under this parameter focused on family engagement with their children, especially for Finnish Parents. A study by Levinthal et al. [208] supports Finnish and Portuguese parental engagement in home learning environments as well as highlighting implicit beliefs about learning. Additionally, parents' involvement at home can be categorized into three categories: involvement with their child's holistic development, involvement with their child's education, and involvement with their child's physical health. Kosunen et al. [209] believe that it is the parent's responsibility to set up preferences in school choice for their children's education.

4.5.9. Italy

The families and homes research related to Italy have focussed on dimensions including psychopathology of children, sociocultural and socio-political factors, factors for employment prospects, the significance of house architectures for Italians, and others. The parameter includes the following keywords, italian, family, social, study, work, child, migrant, language, article, history, parent, home, migration, house, immigrant, lockdown, gender, economic, and life. Examples of research captured under this parameter are as follows: Zanfi et al. [210] noticed that Italian families place great significance on their family house and its relationships with peculiar welfare models and families consider their houses to be their sole inheritance. Pepe et al. [211] found that family dysfunction might cause Italian children with psychosomatic conditions. Curdt-Christiansen et al. [212] studied the difficulty for transnational families to develop literacy in the home language for their children due to socio-cultural and socio-political realities [212]. For Italian jobseekers, Lo Presti et al. [213] discovered that employment prospects are more strongly influenced by personal dispositions than by external factors such as life circumstances. In contrast to culture, family support, and previous job experience, personality, self-evaluation, and educational level were the most important factors of employability. Castori et al. [214] conducted a seismic analysis on an Italian fresco and stressed that the vulnerability of a historical monument should be assessed not only with regard to its architectural and structural components but also with regard to its movable and immovable artistic contents [214].

4.5.10. Spain

This parameter covers concepts about spanish language, bilingual, family, vocabulary, spanish speak, study, heritage, speaker, literacy, home, parent, home language, proficiency, linguistic, read, social, and learner. For example, Abchi et al. [215] found that as Spanish heritage speakers grow up in multilingual environments, their syntactic complexity in written narratives does not differ greatly from that of full Spanish speakers. By studying two old stone-based houses in the Philippines that were resettlement by the Spanish colonists, Barretto-Tesoro [216] concluded that both the artefacts and the architectural style of the houses indicate when it was built. Blair and Lease [217] mentioned that a combination of linguistic and social factors can contribute to differences in pronunciation of voice segments over generations of Spanish heritage speakers. During Covid-19, Pizarro and Ordóñez [218] explored the psychological effects of confinement on the mental health of Spanish children and teenagers, at a time when children and teenagers were locked up in their homes. It was found that children and adolescents experienced emotional and behavioural changes during confinement. Suárez-Perdomo et al. [219] studied how personal learning environments offer parents an innovative and successful way to learn that can ultimately promote a child's positive development and family wellbeing in Spain. Repke et al. [220] found that the social networks of immigrants, residing in Catalonia, can reflect psychological adjustment and sociocultural integration, as well as bicultural identity integration. Such networks positively predicted immigrants' adaptation and cultural identity overall.

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4.5.11. China

This parameter includes keywords, Chinese, family, child, study, social, housing, chinese family, home, market, parent, policy, culture, immigrant, migrant, filial, firm, government, economic, relationship, and research. Researchers studied various topics related to China and Chinese people, in the following we give examples of research captured by our model under this parameter. As China is a state with a father-figure leader who represents the country as a family, Steinmüller [221] believes this clearly illustrates the relationship and feeling between the leader and the country. The meaning of housing in China, especially for young people, and its role in society as a whole, as explained by Xiaoming [222], is demonstrated by its relationship to the subsystems: state politics, its culture, market economics, and urbanized at-home lifestyles. These four aspects serve as a reflection of Chinese society today. Chen [223] assert that middle-class Chinese families believe higher education is necessary in order to develop their socialist ideal personas and make significant contributions to society. Gao [224] compared two Chinese cultures in terms of life index and antecedents. An association between socioeconomic inequality and life satisfaction has been found in late childhood and adolescence explained by Zou et al. [225].

4.5.12. Japan

This parameter covers issues related to families and homes that are specific to Japan and Japanese society. The issues in this parameter include care, language, family, home, child, work, caregiver, culture, life, health, medical, student, old, house, adult, and social. For example, Li [226] explains that a stable and safe home remains one of humankind's most fundamental needs in Japanese Americans' literature**.** Gould [227] studied the placement of Japanese Buddhist altars in their western homes and how that emphasis on that the home is a place to practice the domestic religious sphere by decorating it with concrete artefacts. Moreover, Uriu et al. [228] explained how artefacts can be used to support everyday domestic rituals of remembrance and memorialization. Ono [229] found that in rural Japan**,** cultural values of landscape visibility are major factors that contribute to its resident's daily life [229]. Choe [230] pointed out to a translator that can refer to the unfamiliar emotional language used in the original text also such topics as child murder and mental illness. Nakamura [231] explained that strong parental beliefs about the importance of language development led them to insist on raising bilingual children who speak a specific language and also practice their home literacy activities regularly. LINE, a mobile social media platform that has become dominant in Japan, is explored by Ohashi [232]. This article specifically discusses its use for preserving familial ties, especially between matriarchal connections in Japanese families. Asai et al. [233] discussed the formal childcare and informal childcare provided by grandparents in Japan and if the change in the household structure did not occur, the growth of childcare availability would have increased the maternal employment rate. Kayama and Yamakawa [234] pointed out that Japanese families who are acclimated to a new culture (in the U.S.) encounter various psychosocial challenges, including a loss of a sense of belonging, which can result in social isolation and withdrawal.

4.5.13. Australia

This parameter explores the following keywords australian, australia, homelessness, housing, homeless, home, health, social, study, parent, young, research, mental, community, aboriginal, work, policy, article, school, and interview. This is the largest in terms of the number of documents and most diverse parameter in the Communities & Nations macro-parameter and this may be indicative of higher research activity in Australia about socioeconomic issues of its own people. For example, Ou et al. [235] found that in Australia family's socioeconomic status, health insurance coverage, and region of residence strongly influence the use of general practice services. Furthermore, Twomey et al. [236] claim that socio-economic class intersects with gender and ethnicity in structuring both the ability to pursue further education and the experiences that follow. Rowan et al. [237] found that Australian teacher preparation and education is effective at preparing teachers for many

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different fields of work that interfere with their ability to teach students from diverse cultural, linguistic, and socioeconomic backgrounds. However, Rocha [238] believes that international students living in Australia face precarious lives as a result of migration. They have transitioned into adulthood, living away from home and without their families therefore they pray for permanent residency, and they believe that every obstacle and achievement is God's gift to them. Stahl et al. [239] explained how experiences with a social life are a significant determiner of academic success as well as for future employment.

Brett et al. [240] studied the characteristics of the Australian elderly group and found that most injuries are caused by falls and hospitalization in older adults. Davison et al. [241] noticed the need to provide psychological services to older adults within aged care services, including residential care and homecare. The link between the home environment and obesity-related behaviours among children in Australia is discussed by Hardy et al. [242] and some of these behaviours are prevalent among children from certain cultural backgrounds. In light of the discussion surrounding sexuality education, Robinson et al. [243] found that most parents agree that it should be undertaken collaboratively between schools and families. The effect of adverse childhood experiences and trauma are investigated by Middleton et al. [244] and they found that young people who run away from home or experience homelessness are also more likely to be victimized by sex trafficking. Therefore, vulnerable young people require prevention and early intervention. Moreover, children in out-of-home care (OOHC) are claimed by Devlin et al. [245] to tend to have poor mental health and a poor sense of well-being. A behavioural and emotional intervention aimed at reducing psychosocial impairments and social problems is a beneficial approach to help them. During the COVID-19 pandemic, Beck et al. [246] believe that Australians have followed the advice of the government to avoid travel and social contact. Craig et al. [247] found that COVID-19 restrictions affected gender equality at home. Dual-earner households tend to have a higher level of gender equality and spend more time with their children. With everyone's workload increasing, there is a high level of subjective time stress.

4.6. Resources & Management

The macro-parameter Resources & Management concerns about establishing home resources and managing families and homes. It discusses aspects related to families and homes economics and operations. It comprises eight parameters House Pricing & Affordability, Architecture & Heritage, Work & Employment, Family Business, Agricultural Farming, Animal Farming, Tourism, Energy Management, Water Management, and Disasters.

4.6.1. House Pricing & Affordability

The House Pricing & Affordability parameter is regarding estate prices and different factors that affect the pricing and family affordability. The keywords that were detected by our model include house price, housing, house, market, real estate, estate, housing price, model, housing market, hedonic, prediction, urban, price prediction, mortgage, datum, residential, land, income, and buyer.

An exploration of housing prices in Malaysia was conducted by Osmadi et al. [248], revealing that they are affected by a multitude of factors, including structural, neighbourhood, and locational factors. Property prices must be monitored and controlled by the government. Li et al. [249] investigated macroeconomic parameters that may affect real estate prices and designed a prediction model for price fluctuation. The energy effects on house pricing were investigated by Cespedes-Lopez et al. [250]. They confirmed that qualifications for energy have an effect on the asking price of housing. Moreover, Shi [251] stated that assessments of residential real estate are important to financial institutions and municipalities that depend on property taxes as their primary source of revenue. A study to discover the nature of the relationship between housing type and prices across different regions in the UK is conducted by Hudson et al. [252].

4.6.2. Architecture & Heritage

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The Architecture & Heritage parameter captures various dimensions of house design including architectural design [253], archaeology of houses [254], antiquities [255], sites and locations [256], materials and techniques [257], [258], and some specific heritage homes [259]. This parameter mainly covers articles that discuss the mentioned aspects of house design rather than the relation between the house architecture and their relationship with and impacts on families. We could have removed this parameter from the analysis, however, we decided to keep it with the intention that in the future this topic of the relationship between families and house architecture and heritage can be explored. Examples of research papers under this parameter, Fidanoski [254] studied the Neolithic site at Cerje-Govrlevo in Macedonia. The Balkan Neolithic was characterized by many houses constructed with great architectural skills. A variety of Neolithic artefacts had been discovered within their interiors that reflected their high cultural, economic, and social achievements. Visual analysis of the materials and techniques used to paint the wooden doors in Miyara dunchi was conducted by Kyan et al. [257]. They claimed that in some cases, this will help determine the identity of the painters, whether there are any new painters, whether extravagant pigments were used and how well they may have been conserved.

4.6.3. Work & Employment

The Work & Employment parameter covers topics related to jobs, work environment, and work-family conflicts. Keywords under this parameter include work, employee, work family, job, family, family conflict, worker, work home, workplace, job satisfaction, study, life, stress, relationship, resource, organizational, work life, supervisor, employment, and home.

