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A Ten-Year Bibliometric Analysis of Emotional Responses to Products as Indicators of User Acceptance

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Abstract
The study employs a bibliometric approach, analyzing global literature from the Scopus database related to user acceptance based on emotional responses to products. Initially, 749 documents were identified, narrowed down to 378 final-stage journal articles published in English. The data collected comprises information from the last 10 years (2013–2023). These were analyzed using Vos Viewer for bibliometric network visualization and R-biblioshiny for additional analysis. The research, conducted in November 2023, used the following specific search strings (TITLE-ABS-KEY ("Emotional response") AND TITLE-ABS-KEY (product* OR device*) AND TITLE-ABS-KEY (measur* OR assess* OR evaluat*)). The study highlights the increasing research on emotional responses to products, with a 9.6% annual growth in publications. While the USA, UK, Spain, and Australia lead in this field. Five topic clusters identified involve emotional response measurement, behavior related to product acceptability, the user of the product, behavioral symptoms, and emotion psychology. Emerging areas include consumer goods and product design, with a future focus on physiological assessment, emotional reaction's impact on design, and consumer purchase intentions. Density visualization suggests further exploration in wearable technology, purchase intentions, and emotional response measurements like electroencephalography, electromyography, electrophysiology, facial expression, and skin conductance.

Keywords
Bibliometric Analysis, Emotional Response, User Acceptance, Products, VosViewer.

Introduction

Cognitive ergonomics focuses on mental functions like perception, memory, and cognition, and how these functions are influenced by interactions with the remnants of the observed system (Colovic, 2011). A product is an element of a system that interacts with users or humans. Determining the criteria that a product must satisfy to be accepted by consumers, users, or other stakeholders is known as product acceptance (Maguire & Bevan, 2002). User acceptance of a product is closely related to the extent to which the product meets users' expectations, needs, and preferences. Cognitive ergonomics helps improve product acceptance by reducing cognitive barriers that may make users feel difficulty or frustration when using the product. Users will be more likely to accept a product if the product is easier to understand, use, and interact with.

Acceptance can be described as a self-regulation technique rooted in an open and receptive mindset toward one's own emotions, thoughts, or external circumstances (Williams & Lynn, 2010). It plays a crucial role in the development and implementation of new products, ensuring that the designed product aligns perfectly with the unique characteristics, preferences, and needs of the user. By gaining a deeper insight into how users interact with the product, product developers and manufacturers can assess the extent to which the devices meet user expectations and requirements. The findings from such assessments also offer valuable input for enhancing product design by pinpointing areas in need of modification or improvement.

Measuring user acceptance is a challenging task, primarily due to measurement bias, stemming from inconsistent consumer responses influenced by complex

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internal and external factors (Platz & Veres, 2014). The obstacles that arise in efforts to measure acceptance can be overcome by using the emotional response method after consumers use the product because in evaluating the sensory quality of a product, the emotional aspect is the element involved (Thomson et al., 2010). It has been established that emotions triggered by products greatly impact overall customer satisfaction and success. Designers play a pivotal role in crafting items that elicit specific emotions in consumers, influencing their purchasing decisions. Businesses that have succeeded by anticipating their customers' requirements are those that have concentrated on connecting with their delicate desires. As a result of their diverse perspectives, team members in interdisciplinary settings will certainly clash while deciding how to prioritize meeting the needs of customers. This approach will result in the production of products that evoke the desired emotions (Shah, 2021).

Based on this problem, a bibliometric analysis was carried out regarding user acceptance of products based on emotional response. A bibliometric analysis aims to illustrate the interconnections among disciplines, fields, scholars, and scientific papers through spatial representation (van Eck & Waltman, 2010). Apart from that, potential research directions in this domain are also mapped. To accomplish this objective, the subsequent research questions (RQs) were formulated:

RQ1: Which topics currently dominate the field of product-related emotional response research?

RQ2: What are the novel and emerging topics in the study of emotional responses to products?