Qiu et al. [260] stated that working-family conflict is influenced by the family's boundary characteristics, as is life satisfaction. Similarly, Schieman et al. [261] attested that work-family boundaries are being blurred due to work pressures and role-blending activities. Alacovska [262] focused on creative workers and followed the 'ethics of care' perspective in exploring, acknowledging and valuing the relational, communal, moral, interpersonal, and interdependent aspects of creative work. On the other hand, Liu et al. [263] believe that educational level, job training, and years of experience are not enough to measure effective work behaviour. It is more efficient to connect individual performance to the goals of the company. Since telework from home becomes increasingly important, especially for software engineers, and by comparing office work before and after the pandemic, Smite et al. [264] found that it is possible to determine the differences in productivity between the two periods [264].

4.6.4. Family Business

The Family Business parameter contains keywords business, family firm, family, family business, corporate, company, governance, non-family, social responsibility, corporate governance, corporate social, family ownership, ceo, study, social, financial, sustainability, firm performance, relationship, and innovation. For example, Sanchez-Famoso et al. [265] explained that firm performance is affected by both family and non-family social capital and the non-family social capital affects firm performance more than family social capital, and it also acts as a mediator between the two. Bandelj et al. [266] clarified how the economy and the family are intertwined, whereby economists and financiers teach the logic of the instrumental market to family businesses. Across family-owned enterprises, there are multiple dimensions of "family support" from psychological and resource perspectives. Among these Munagapati et al. [267] defined five dimensions: developing a vocational identity, role modelling, providing resources, supporting human capital, and social capital. Giannakopoulou et al. [268] stressed the importance of corporate governance in determining operational and financial performance [268]. Goel et al. [269] developed a conceptual model linking family functioning to Human Resources (HR) flexibility and subsequent HR outcomes in family businesses.

4.6.5. Agricultural Farming

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The Agricultural Farming parameter is about families involved in agriculture and farming and the various dimensions related to it such as establishing family farming [270], contemporary agricultural practice [271], agricultural recovery [272], modernizing agriculture [273], and agriculture as a main source of income, employment, and economic activity in rural areas [135]. The keywords that were detected by our model include farms, agriculture, land, family farm, farming, food, crops, households, markets, labor, sustainability, and climate.

4.6.6. Animal Farming

This parameter captures studies related to animal farms. It is represented by keywords including dog, home range, range, habitat, pet, chicken, cat, poultry, bird, specie, pig, home, wild, female, male, meat, owner, article, house, and animal. Looking at the academic documents that belong to this parameter we were able to identify some aspects of this parameter. These include human subsistence behaviour and family consumption [274], biosecurity measures in rearing practices [275], intensive poultry farming [276], factors of positive effects of dog ownership in families [277], and understanding animals' role in ecosystems [278].

4.6.7. Tourism

The Tourism parameter is about relations, effects, opportunities, issues, and challenges of tourism with home and family. Our model detected the following keywords for the parameter: tourism, tourist, hotel, travel, guest, holiday, tourist destination, family, sustainable, airbnb, research, cruise, accommodation, social, second home, local, house, tourism industry, heritage, business. Examples of topics captured by this parameter: kinship tourism and the opportunities it can provide for forming a family [279], the home-sharing mobile platforms such as the Airbnb app which connects tourists and local hosts [280], tourism commercial homes and their important immaterial dimensions in the point of view of Lifestyle entrepreneurs [281], how rural tourism opens up new economic opportunities for local municipalities and counties [282], and personal life, family life, home and adequate housing rights preserved by international human rights law [283].

4.6.8. Energy Management

The Energy Management parameter contains keywords energy, grid, electric, management, electricity, building, solar, energy management, air, appliance, renewable, residential, house, home energy, thermal, battery, indoor, heating, renewable energy, and energy consumption. This parameter capture several important energy-related dimensions including energy usage patterns and various smart home systems that can improve energy consumption such as smart plugs, smart circuit breakers [284], energy efficiency and the renewable energy systems in energy-positive houses [285], decarbonization of housing for mitigating climate change and rising fuel prices [286], and Smart Grids utilities that collect and analyze consumption’s data, and efficiently manage household appliances through advanced (smart) meters [287], [288].

4.6.9. Water Management

The Water Management parameter discloses several important dimensions of water resource management. It is represented by keywords (detected by our model) such as water, water supply, drinking water, sanitation, water quality, household, drinking, supply, water consumption, urban, water treatment, drink water, rainwater, water source, water use, water management, sensor, wash, household water, and toilet. Looking at the documents that belong to this parameter we were able to capture various dimensions of this parameter including environmental sanitation and public awareness [289], water scarcity and insecurity including required interventions [290], polluted water sources and rainwater harvesting [291], water conservation [292], and water consumption prediction models [293].

4.6.10. Disasters

This parameter captures the effects of floods, earthquakes, and other disasters on families and homes. The keywords include flood, disaster, earthquake, hurricane, evacuation, coastal, landslide, community, tsunami, flooding, flood risk, impact, event, natural disaster, recovery, household, storm, housing, and resilience. The overarching theme of the documents in this parameter is the disaster management and decision-making process. For example, Dobson et al. [294] observed the influence of visualizing flood hazards on house purchase decisions and Faulkner et al. [295] claimed that the number of flood-affected homes has decreased due to flood frequency analysis and risk management. To help people recover from trauma such as earthquakes, Warner et al. [296] considered self-efficacy and social support to be coping resources. Chatterjee et al. [297] found that COVID-19 lockdowns reduce noise levels, making low-magnitude earthquakes easier to detect. As natural disasters have become more frequent across the world, Jauhola [298] noticed that the paradigm of "build back better" is emerging as a way to encourage resilience and long-term development.

4.7. Technologies

The Technologies macro-parameter captures parameters related to the utilization of technology in various aspects related to the families, homes, and individuals to improve the quality of life. It captures the following parameters: Assistive Robots, Remote Healthcare, Social Media, Smart Environments, Sleep Monitoring, and Rehabilitation Technologies.

4.7.1. Assistive Robots

The Assistive Robots parameter is represented by keywords including robot, robotic, home, human robot, robot interaction, design, service robot, environment, mobile robot, user, mobile, social robot, assistive, base, social, machine, propose, intelligent, paper, and technology.

Parisi et al. [299] believe that assistive mobile robots have the capability of operating in complex environments such as houses, which are ideal for self-care and independent living applications and enhance the perception of safety among elderly people and prevent them from losing their confidence in their homes. For example, a home biomonitoring robot can sense and recognize human activity in a living environment by using active sensing [300], Humanoid robots can interact with the elderly in nursing homes using spoken dialogue which provides companionship and helps the elderly stay mentally active [301], in the home environment, a robot can assist the elderly in finding misplaced items [302], and the smart housekeeper (an IoT-based indoor mobile robot) can provide housekeeping services and control home appliances and provide indoor security [303].

4.7.2. Remote Healthcare

This parameter highlights the use of technologies in developing better lifestyles and healthcare. The keywords corresponding to this parameter are listed below: health, patient, healthcare, medical, internet, datum, sensor, internet thing, monitor, remote, health monitoring, security, wearable, network, health care, home, cloud, technology, mobile, and privacy.

Bendahan et al. [304] believe that Virtual Care (VC) can make health care more accessible, more affordable, and more available though it may not be appropriate for all clinical scenarios, especially when a thorough examination is required. Jita et al. [305] explained that using IoT technology in in-home care offers a number of benefits including allowing caregivers and physicians to monitor patients remotely, empowering the patients to be more independent, reducing costs and giving loved ones peace of mind. Similarly, Huifeng et al. [306] noticed that IoT devices are used widely to reduce health-related risk factors, such as wearable sensors for a continuous health monitoring system for athletes. However, due to the vulnerability of these wearable devices' data transmissions, privacy and integrity need to be protected. Jan et al. [307] presented a lightweight and secure communication approach for data exchanged among the devices of healthcare infrastructure.

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Alam et al. [308] affirmed that being physically, mentally, and socially healthy can all be enhanced by a healthy living environment and introduced an ambient assisted living framework for predicting the emergency state of psychiatric.

4.7.3. Social Media

The Social Media parameter is represented by keywords including social medium, twitter, facebook, online, user, networking, social networking, tweet, social network, network, news, networking online, youtube, friend, online social, broadband, internet, study, digital, and video.

Looking at the documents that belong to this parameter we were able to capture various dimensions of this parameter including using social networking sites such as Facebook, one can obtain and provide social support, which is widely regarded as important for one's health [309], how social media technologies are being used to enable users to suggest policy changes and solicit support for them [310], the diversity of content generated through ICT provides a platform for a free press to inform and debate instead of being controlled by traditional media channels [311], using the analysis of social media platforms (e.g. Weibo and Twitter) we can better understand the Challenges of Working from Home (WFH) during COVID-19, such as long work hours, family and food commitments, and health concerns [312], and Twitter and social media commentaries revealed two particular trends: first is a result of computational processes that analyse and mine data, and second is a result of financial algorithms that make automated trades [313].

4.7.4. Smart Environments

This parameter focuses on intelligent and smart environments and the Internet of Things (IoT). It is represented by keywords including internet, network, security, internet thing, sensor, automation, wireless, base, technology, intelligent, malware, datum, detection, home automation, attack, and mobile. Looking at the academic research that belongs to this parameter we were able to find a number of topics that capture various dimensions of this parameter. These include sensing, activity recognition, smart system design, wireless network, smart cities and homes, smart home system security, energy management systems, ambient intelligent environment, and virtual assistants. For example, Rabinowitz [314] discussed a sense of home which is a brain-wide phenomenon that involves many factors, including memory, language, emotions, and cognition. A study by Benmansour et al. [315] explained how multi-occupant smart homes could recognize human activity and that identifying residents and recognizing human activities are the two main factors causing difficulty. Shih et al. [316] emphasized the importance of improving the quality of living and reducing construction costs in response to society's economic development needs. Khattar et al. [317] explained how virtual assistants can be installed in any home to turn them into smart homes and as they perform various functions inside the house, it is highly beneficial for visually impaired people. Despite the interference caused by simultaneous transmissions, Halldórsson and Tonoyan [318] established that efficient use of a wireless network requires grouping transmissions into feasible sets, which can be decoded regardless of interference. The way to combine various types of sensor deployment, including smart home sensors, vehicular networking, weather and water sensors, smart parking sensors, and surveillance objects formulate a scalable and efficient system for smart city development and urban planning than existing systems [319]. Yakimov et al. [320] explained how cloud computing can be integrated into industrial and home energy management systems through the IoTs. In Wireless Sensor Networks, Sah et al. [321] believe that energy harvesting and energy management are the most efficient means of charging the batteries of sensor nodes.

Some documents present examples of proposed and developed smart systems. For example, an Intelligent Voice Controlled Devices proposed by Kehua et al. [322] that cope with ambiguous instructions while operating within a multi-device scenario and handle simultaneous commands from multiple users. Sukor et al. [323] developed smart homes

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assist the elderly in living independently and monitoring their daily routines and identifying any abnormalities that arise. Nguyen et al. [324] proposed a novel unsupervised Bayesian nonparametric method for discovering activities in smart homes, which makes no prior assumptions regarding the number of activities. Nevertheless, the model was able to infer these numbers only from sensor data, which makes it an easy model to adopt.

Regarding smart home system security, the use of leveraged 1-wires as a communication channel in home automation systems is suggested by Magre et al. [325] to allow for secure communication by implementing information security. Aliabadi et al. [326] explained that Monitoring Cyber-Physical Systems (CPSes) dynamically is essential and most CPS systems rely on timing, so integrating it with the data and events is essential for achieving high efficiency. Mazuera-Rozo et al. [327] stressed that defining access control policies for smart homes must be made as simple as possible for the smart homeowner to manage users and devices. Muhammad et al. [328] proposed a method to detect multiple attacks simultaneously and to distinguish between different types of attacks. Jiang et al. [329] developed a system that offers real-time monitoring of indoor environmental conditions, as well as the automatic control of home appliances that meets the demands of smart homes.

4.7.5. Sleep Monitoring

The Sleep Monitoring parameter capture dimensions related to monitoring sleeping habits and discovering sleeping disorders. The keywords that were detected by our model include sleep, apnea, sleep quality, sleep apnea, sleep stage, night, polysomnography, sleep disorder, disorder, sleep duration, stage, study, home, sleep, sleep research, wake, adolescent, patient, sleep monitor, and male. Using an in-home sensor-based sleep assessment methodology, it is possible to continuously monitor sleep behaviour and other activities that may affect mental performance in healthy older adults [330]. Electroencephalograms (EEGs) can be used for sleep stage classification, which is highly desirable for many emerging technologies, including telemedicine and home healthcare [331]. Sharma et al. [332] were able to identify six sleep disorder types using electroencephalography signals, including insomnia, nocturnal frontal lobe epilepsy (NFLE), narcolepsy, rapid eye movement disorder (RBD), periodic leg movement disorder (PLM), and sleep-disordered breathing (SDB). Radha et al. [333] designed a home-based system for monitoring sleep using heart rate variability (HRV) may be a cost-efficient and ergonomic alternative to polysomnography. Honda et al. [334] explained how flexible, wearable sensors, such as a mask-borne flexible humidity sensor, can be used to measure respiratory rates during sleep to diagnose sleep apnea symptoms.

4.7.6. Rehabilitation Technologies

This parameter captures studies related to home-based training and rehabilitation systems. It consists of the following keywords: rehabilitation, exercise, patient, parkinson, game, stroke, training, disease, home, base, therapy, motor, virtual, home base, pd, week, feedback, wearable, and upper limb. Looking at the academic documents that belong to this parameter we were able to identify some aspects of this parameter. These include cognitive rehabilitation using computers is a promising way to update working memory in Parkinson's disease patients [335], the use of an Automated Rehabilitation System (ARS) for physical rehabilitation in rehabilitation clinics (e.g. knee and hip replacement clinics) [336], variety of rehabilitation games (e.g. the Microsoft Kinect and Nintendo Wii Balance Board) are available for range-of-motion and balance training [337], a stroke rehabilitation game includes players receive haptic feedback based on facial expressions for patients who suffer from a combination of motor and sensory dysfunction and central facial paralysis [338], and designing smart mirrors to assist people who cannot receive professional guidance in standardizing and correcting their actions [339].

4.8. Temporal Analysis

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In this section, our analysis shows the frequency of the research of the parameters over time. Figure 12 to Figure 15 plots the temporal progression of the discovered parameters. The plots are generated automatically using the Bert library. Each figure depicts the parameter name and its number, trace line colour, the x-axis indicates publication year, and the y-axis indicates the frequency of the articles. The period time of the publication year is from 2015 until 2022. A trend might be related to the COVID-19 pandemic in 2021, a major focus of many researchers. For a hint, since the full data for 2022 is unavailable, we can note that the trace line in all figures in 2022 seems to be going down. While we expect increases in the number of published research by the end of 2022.

The Nurturing Families macro-parameter is plotted in Figure 12. It includes four parameters: Nurturing Children, Women, Elderly, and Spirituality. We can see that spirituality is less important than other issues. The highest issues it appears is Nurturing Children followed by Woman, Elderly, and Spirituality. Nurturing Children had a peak value around 1400 in 2021.

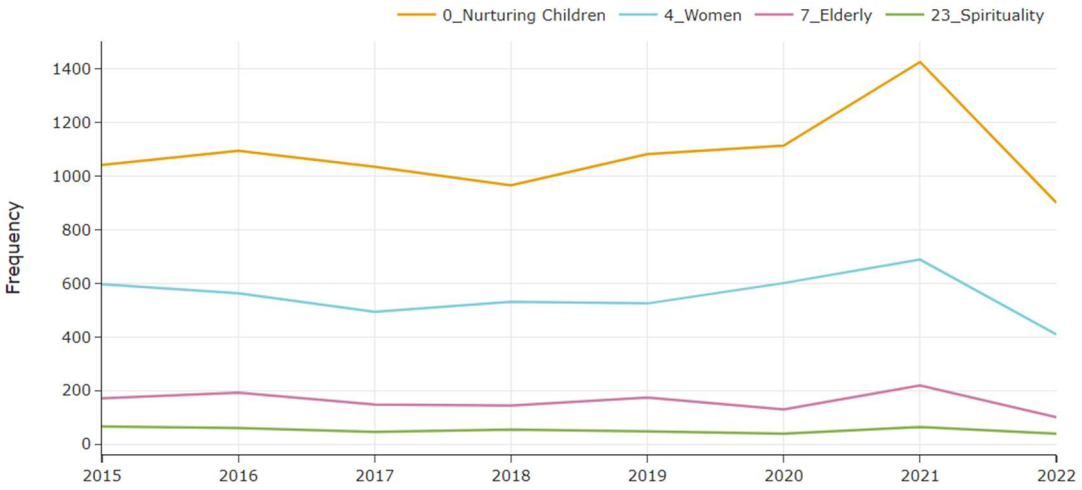

Figure 12 Temporal Progression (Macro-Parameter: Nurturing Families) (Data Source: Scopus).

The temporal progression of the macro-parameter Health & Lifestyles which includes 11 parameters is shown in Figure 13. Among the other parameters, cancer parameter was highly discussed in 2021 and had the highest peak value of more than 800. We note that in 2019 as the time of spreading COVID-19 pandemic might affect in the number of research of some parameters like Nursing & Homecare, Food, Pandemics.

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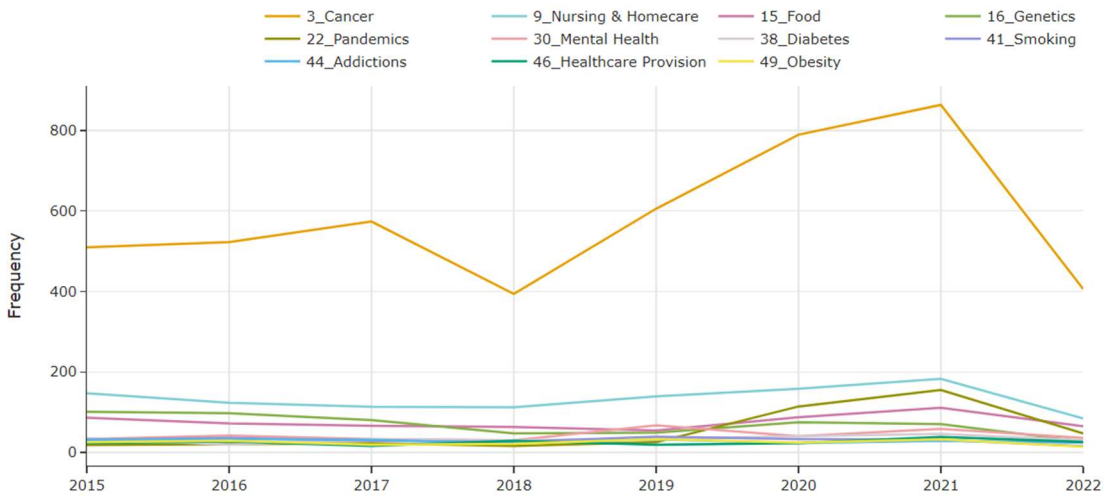

Figure 13 Temporal Progression (Macro-Parameter: Health & Lifestyles) (Data Source: Scopus).

Figure 14 plots temporal progression for 13 parameters which formulate the macro-parameters Communities & Nations. According to the figure, the Australia parameter frequency is the highest activity compared to the other parameters, and more research has been done on it. Followed by Germany, Political Affiliations, China, and Canada.

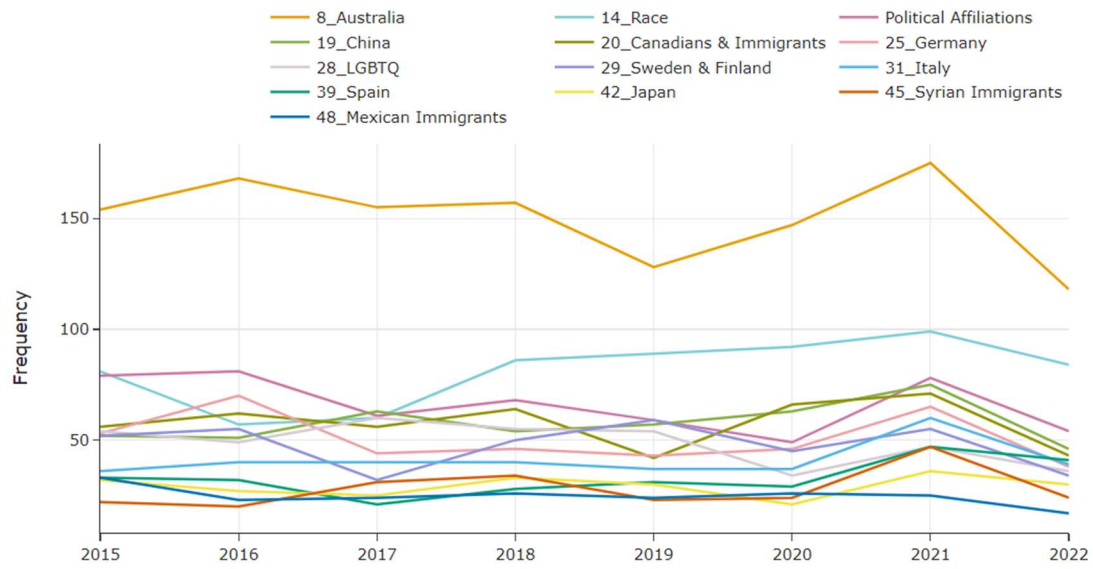

Figure 14 Temporal Progression (Macro-Parameter: Communities & Nations) (Data Source: Scopus).

The temporal progression of the macro-parameter Resources & Management, which includes tenth parameters, is shown in Figure 15. We observed that all parameters have similar activities except the Energy Management parameter which has the highest activity referring to its important. For the parameters Agricultural Farming and Animal Farming, there is a few papers that has publication date on 2023.