RQ3: What trends and potential areas of future research exist in the research of emotional responses towards products?

Through this analysis, it is possible to comprehend the current research trends, identify areas that have not been extensively explored, and reveal the critical relationship between user emotions and product acceptance. This is crucial since emotions have significant effects on whether a product succeeds or fails. Additionally, this bibliometric analysis contributes to the development of ergonomic theory and product design, providing insights for more effective product design, and supporting a multidisciplinary approach in research. The knowledge gained from this analysis is extremely valuable for decision-makers in product strategy design and assists in developing better research methodologies. Finally, it enables us to identify potential collaborations and synergies in research, promoting innovation and progress in user-focused ergonomics and product design.

Literature review

Ergonomics or human factors aim to ensure appropriate interaction between work, products, and environments, and the needs, abilities, and limitations of humans, as defined by the Human Factors and Ergonomics Society. The International Ergonomics Association further explains three domains of specialization within this discipline, one of which is cognitive ergonomics, which deals with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system (Kalakoski, 2019).

Given the importance of mental processes in cognitive ergonomics, a deep understanding of how perception, memory, and reasoning affect human-system interactions is highly relevant. This introduces Patrick Jordan's concept of four types of pleasure experienced when using a product, which not only impacts user performance but also comfort.

Jordan (2000) dentified four conceptually distinct types of pleasure that can be experienced when using a product: physio-pleasure, sociopleasure, psycho-pleasure, and ideo-pleasure (Desmet, 2007; Helander, 2002). Regarding psycho-pleasure, cognitive ergonomics plays a crucial role in creating product designs that are not only easy to use but also mentally and emotionally pleasing. Based on Wangphanich & Kongprasert (2022) research on an innovative design approach to meet customer requirements, it is stated that the relationship between emotional response and design is very close, where design focuses not only on physical aspects such as style, function, form, and usability but also significantly considers how the product can evoke emotional reactions from users.

The volume of publication articles is growing swiftly, making it more challenging to stay updated with all published works. Additionally, the focus on empirical studies has led to the production of extensive and scattered streams of research (Briner & Denyer, 2012). Consequently, comprehending the underlying information in research from a comprehensive viewpoint, including aspects like research trends, popular topics, networks of collaboration, citations, and more, becomes challenging.

Researchers employ a variety of qualitative and quantitative methods for reviewing the literature to comprehend and categorize previous discoveries. Within these methods, bibliometrics offers the ability to implement a review process that is systematic, clear, and replicable, grounded in the statistical analysis of science,

scientific researchers, or scientific endeavors (Aria & Cuccurullo, 2017). This approach is especially apt for mapping scientific research during a period where the focus on empirical work is leading to an abundance of diverse and often contentious research outputs.

Bibliometrics analysis is increasingly being applied across various fields. Syed & Khan (2022) used bibliometric analysis to provide an extensive review of how AI has evolved in diagnosing and predicting breast cancer. This study offers valuable insights and research pathways for future AI applications in breast cancer, beneficial for policymakers and academic researchers in guiding collaborations and research advancements. Then, Mougenot & Doussoulin (2023) use bibliometric analysis to identify global trends of the Global Reporting Initiative (GRI) in developed and developing countries. This bibliometric analysis provides a comprehensive understanding of GRI-related research trends and impacts, aiding future research direction in this area. Ba Awain et al. (2023) conduct a comprehensive review of the development, applications, and future directions of Green Supply Chain Management (GSCM) based on the Scopus database. This study identified current trends, mapped impactful GSCM practices related to the subject, and evaluated the advantages and challenges of GSCM. Moreover, the study aimed to address existing research gaps and provided recommendations for future research directions in the field of GSCM.

Furthermore, Zhang et al. (2024) conducted bibliometric and visual analysis of health risks associated with heavy metals based on data from the Web of Science. Co-citation and collaboration analysis among authors, institutions, and countries revealed strong collaboration patterns and established networks, reflecting dynamic developments and research directions in this field. The findings also suggested that future research might focus more on the health risks of heavy metals in different functional urban areas and how these exposures affect urban populations.

Based on previous usage of bibliometric analysis, it can be concluded that bibliometric analysis, through its statistical approaches, helps to depict the knowledge frameworks and the ongoing progression of specific research areas. This quantitative method provides an in-depth summary of a field, subject, or issue (Daim et al., 2006). Furthermore, bibliometric analysis plays a crucial role in assessing the feasibility of a research topic. It also helps decide which research should be conducted and supported by governments and funding organizations. Researchers, institutions, publishers, and governments pay attention to worthy research topics due to limited resources (G'uven & Dem Rkale, 2018).

Materials & Methods

The data source for this research is all literature worldwide related to user acceptance of the product based on emotional response. The research used only the Scopus database for literature searches to reduce the possibility of differences in data and field tags that might arise from the use of different databases. Furthermore, the Scopus database contains a greater number of citations and articles (Pranckutė, 2021). Scopus is a database that compiles over 14,000 scientific journals and various other sources with daily update (Burnham, 2006). This platform is equipped with features that facilitate effective navigation of scientific literature. Users can track references through links to both citing and cited documents, enabling both forward and backward citation tracking. Scopus includes a range of open-access titles and indexes over 167 million web pages and patents, ensuring the availability of a broad spectrum of information resources. With Open URL compatibility and an access rights checking system before displaying full text, Scopus makes it easier for users to access content. Additionally, Scopus emphasizes citation accuracy by employing the latest technology, which ensures a high level of match between references. These features enhance the quality and comprehensiveness of the information available in Scopus.

Several stages were done in the data-gathering process for this research. Figure 1 illustrates the process of gathering data, from selecting the subject to providing the information needed for the bibliometric study. The data-collecting procedures used in this study are based on and modified from the PRISMA flow diagram, as shown in Figure 1 (Page et al., 2021).

To make the search on Scopus more focused, the research utilizes specific keywords, namely "Emotional Response", "Product", "Device", "Measure", "Measurement", "Measuring", "Assessment", "Assessing", "Assessed", "Evaluation", "Evaluate", and "Evaluating". This research has established several inclusion and exclusion criteria for this literature study. The data collected comprises information from the last 10 years (2013–2023) for several reasons. First, it is because it has higher relevance to the latest developments in specific study areas, potentially reflecting recent findings or ideas that provide sharper insights into research. Additionally, more recent research also illustrates advancements in research methods and technology, enabling the use of more sophisticated and accurate methods.

The total number of articles identified using the specified keywords amounts to 749 documents, with the earliest article published in 1957. This analysis, however, focuses solely on publications from the period 2013

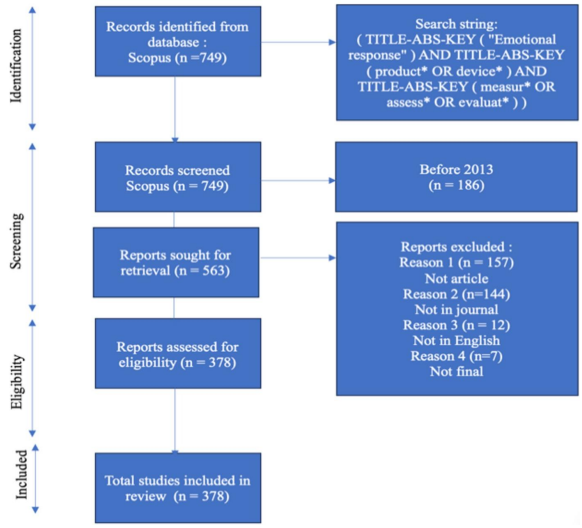

Fig. 1. A search method modified from the PRISMA flow diagram

to 2023, resulting in the exclusion of 186 articles published prior to 2013, leaving a dataset of 563 documents. When the search is confined to the keyword "emotional response", the results encompass 17,766 documents, with the oldest article published in 1908. Within the timeframe from 2013 to 2023, there were 10,708 articles containing this keyword. This suggests that research into human emotional responses to products has been ongoing since at least 1957. However, when limiting the scope to the most recent decade, the number of articles diminishes to merely 1,064 documents.