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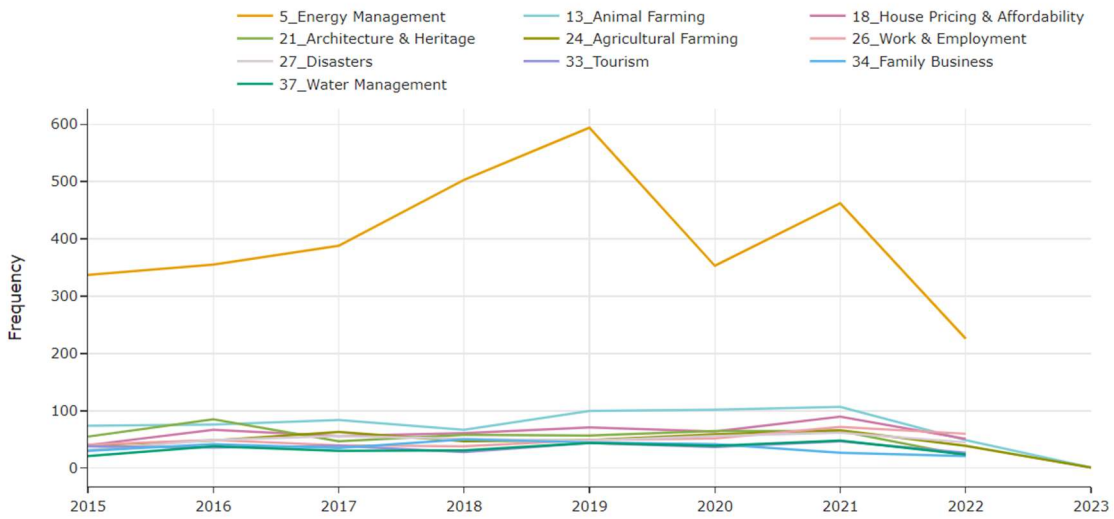

Figure 15 Temporal Progression (Macro-Parameter: Resources & Management) (Data Source: Scopus).

Figure 16 shows the temporal progression of the Technologies parameters. More research has been done on the Smart Environment parameter than other Technologies parameters. It appears that there is drop in 2020 in the Smart Environment research activities which might be due to the COVID-19 pandemic as more research focus on the pandemic itself.

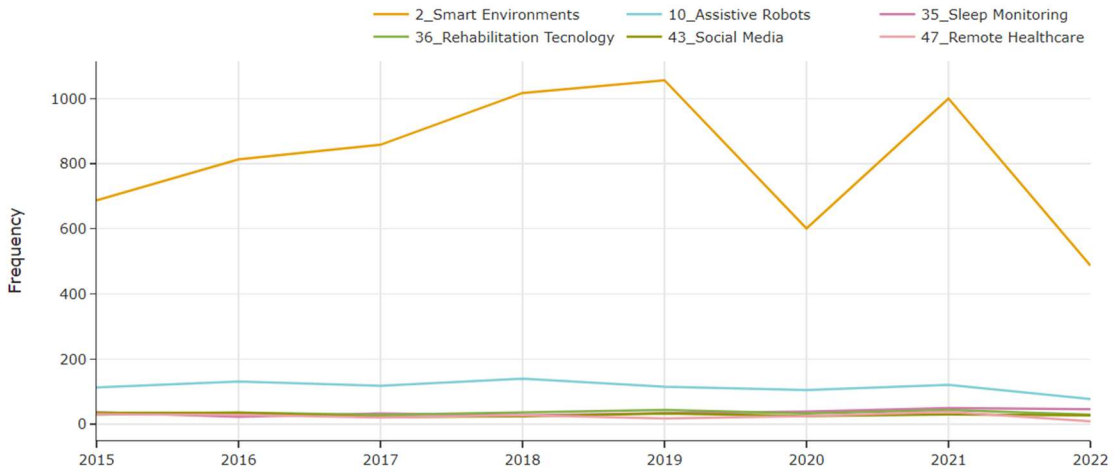

Figure 16 Temporal Progression (Macro-Parameter: Technologies) (Data Source: Scopus).

5. Parameter Discovery for Families & Homes (Public: Twitter)

The purpose of this section is to discuss the parameters that our BERT model detected from Arabic Twitter dataset which includes 930,110 tweets. it reflects the view of public in Saudi Arabia about Families & Homes. The parameters are grouped into three macro-parameters: Nurturing Families, Resources & Management, and Challenges. We provide an overview of the parameters and taxonomy in Section 5.1. The quantitative analysis is discussed in Section 5.2. Subsequently, we discuss each macro-parameter in separate sections, Sections 5.3–5.5.

5.1. Overview and Taxonomy

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Our Bert Topic modeling detected a total of 226 clusters and reducing it to 25 clusters based on the Arabic twitter dataset. Then after the analysis of all the clusters we found 3 clusters are irrelevant and we exclude them from our analysis for different reasons. The cluster 14 was removed since it was about hate speech against particular people, while clusters 15 and 18 were excluded due to their unclear themes. The remining is 22 clusters called parameters. The parameters were grouped into three macro-parameters based on our domain knowledge, similarity matrix, hierarchical clustering, and other quantitative methods. In Section 3, we discussed the methodology and process used to discover parameters and group them into macro-parameters.

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Table 2 lists the parameters and the macro-parameters detected by our BERT model from the Arabic twitter dataset with its top 10 keywords. The Keywords are sorted according to their importance score. We grouped the parameters into three macro-parameters represented in column 1. These are Nurturing Families, Resources & Management, and Challenges. The parameters and its IDs listed in column 2, 3 respectively. The fifth column highlights the top 10 keywords associated with each parameter. This list of keywords is primarily reflected and represent the theme of the parameter. As part of our effort to gain a better understanding of the parameters, we examined the tweets associated with each parameter. As shown in the following table, the Arabic keywords are listed along with their English translations. We have also contextually translated the Arabic tweet's content so that English readers can better understand the content.

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Table 2 Macro-Parameters and Parameter for Families & Homes (Data Source: Twitter).

Macro	Parameter	ID	Keywords
رعاية الأسرة Nurturing Families	امتنان Gratitude	0	نعمه، الناس، بيوتنا، الوطن، اننا، ابناء، الحياه، نقدر، صغار،الدنيا Blessing, People, Our Homes, Homeland, That We, Sons, Life, Appreciate, Young, World
	التعليم والمجتمع Education & Society	8	التربيه، وزاره، العربيه، الأطفال، الاجتماعيه، المملكه، المدرسه، الابتدائيه، التعليميه، المجتمع Education, Ministry, Arabic, Children, Social, The Kingdom, School, Primary, Educational, Society
	البحث عن الزواج Seeking Marriage	23	سعوديه، جميله، الجنسيه، موظفه، البشره، الوظيفه، لايوجد، بزواج، الزوجيه، الاجتماعيه Saudi, Beautiful, Nationality, Employee, Complexion, Job, Not Exist, With Marriage, Marital, Social
	رعاية قيم الأسرة Nurturing Family Values	13	رجعت، رجعوني، رمضان، رعايه، تتملك، روحي، وحفظه، الوالدين، راجعه، رياض Get Back, Bring Me Back, Ramadan, Take Care, Own, Take Possession of My Soul, Preserve It, Parents, Take It Back, Riyadh
	الترابط الأسري Family Cohesion	6	بيتنا، البيت، اخوات، العائله، عائلتي، بيتك، العايله، مسكن، الأطفال، أبناء Our House, House, Sisters, Family, My Family, Your House, Your Family, Dwelling, Children, Sons
	رعاية الأطفال Nurturing Children	2	شخص، طفل، تقول، بيتك، طيب، شغل، البنت، تعرف، دخل، ممكن Person, Kid, Say, Your Home, Ok, Work, Girl, Know, Enter, Possible
	الرفقة الحسنة Good Companionship	20	بيتنا، سطح، سوريا، صاير، صرت، صديق، صاحب، صوره، اطفال، صغار Our House, Roof, Syria, Became, I Became, Friend, Owner, Picture, Children, Young
	الزيارات العائلية Family Gatherings	17	دخل، بيتنا، دائما، اخوات، داخله، دكتور، دكه، دقايق، مجلس، العيله Entered, Our House, Sisters, Doctor, Bench, Minutes, Sitting Room, Family
	الاجتماع بالجدة Gatherings with Grandmothers	9	جدتي، جديد، جنه، جعلنا، جمعه، جاك، جاب، جميله، جمالك، جلسه Grandmother, New, Paradise, We Made, Gather, Come to You, Bring, Beautiful, Your Beauty, Gathering
	أنشطة ترفيهيه Entertainment Activities	10	فعاليات، فخر، فديت، بيتكم، فوازير، فاتنة، فطار، فقدان، فلتحيا، بالعز Events, Pride, Redeemed, Your House, Riddle, Beautiful, Breakfast, Loss, Long Live, With Honor
الموارد والإدارة Resources & Management	تمويل المنزل House Financing & Affordability	7	تتملك، تمويل، تملك، تربيه، تمويلك، تمول، طلعت، عقار، تعالي، تويتر Own, Finance, Hold, Raise, Investment, Your fund, Went Out, Real Estate, Come, Twitter
	تنظيف المنزل Home Cleaning	11	تنظيف، خزانات، سجاد، منازل، مفروشه، وحديثه، مكيفات، التشطيب، مسابح، استراحات Cleaning, Tanks, Carpets, Homes, Furnished, Modern, Air Conditioning, Finishing, Swimming Pools, Rest Houses
		16	التنظيف، الموجوده، خدماتنا، شبابيك، موكيت، الواجهات، بافضل، حسابنا، كنب، منازل Cleaning, Existing, Our Services, Windows, Carpets, Interfaces, Best Way, Our Account, Sofa, Homes
		19	غريبه، بساطك، غرفتي، ترتيب، مزعج، غبار، غابت، غازي، غبنه، غداي Strange, Your Rug, My Room, Organize, Annoy, Dust, Absent, Gazi, Overcome, Lunch
		21	مكيفات، منازل، خزانات، مبيدات، شركه، مكافحه، بالخرج، نظافه، للتنظيف، فراشات Air Conditioners, Homes, Tanks, Pesticides, Company, Combat, In Al-Kharj, Cleaning, For Cleaning, Butterflies
	مكافحة الحشرات Pest Control	22	مكافحه، الحشرات، مبيدات، الفئران، تركيب، الذهبيه، المبيدات، صراصير اشواك، العقارب Anti, Insects, Pesticides, Mice, Installation, Golden, Pesticides, cockroaches, Thorns, Scorpions
	تنظيف المسابح Swimming Pool Cleaning	24	تنظيف، منازل، خزانات، الذهبيه، تعقيم، شركه تنظيف، السيراميك، بالمدينه، مسابح، والحناكيه Cleaning, Houses, Tanks, Golden, Furnished, Cleaning Company, Ceramics, In the City, Swimming Pools, The Hanakia
تحديات Challenges	العمل والتراخي Work & Indolence	1	شغل، شخص، شكلي، شيخ، شوارع، شجره، شركه، شوفي، تنظيف، بيتك Work, Person, Formal, Old, Streets, Tree, Company, Shop, Cleaning, Your Home
	الخمول البدني Physical Inactivity	5	البيت، بيتنا، بيتي، طفل، برا، سنة، الاطفال، الف، ساعه، الوداد Home, Our Home, My Home, A Child, Outside, A Year, Children, A Thousand, An Hour, Al Wedad
	عادات النوم Sleeping Habits	3	نعمه، الكهف، نرجع، صغار، نروح، بيوتنا، نورت، نحنا، نومه، نشوف Grace, The Cave, We Go Back, Young, We Go, Our Homes, We Light Up, We Sleep, We See
	التحديات الاجتماعية والاقتصادية للمرأة Socioeconomic Challenges for Women	12	زواج، مطلقه، سعوديه، جميله، موظفه، البشره، الوظيفه، قبيليه، الجنسيه، الاجتماعيه Marriage, Divorced, Saudi, Beautiful, Female Employee, Complexion, Job, Tribal, Nationality, Social
	كورونا COVID-19	4	الأطفال، البيوت، بيوتنا، الآخرة، أنزله، الصديقين، مراتب، الأرزاق، والشهداء، كورونا Children, Homes, Our Homes, The Hereafter, Sent Down, The Two Friends ,Ranks, Livelihoods, Martyrs, Corona

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The parameters detected by our tool were used to build a taxonomy (see Figure 17) describing Families & homes. The taxonomy shows the parameters, their macro-parameters. The first level represents the macro-parameters Nurturing Family, Resourcing & Managements, and Challenges. Every macro-parameter contains many parameters. The second level branches represent these parameters e.g., Gratitude, Education & Society, Nurturing Family Values, and Seeking Marriage, etc.

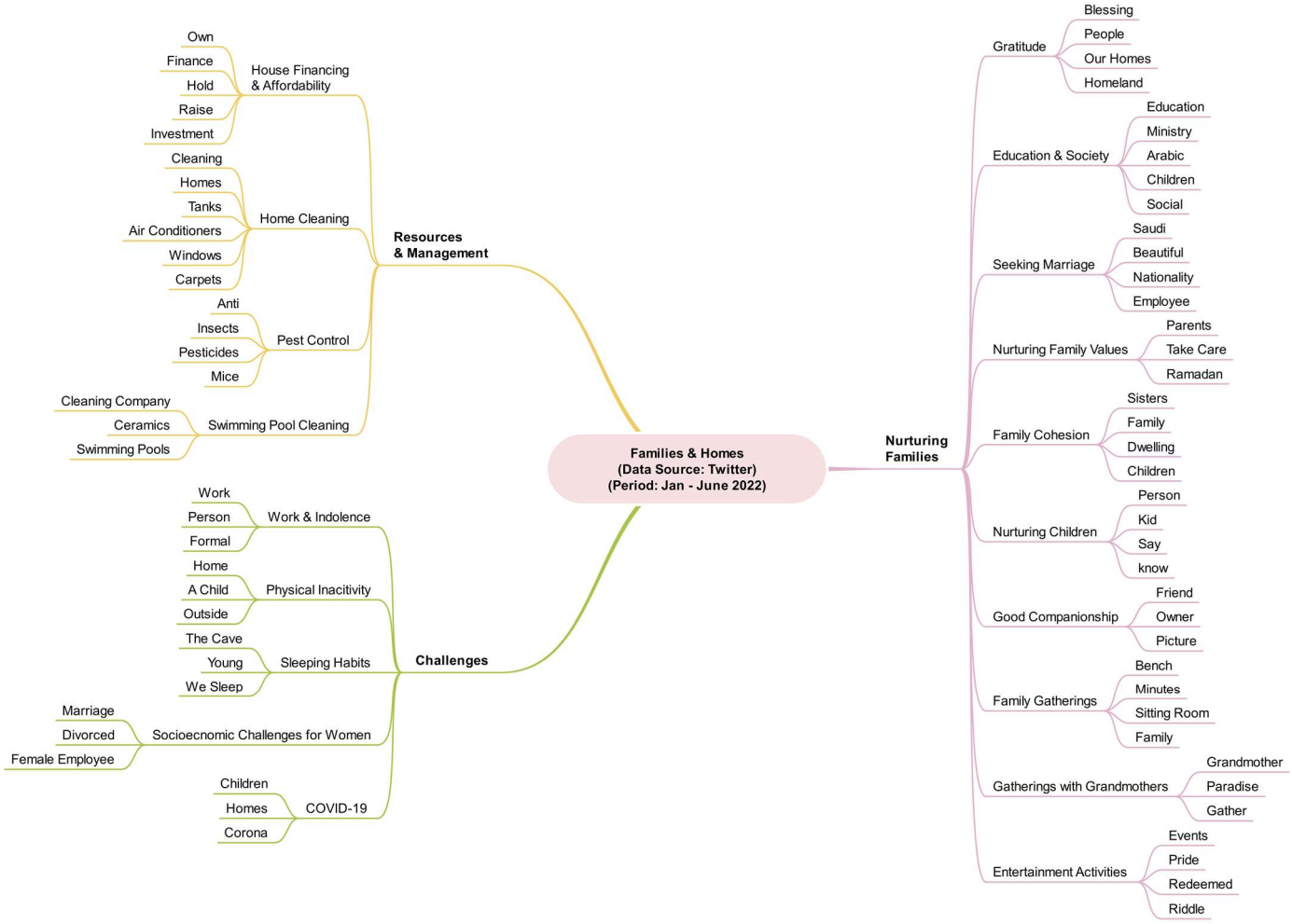

Figure 17 Taxonomy of discovered Home and Families parameters extracted from Twitter data.

5.2. *Quantitative Analysis*

This section outlines term scoring, word scoring, intertopic distance maps, hierarchical clustering, and similarity matrices. Almost all parameters are represented by a group of ten keywords that accurately describe that parameter.

Figures 18 visualize the top 10 keywords for each parameter (see Section 3.9). The importance score, or c-TF-IDF, is used to order the keywords. There are 25 subfigures, and, in each subfigure, the horizontal line shows the importance score, and the vertical line shows the parameter keywords.

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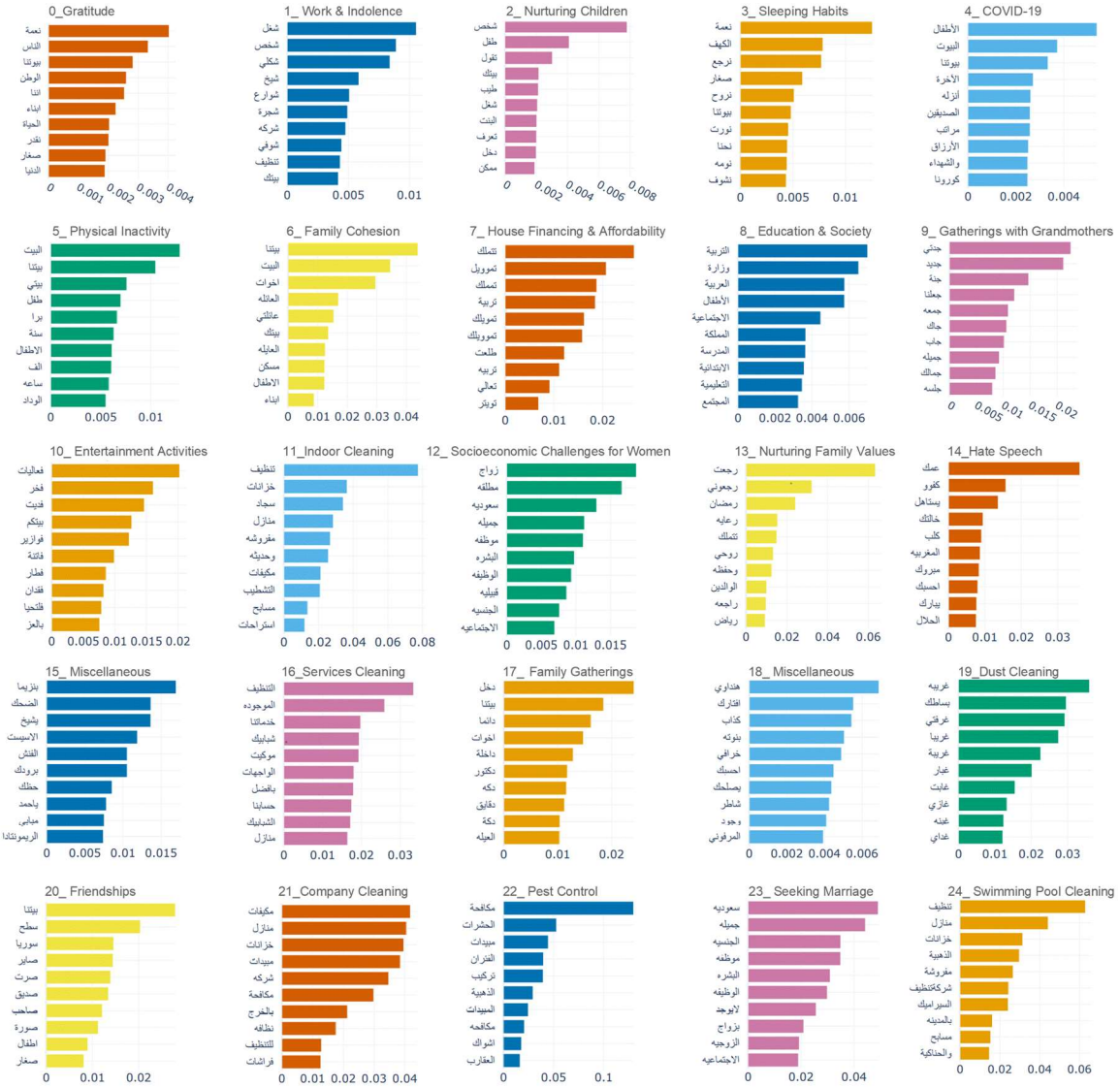

Figure 18 Twitter parameters with keywords c-TF-IDF score (Data Source: Twitter).

As shown in Figure 19, the intertopic distance map is based on a multidimensional scale, in which six groups of parameters are identified (see Section 3.9). The bottom left group has larger parameters size than the other groups. On the right side, there are three parameters of small size. Additionally, there are two clusters with approximately the same size around the middle of the map. However, the parameters were manually grouped into three macro-parameters.

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Figure 19 Intertopic distance map (Data Source: Twitter).

Figure 20 describes the hierarchical clustering of the 25 parameters and systematically pairs them based on the cosine similarity matrix (see Section 3.9).