A total of 563 documents were obtained from the search results with search string: (TITLE-ABS-KEY ("Emotional response") AND TITLE-ABS-KEY (product* OR device*) AND TITLE-ABS-KEY (measur* OR assess* OR evaluat*)). The asterisk (*) in Scopus searches indicates word variation by allowing users to search for all word forms that share the same beginning but have different endings. The data were then further filtered to include only journal articles published in English and in final stages, resulting in 378 documents. These 378 bibliometric data were then processed using Vos Viewer to create and visualize bibliometric networks. In addition, an additional analysis was performed using R-biblioshiny. Literature identification was conducted in November 2023.

Results

This study presents the status of research on consumers' emotional reactions to products using bibliometric analysis. Initially, descriptive results will provide a quantitative overview of this field's current status. Subsequently, the findings from network analysis, based on co-occurrence analysis and thematic mapping, will be presented to respond to the research questions.

The publishing chart over time is a useful tool for evaluating the expansion and popularity of a particular field of study. The development of publications on product acceptance based on emotional response throughout time is seen in Figure 2. The average growth trend in publications with this theme is 9.6%.

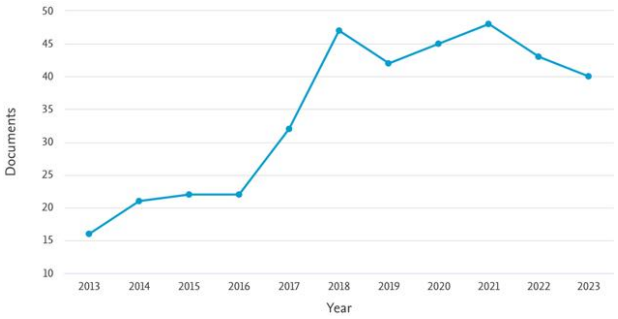

Fig. 2. Number of publications per year

Overall, the trend of publications with the topics of emotional response to a product is increasing. The significant growth of publications throughout this time frame indicates a sustained and obvious trend, showing the high degree of interest and attention this topic has attracted from the academic world. Meanwhile, the citation trend experienced fluctuations with a decreasing trend, with the peak occurring in 2018 (Figure 3).

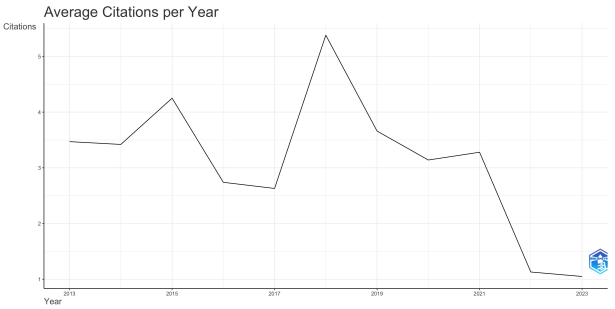

Fig. 3. Number of citations per year

The journal that publishes the most articles with the theme of emotional response to products is the Journal of Food Quality and Preference with a total of 49 articles. There is a significant difference with other journals with a range of 4–17 regarding the publication of articles with similar themes (Figure 4). This shows that much research on emotional responses to products has been carried out on food products.