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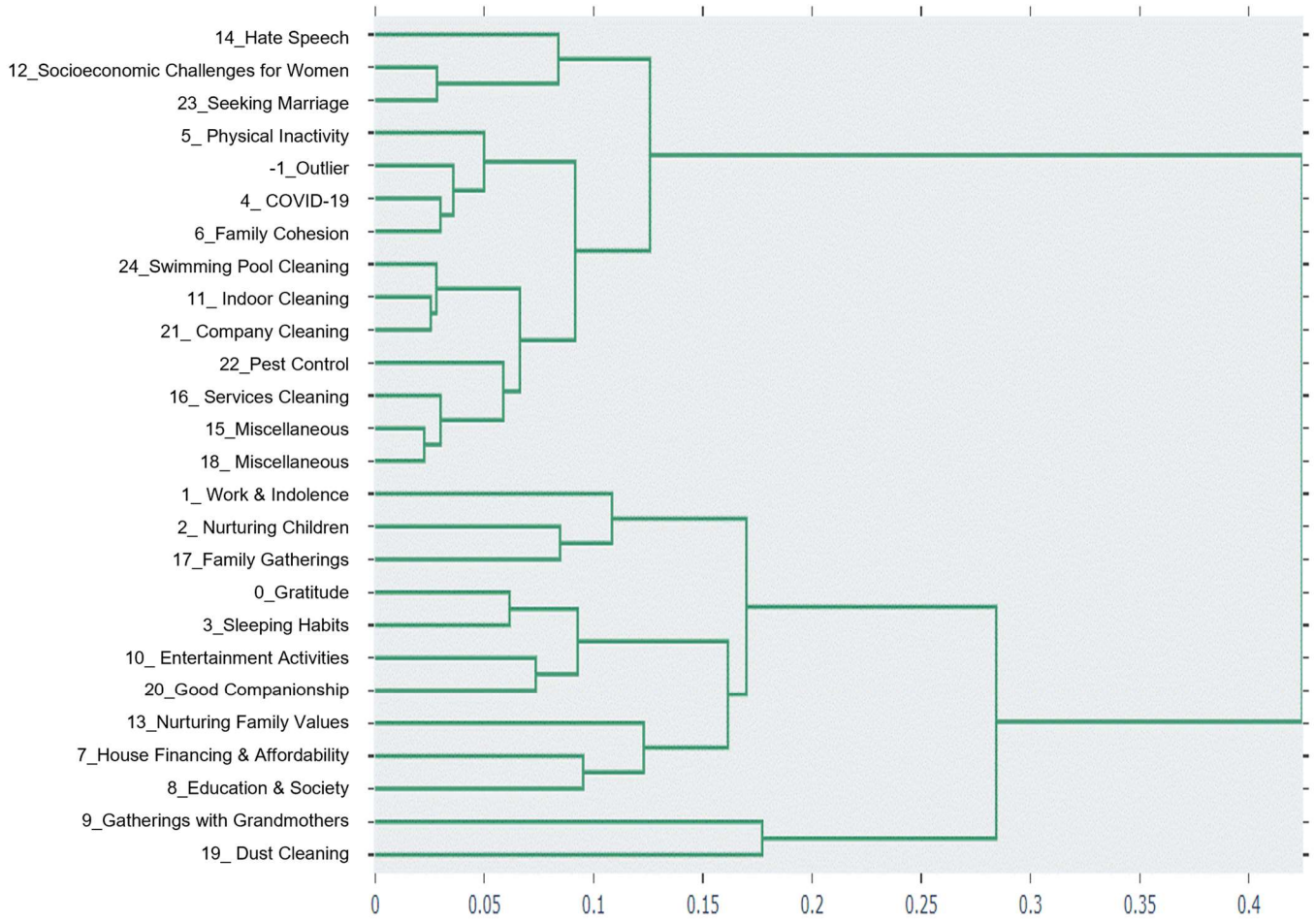

Figure 20 Hierarchical clustering (Data Source: Twitter).

Figure 21 visualizes the similarity matrix among the parameters (see Section 3.9). Light green color represents the least similarity between parameters, while dark blue represents the highest similarity.

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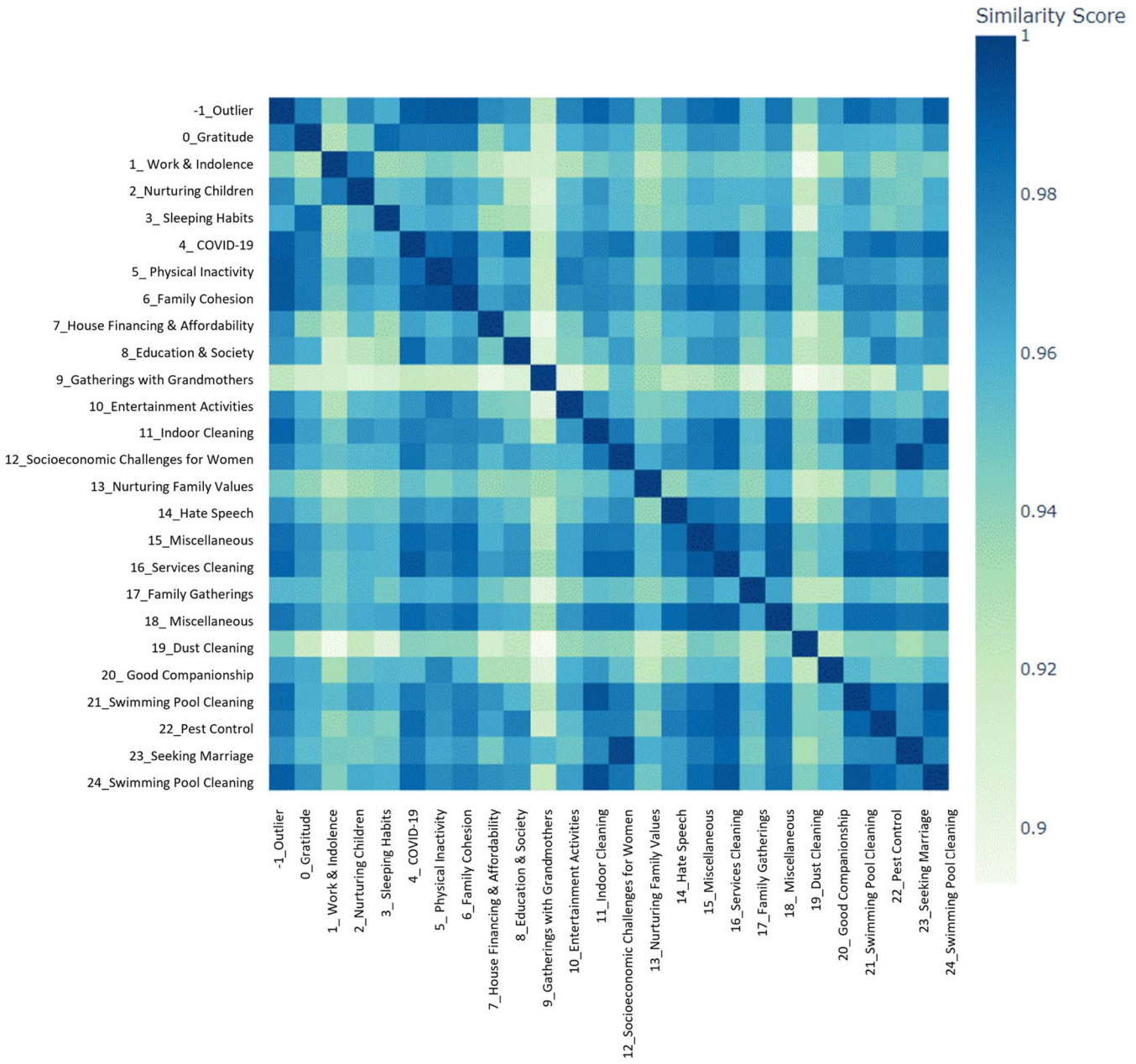

Figure 21 Similarity matrix (Data Source: Twitter).

5.3. *Nurturing Families (Twitter)*

We begin discussing the parameters related to the first macro-parameter, Nurturing Families. It includes ten parameters, which are Gratitude, Education & Society, Seeking Marriage, Nurturing Family Values, Family Cohesion, Nurturing Children, Good Companionship, Family Gatherings, Gatherings with Grandmothers, Entertainment Activities. The first parameter is Gratitude and represented by key terms such Blessing, People, Our Homes, Homeland, That We, Sons, Life, Appreciate, Young, World. The tweets related to this topic for example

"هذا التاريخ العميق يستحق أن يستذكره أبناء هذا الوطن."

"This deep history deserves to be remembered by the people of this country."

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The second parameter is Education & Society. This parameter was referred to by keywords such as Education, Ministry, Arabic, Children, Social, The Kingdom, School, Primary, Educational, Society. There are tweets related to this parameter, for example

" ...الأُمُّ الصالِحةُ إذا صَلَحَتْ صَلَحَ حال الأُسْرة؛ فصَلَحَ المجتمعُ بأسرِهِ."
"Good mother is good for the family; when she is good, the whole society is reconciled."

"... التربية و التعليم عبارة عن مجموعة من التحولات الايجابية المركبة والمتنوعة التي يلحظها الاستاذ بدقة ولا ينتبه لها اولياء الامور الا من رحم ربي."
"...Education is a series of complex and varied transformations that the teacher observes precisely but that parents might ignore."

The third parameter is Seeking Marriage. Several keywords are used to describe it, including Saudi, Beautiful, Nationality, Employee, Complexion, Job, Not Exist, With Marriage, Marital, Social. In our dataset, this parameter represented by the following tweets.

" الزواج مو هدف لكن تحقيقه وتكوين اسره شي جميل ويسبب سعاده."
"Marriage is not a goal but achieving it and starting a family is beautiful and causes happiness."

"الزواج تعاون و مشاركة، في حال اذا كانت الزوجه تعمل، الزوج يقوم بواجبات المنزل و العكس صحيح، في هذه الحالات العناد يسبب الإهمال."
"In a marriage, there is cooperation and partnership, if the wife works, the husband performs the duties of the house, and vice versa, in these situations, stubbornness can cause neglect."

Families are the building blocks of a better society and a stronger nation. People believe that once the family is set right, society will be able to find its way toward unity and progress. Nurturing Family Values is the main thing to build a better and strong family. Our fourth parameter is Nurturing Family Values which represented by keywords such as Get Back, Bring Me Back, Ramadan, Take Care, Own, Take Possession of My Soul, Preserve It, Parents, Take It Back, Riyadh. A sampling of related tweets is provided below

"كلما زادت الصدقة زاد الرزق، كلما زاد الخشوع في الصلاة زادت السعادة، كلما زاد بر الوالدين زاد التوفيق بحياتك"
"Charity brings sustenance, reverence in prayer correlate with happiness, if you honor your parents, your life will be more successful."

"البنت لا تعرف مسؤولية البيت وتحمل رعاية أسرة... علموا بناتكم ان الأسرة بناء يحتاج إلى أسس لابد أن نتعلمها. فالاسرة مسؤولية كبيرة."
"The child does not realize the responsibility of the house and the care of a family... It is important to teach your children that the family is a building that must have foundations. Family is a great responsibility."

"فيه ناس طموحها تصنع عائلة، وناس تشوف السفر والترحال نمط حياة، والناس تشوف التفوق بالشهادات،وناس حتى قومتهم من السرير ونفض الكسل. يشوفونه انجاز"
"The ambition of some is to create a family, another is to travel, and others see excellence in diplomas. People even see getting up from bed and overcoming laziness as an achievement."

Family Cohesion is the fifth parameter. The list of the keywords describe it are: Our House, House, Sisters, Family, My Family, Your House, Your Family, Dwelling, Children, Sons. A lot of tweets, found in our dataset, related to this parameter were like the following tweets

"اللهم عائلتي ومن أحب حتى ظلال الجنه."
"Please God, my family and those who I love in Heaven"

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"صوت الوالدين فالبيت أجمل وأكبر نعمة."
"Parents' voice, home is the most beautiful and greatest blessing."