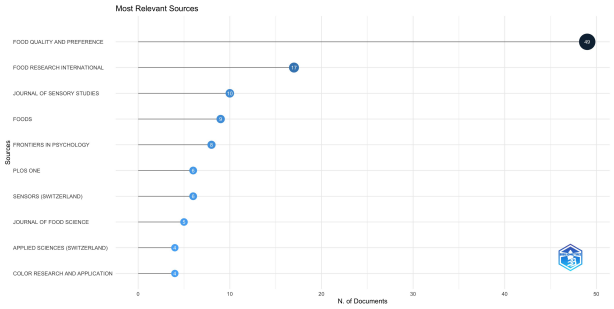

Fig. 4. Most Relevant Sources

Figure 5 shows the countries that are most active in publishing on this topic. The most productive authors are from the USA with 109 articles, the United Kingdom with 48 articles, Spain with 46 articles, Australia with 36 articles, and other countries with below 30 articles or none at all.

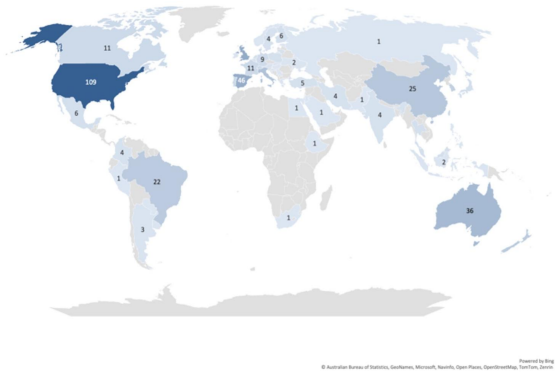

Fig. 5. Publications per Countries

Several scientific fields conducting research in the field of emotional response to a product are presented in Figure 6. This topic is not only applied to one particular field of science but can be applied widely in several scientific fields. The other subject areas that are not presented in Figure 6 are biochemistry, genetics, and molecular biology (24 documents), genetics and molecular biology (24 documents); health profession

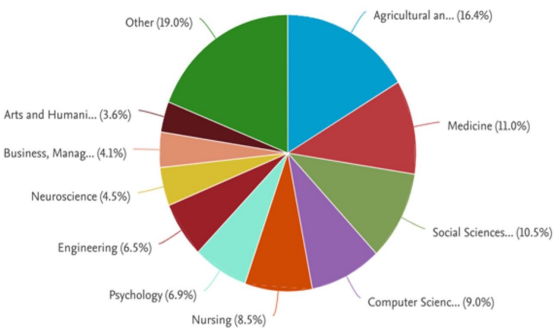

Fig. 6. Documents by Subject Area

(18 documents); chemistry (15 documents); physics and astronomy (14 documents); chemical engineering (12 documents); immunology and microbiology (11 documents); economics, econometrics and finance (8 documents); material science (7 documents); mathematics (6 documents) and multidisciplinary (6 documents).

Main Research Themes and Topics

The visualization produced by VOSviewer may be used to answer RQ1 on the current state of research on the emotional response to a product. The minimum number of occurrences of a keyword used in VOSviewer is five, resulting in a threshold of 145. The co-occurrence analysis graphic shows the relationships between subjects of research, their popularity, and the clusters of topics that form. Consequently, co-occurrence analysis could look at the primary ideas or themes as well as the subjects of publications (Shafin et al., 2022). Five separate clusters of topics are seen in the network visualization produced by the co-occurrence analysis (Figure 7).

Every cluster has a different color that represents it. Cluster 1, represented by red color, focused on physiological methods used to measure emotional responses to a product. Within this cluster, the most popular topics are physiology, human experiments, and product design. Physiological measurement is an implicit method for measuring emotional response to a product (Lagast et al., 2017). The purpose of physiological measures is to access the biological responses that define emotions, such as cardiovascular response (heart rate, blood pressure), the respiratory response (respiration rate), the electrodermal response (skin conductance response, skin conductance level), the brain response (frontal alpha asymmetry), and the pupillary response (pupillary reflex) (Kreibig, 2010). The electroencephalography (EEG) technique is presently the most utilized method for measuring brain responses due to its high temporal resolution. It enables real-time monitoring of brain waves, yielding an abundance of valuable data. The EEG data, derived from brain wave measurements, can be analyzed to discern mood, receptivity tendencies, and overall brain functionality (Andersen et al., 2019).