"الأخت الكبيرة هي جمال كل بيت، تُشعرك بالسعادة اللهم احفظها."
"The big sister is the beauty of every home, she makes you feel happy, may God protect her."

"مهما كانت درجة قربك من اي حد سواء اخت. اخ. صاحبة او اي احد ثاني هتفضل الأم هي الأقرب وأكتر شخص ممكن يحس بيك ويفهمك وصدقني اللي ممكن تحكيه لوالدتك ما ينفعش تحكيه لاحد ثاني مهما كان."
"It doesn't matter how close you are to your sister or brother. The mother is the closest and most understanding person, and believe me, what you can tell your mother, you won't be able to tell anyone else, no matter what, no matter what."

The sixth parameter is Nurturing Children. It is characterized by keywords such as Person, Kid, Say, Your Home, Ok, Work, Girl, Know, Enter, Possible. Following are tweets related to this parameter that discuss raising children under a set of values, developing personality traits in children, etc.

"في ظل انتشار وسائل التواصل ومعها المشاهير اصبح ضرورة تربية الأبناء على الاعتزاز بالقيم وتقوية شخصياتهم ".
"In light of the proliferation of social media and celebrity culture, it has become increasingly essential to raise children to be proud of the values and strengthen their personalities"

"الشخص يتفاعل مع البيئه اللي نشأ فيها و يطور مهاراته من خلال المشاكل اللي تواجهه خصوصا لو كان طفل. الامهات دايم حريصات بزياده اكثر من الاباء و الشخص الحريص على ولده بزياده ولا يخليه يحل مشاكله يطلع ولده مايفهم ماهو ذنب الطفل لكن ذنب الاب اللي حرمه حقه من التعلم من مشاكل الحياه."
"A person interacts with his environment and develops his skills based on the challenges he faces, especially as a child. Mothers always put more effort into that than fathers, and if a father does not allow his son to solve his problems, his son will not develop a strong personality. It may not be the child's fault, but the father's who may have deprived him from his right to learn from life's problems."

"في مرحلة بناء شخصية الطفل، اذا تدخلتي في هذي المرحلة بكره راح يغلط على اي شخص و يتصفق و يجي يكلمك. لازم يعرف كيف انه يتجنب الناس هذي وكيف يتعامل معهم …."
"As the child is building his personality, if you interfere in this stage, tomorrow he will make a mistake, be hit, and come to talk to you. He must learn by practice how to avoid and deal with these people…"

"البنت اللي اهلها معطينها الحب والثقه دايماً بتكون شخصيتها جداً قوية ، فعلاً ان وراء كل بنت عظيمة أهل عظيمين جد"
"A girl whose parents give her love and trust will always have a very strong personality. There are very great family behind every great girl."

Good Companionship is the seventh parameter for the macro-parameter Nurturing Families. It described by a set of keywords as Our House, Roof, Syria, Became, I Became, Friend, Owner, Picture, Children, Young. A few examples of tweets are listed here

"... قد تُكتسب الأخلاق الحسنة بمصاحبة أهل الخير، فإن الطبع لِصٌّ يسرق الخير والشر …"
"Good manners may be acquired by accompanying good people, …"

"انصحك اذا تبغين حياه سعيده ودائمه واستقرار بحياتك. اقطعي علاقتك تماما بهالصديقات وغير مأسوف عليهم"
"I advise you if you want a happy and lasting life and stability in your life. Completely cut off your relationship with bad friends and do not regret them."

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The eighth parameter is Family Gatherings which represented by the following keywords Entered, Our House, Sisters, Doctor, Bench, Minutes, Sitting Room, Family. Following are tweets posted related to this parameter.

"منظر ضحكة العائلة بشكلٍ جماعي يستحق التخليد في إطار. يعلق في زوايا القلب."
"The sight of the family laughing together deserves to be immortalized in a frame. It will always remain in my heart."

"سعادة الأسرة والأقارب والأهل وحلاوة الزيارات العائلية اجمل بكثير من لوثة العلاقات المبنية على مصلحة. "
"The sweetness of family visits and the happiness of family, relatives, and parents is much more beautiful than the pollution of interest-based relationships."

The ninth parameter is Gatherings with Grandmothers. It includes keywords such as Grandmother, New, Paradise, We Made, Gather, Come to You, Bring, Beautiful, Your Beauty, Gathering. Here are examples of tweets

"الجدّة نُور كل بيت و روح العائلة ، ياربّ احفظ جدتي."
"Grandmothers are the light of every home and the soul of every family. Lord, protect my grandmother."

"وتبقى الجده هي الحُب الذي لاينتهي ،عكاز كل بيت ونور كل بيت وروح العائلة ،يارب جدتي في ودائعك وحمايتك. "
"Grandmother remains the pillar of every home, the light of every home, and the soul of every family"

The last parameter is Entertainment Activities. This parameter is referenced in the following tweets

"في آرت بروميناد الكل سعيد ومستمتع بفعالياته اللي تناسب العائلة والأصحاب."
"At … , everyone is happy and enjoying its activities that are suitable for family and friends."

"صار وقتنا في البيت مع العائلة أكثر وعرفنا دفء البيت وقيمة عوائلنا.. ويومنا خفيف وكله فعاليات و اكل و مسلسلات وضحك وسوالف و اكتشفنا اهتماماتنا وصار عندنا هوايات وحاجات جديدة في حين كان الدوام أكبر عائق."
"As we spent more time at home with our families, we became aware of the warmth of the home and the value of our families. We have a light day with all events, eating, series, laughter, and sideburns, and we discovered our interests and needs, while work was the biggest obstacle."

"ضمن فعاليات ملتقى الأم والطفل فلذات تم بحمد الله الانتهاء من دورة فن التعامل مع الأطفال"...
"Within the activities of the Mother and Child Forum, the course of the art of dealing with children has been completed."

5.4. *Resources & Management (Twitter)*

Next, we discuss the second macro-parameter Resources & Management. It involves the tweets and parameters that are related to home finance and clean. It includes four parameters; the first parameter is House Financing & Affordability. It includes keywords Own, Finance, Hold, Raise, Investment, Fund. An example of tweet is

"اقتصد من راتبك الذي تستطيع وادخل في جمعيات كي تمسك المبلغ سنه على سنه تستطيع ان تجمع مبلغ افضل لك من البنوك وبعيد عن الاقتصاد وبعدها خذ التمويل العقاري مع المبلغ الذي جمعته ..."
"Save as much money as you can from your salary and join associations to keep it year after year. You can collect a better amount from those banks give and away from the economy, and then take the real estate financing with the amount you collected ..."

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The second parameter is about Home Cleaning. It created from merging four parameters 11, 16, 19, and 21. All these parameters discussing general home cleaning for Tanks, Carpets, Homes, Furnished, Air Conditioners, Windows, Rooms. The third parameter is Pest Control parameter, and the fourth is Swimming Pool Cleaning. Examples of tweets related to these parameters is listing in the following

"شركة تنظيف شقق فلل بالرياض تقدم خدمات بمنتهي الدقة في تنظيف شقق مجالس فلل و غسيل خزانات فرشات زوليات"
"A company cleaning villas and apartments in Riyadh provides very meticulous services in cleaning villa council apartments and washing tanks, carpets, and mattresses"

"تعقيم مكافحة حشرات رش مبيدات نظافة عامة"
"Insect control sterilization, spraying general hygiene pesticides"

"تنظيف مجالس كنب موكيت سجاد ستائر تنظيف خزانات مسابح"
"Cleaning of sofas, carpets, curtains, cleaning swimming pool tanks."

5.5. Challenges (Twitter)

Our last macro-parameter, Challenges, refers to what family members experience in terms of challenges. It consists of five parameters. Work & Indolence, Physical Inactivity, Sleeping Habits, Socioeconomic Challenges for Women, and COVID-19.

Work & Indolence parameter includes the list of keywords Work, Person, Formal, Old, Streets, Tree, Company, Shop, Cleaning, Your Home. Examples of tweets are

"عاادي الرجال مايعيبه الا الجلسه في البيت بدون عمل اما الشخص اللي يشتغل ويكد على بيته واطفاله ومكفيهم الحاجه لايضره بل فخر له مهما كانت الوظيفه. "
"The only thing wrong with men is sitting at home without working. For a person who works hard for his family to provide for their needs, it does not harm him, rather it makes him proud, whatever his job may be."

" الحمدلله على نعمه الشغل من البيت بس اشتقت للمكتب."
"It is a blessing to work from home, but I miss the office."

Physical Inactivity is about people complaining about physical inactivity of children mainly and adult because they are addicted to playing game and watching football, etc. This parameter is represented by the keywords Home, Home, Our Home, My Home, A Child, Outside, A Year, Children, A Thousand, An Hour. The following tweets were posted

"كيف أقلل من وقت جلوس أطفالي على الشاشات؟ "
"How do I reduce my children's screen time?"

"الطفل الطبيعي يجب أن يحب الخروج من المنزل، ويحب الاجتماعات... بعض الأمهات تفخر بأن طفلها يحب الجلوس في البيت"
"A normal child should like to go out of the house, and like meetings … Some mothers are proud that their child likes to sit at home."

The Sleeping Habits is the third parameter for the Challenges macro parameter. There are some keywords that pertain to it: Grace, The Cave, We Go Back, Young, We Go, Our Homes, We Light Up, We Sleep, We See. Several tweets about this parameter are listed below.

"نومي نوم اهل الكهف"
"My sleep is the sleep of the people of the cave."

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"نوم الليل ودعته مع الأمومة"
"The night's sleep is over because of motherhood"

"شاهد أفضل وضعية للنوم لمن يعانون من آلام الظهر"
"See the best sleeping position for back pain sufferers"

The fourth parameter is Socioeconomic Challenges for Women. As part of the Saudi Vision of 2030 and the National Transformation Program 2020, women with various social statuses of the Saudi Arabian Kingdom are supported. This parameter is represented by keywords such as Marriage, Divorce, Saudi, Female Employee, Tribal, Nationality, Socially and others are used to represent this. Listed below are some examples of related tweets

"انتبهو تفرطون في : (الشهادة الجامعية، الوظيفة، الاستقلال المادي) نصيحتي لبنات العايلة. "
"My advice to the daughters of the family is to not lose university degree, job, financial independence"

"المرأه العاقله المتزنه لايهما من يحاول ان يهدم كيانها هي تعلم بانها سيدة البيت ولها كل احترام وتقدير وحريه فيما يكون لها مناسب ويرفع قيمتها و مكانتها الاجتماعية."
"Women who are sane and balanced are aware that they are the masters of their houses and have all the respect, appreciation, and freedom that increases their value and social status."

The last parameter for this last macro-parameter is COVID-19. It is about supporting people in taking the vaccines and taking all precautions against the Coronavirus. Furthermore, it highlights COVID-19 deaths and wishes well to those who lost their lives to it. The following are a few tweets relating to this parameter.

"...: كورونا يصيب الأطفال وينتشر بينهم وتطعيمهم باللقاح ضرورة"
"… Corona infects children and spreads among them, and vaccinating them with the vaccine is a necessity"

" أثبتت وزارة التعليم قدرتها على مواجهة التحديات في ظل جائحة فيروس كورونا ، واستمرار العملية التعليمية بجهود وإخلاص من كافة العاملين في الميدان التعليمي وبشراكة مع الأسرة والمجتمع"
"The Ministry of Education has proven its ability to face challenges in light of the Corona virus pandemic, and the continuation of the educational process with the efforts and sincerity of all workers in the educational field and in partnership with the family and society."

6. Discussion

In our work, we aim to identify families & homes parameters through discovery and analysis of two different perspectives: academic view and public view from two different data sources, English Scopus and Arabic Twitter. Detailed of these two types of families & homes parameters can be found in Sections 4 and 5.

We discovered a total of 50 Families & Homes parameters that we grouped into five macro-parameters. These are Nurturing Families, Health & Lifestyle, Communities & Nations, Resources & Management, and Technologies. Six parameters were excluded from the original clustering result as they were out of the scope of this paper, for example, some clusters were capturing parameters related to the animals (clusters 12 and 40) or plants (clusters 11 and 32) families rather than the human families, Programming Families and Packages (cluster 1), or miscellaneous (cluster 6).

The first macro-parameter Nurturing Families touch upon establishing families & homes. It captures research related to the children's mental, physical, social, and academic development including their parent's involvement. The roles, responsibilities, challenges,

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and issues concerning women while developing, maintaining, and taking care of their families and homes. In addition to the elderly people's related topics involving their lifestyle, health, psychological conditions at care homes, and various aspects of the family spirituality including religion, faith, religious education, and religion-related social studies. The Health & Lifestyle macro-parameter captures parameters related to lifestyles, diseases and provision of healthcare. For example, the effects of genetic characteristics, food consumption and eating habits, obesity prevalence, causes, treatments, and prevention, smoking's effects, addictions, and drug abuse factors, supporting and dealing with mental conditions, cancer patients, detection and social support, diabetes-related research, healthcare provisioning and developing healthcare professionals, homecare and nursing homes, and Pandemics effects. The Communities & Nations macro-parameter covers various dimensions of families and homes distinguished by different communities, countries, societies, or nations. It captures parameters related to different racial groups, LGBTQ communities, various political affiliations, Mexican immigrants, Canadian people and immigrants in Canada, Syrian Immigrants, and other countries such as Germany, Sweden, Finland, Italy, Spain, China, Japan, and Australia.

The macro-parameter Resources & Management concerns about establishing home resources and managing families and homes. It discusses aspects related to families and homes economics and operations. Examples of academic research captured by this macro-parameter include research regarding estate prices and different factors that affect pricing and family affordability. Studies related to house design include architectural design, archaeology of houses, antiquities, sites and locations, materials and techniques, and some specific heritage homes. Research related to jobs, work environment, work-family conflicts, family business, and families involved in farming and agriculture. Moreover, it captures dimensions related to tourism and its effects, opportunities, issues, and challenges with families and homes. Energy and water resource management and the effects of floods, earthquakes, and other disasters on families and homes have also been captured by this macro-parameter. The Technologies macro-parameter captures parameters related to the utilization of technology in various aspects related to the families, homes, and individuals to improve the quality of life. Parameters under this macro-parameter discuss assistive robots, remote healthcare, social media, smart environments and IoTs, sleep monitoring, and home-based training and rehabilitation systems.

We discovered 49 families & homes parameters from the Scopus academic dataset and grouped them into five macro-parameters. These are Nurturing Families, Health & Lifestyles, Communities & Nations, Resources & Management, and Technologies. **Error! Reference source not found.** shows the word cloud of the keywords of the academic parameters determined by BERT modelling, where the size of the keywords represents their frequency, which is linked to their importance. The keywords like home, family, social, parent, health, care, and child are highly related to the families & homes field. There are a wide variety of topics covered by academic research on families & homes such as nursing & homecare, women, children development, elderly, smart environments technologies, assistive robots, family business, and so on.

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Figure 22 A Word Cloud Generated from the Families & Homes Parameter Keywords (Data Source: Scopus)

From the Twitter dataset, 25 parameters were identified and grouped into three macro-parameters: Nurturing Families, Resources & Management, and Challenges. The word cloud illustrating the families & homes parameters discovered by our Bert modelling from Twitter dataset. **Error! Reference source not found.** depicts the word cloud of the keywords of the parameters where the size of each keyword indicates how frequently it is found. Public families & homes discussion covers a wide range of topics, such as nurturing children, family values, home cleaning, family relationship, employment and so on.

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Figure 23 A Word Cloud Generated from the Families & Homes Parameter Keywords (Data Source: Twitter)

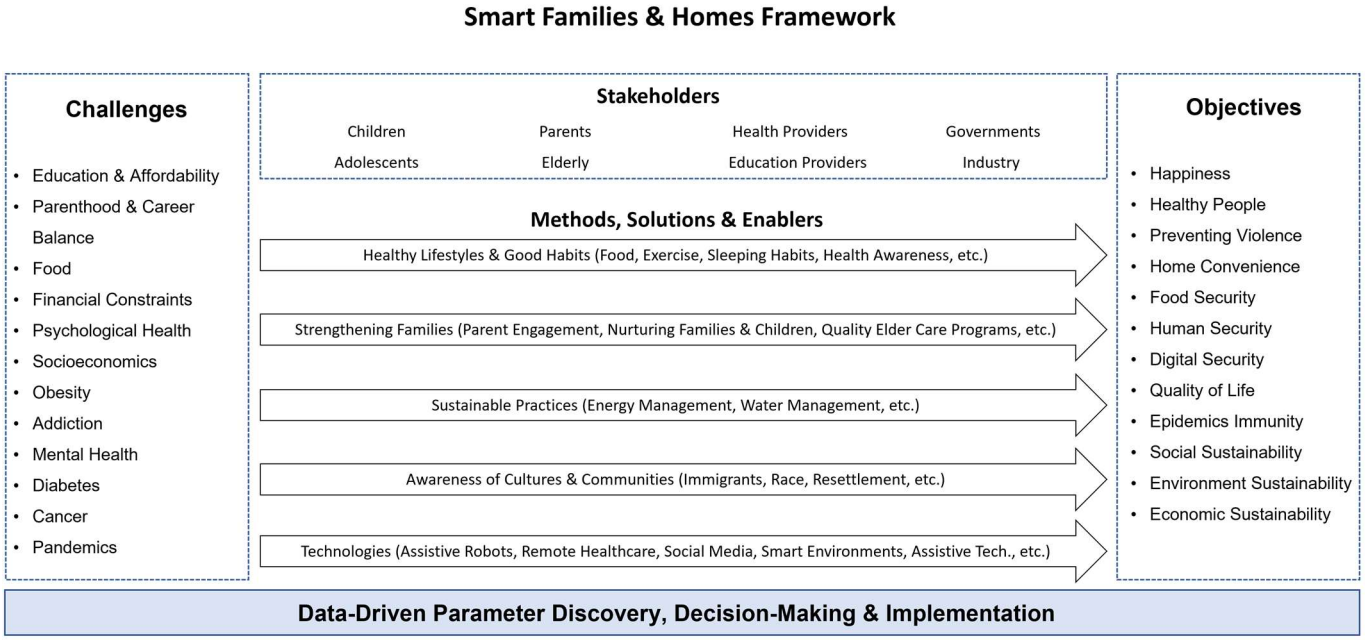

Figure 24 Smart Families & Homes Framework

Based on our data-driven families & homes parameters discovery, we introduce a data-driven parameter discovery, decision making & implementation approach aiming to

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improve families. A high-level framework showing our proposed data-driven approach for smart families & homes is provided in Figure 24. It shows that various actors work on identified challenges to achieve and reach families & homes objectives by using methods and solutions. Our framework can identify challenges, methods & solutions, and objectives that aim to benefit and improve families. The high-level or ultimate objectives are to enable better smart families & homes. Example of objectives includes Happiness, Healthy People, Preventing Violence, Home Convenience, Food Security, Human Security, Digital Security, Quality of Life, Epidemics Immunity, Social Sustainability, Environment Sustainability, and Economic Sustainability. The stakeholders are Children, Adolescents, Parents, the Elderly, Health Providers, Education Providers, Governments, and Industry. Several challenges include Education & Affordability, Parenthood & Career Balance, Food, Financial Constraints, Psychological Health, Socioeconomics, Obesity, Addiction, Mental Health, Diabetes, Cancer, and Pandemics. Technologies, Awareness of Cultures & Communities, Sustainable Practices, strengthening Families, Healthy Lifestyles & Good Habits are considered enablers, methods, and solutions.

7. Conclusions

Innovations and advances in technology have dramatically transformed people's lives, giving rise to smart environments, cities, and societies. As the foundation of cities and societies, smart homes are critical to establishing smart living and are expected to play a key role in enabling smart cities and societies. The current academic literature and commercial advancements on smart homes have primarily focused on developing and providing smart functions for homes to provide security management and to assist residents in their various activities such as ambiance management.

Homes are much more than the physical structures, buildings, appliances, operational machines, and systems that they contain. Homes are made up of families and are inherently complex phenomena characterized by humans and their interactions with one another, all of which are subject to individual, intragroup, intergroup, and intercommunity goals. There is an obvious need to comprehend, define, consolidate existing research, and actualize the overarching roles of smart homes, roles that would serve the needs of future smart cities and societies.

This paper introduced our data-driven parameter discovery methodology and used it to provide, for the first time, a comprehensive analysis of the families and homes landscape as seen by academics and the general public, using over a hundred thousand research papers and nearly a million tweets. We created a methodology that uses deep learning, natural language processing (NLP), and big data analytics to automatically discover parameters that capture a comprehensive knowledge and design space for smart families and homes that includes social, political, economic, environmental, and other dimensions. The 66 discovered parameters and the knowledge space with hundreds of dimensions were explained by reviewing and referencing over 300 academic articles and tweets.

The knowledge and parameters discovered in this paper can be used to develop a holistic understanding of issues concerning families and homes, thereby facilitating the development of better policies, technologies, solutions, and industries for families and homes, and thus strengthening families and homes and, as a result, empowering sustainable societies worldwide. The parameters detected by Twitter data reveal a very local national view of families, with parameters such as an emphasis on good companionship, gatherings with grandmothers, and laziness. These could be used to research and develop cultures-specific, intercultural, and intercommunal norms, traditions, and sensitivities in families and homes. Many works relating to families and homes are being carried out under various research umbrellas. Our approach could aid in the consolidation and streamlining of efforts to develop more sustainable technologies for smart homes and societies.

The methodology and analysis developed in this work are extensible and applicable to other subjects and topics, with seemingly limitless applications. For example, the approach makes use of Scopus data, which could be extended to other academic databases in order to develop and discover more comprehensive models of families and homes. Similarly, data sources other than Twitter, such as social media platforms, magazines, and web resources, could be added. One challenge of using social media platforms such as Twitter is that businesses use them to market their products. This has most likely contributed to the overemphasis of home cleaning-related parameters, but it may also reflect demand and thus an acceptable view of families and homes. This will be looked into further in the future in order to address the undesired influence of commercial tweets on the knowledge space.

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