Consequently, it is unsurprising that the study of consumer brain activity holds significant importance. The use of EEG techniques is particularly emphasized in sensory research and the evaluation of consumer behavior (Shaw & Bagozzi, 2018). The other implicit methods are eye tracking and pupillometry methods. While these techniques offer compelling insights into

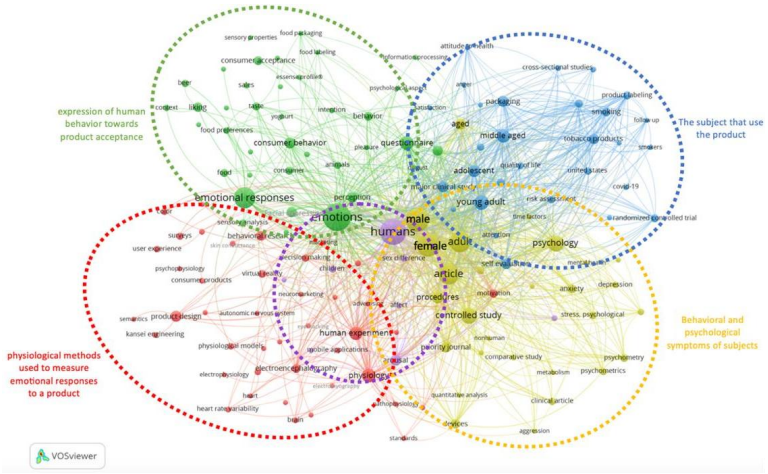

Fig. 7. Network Visualization from Co-occurrence Analysis

emotions related to memory and expectations, their scope is limited to the visual analysis of products or packaging (Köster & Mojet, 2015).

Cluster 2, represented by a green color, focused on the expression of human behavior toward product acceptance. Within this cluster, the most popular topics are emotions, emotional response, and consumer behavior. Direct observation of the subject's behavioral expression of emotions is an even more natural, unobtrusive, and uninterrupted technique for measuring emotions (Mauss & Robinson, 2009). One method implicit method of measuring expressions is using facial expressions (Lagast et al., 2017). Facial expression is divided into two categories: observer ratings of videotaped facial expressions and electromyography (EMG), which measures the electrical potential from facial muscles via electrodes on the face (Mauss & Robinson, 2009).

Apart from that, measuring the expression of human behavior can also use an explicit method, namely a self-report measurement or questionnaire. There are two explicit methods for measuring emotional response, which are verbal and visual Fields (Lagast et al., 2017). Explicit methods employ self-reported measures, where participants articulate their feelings and emotions while interacting with a product. This verbal approach uses an emotional lexicon, typically in a questionnaire format. The questionnaire includes a variety of emotional terms descriptions, or sentences to be assessed, like Emosemio (Spinelli et al., 2014). There are two assessment methods used. There are CATA (Check-all-that-apply), where consumers check all relevant terms, and RATA (Rate-all-that-apply), a variation of CATA requiring consumers to rate the intensity of applicable terms (Ares et al., 2014). The emotional lexicon can be predetermined (e.g., EsSense Profile® by Kring & Gordon (1998)) or determined by consumers. Alternatively, the visual reporting method employs images to represent various emotions from the lexicon. Several tools have been developed for this purpose, including the Product Emotion Measurement Instrument (PrEmo), one of the most renowned tools in this area (Desmet, 2004).

Cluster 3, represented by a blue color, focused on the subject that uses the product. Within this cluster, the most popular topics are young adults, adolescent, and middle-aged. This is because most people in this age group are product users or customers. Furthermore, Cluster 4, represented by a yellow color, focused on the behavioral and psychological symptoms of subjects. Within this cluster, the most popular topics are male, female, and adult. Negative emotions and behavior are psychological aspects that must be resolved. The topics that are often discussed are depression, anxiety, aggression, stress, and mental health. Brimelow et al. designed a group-based virtual reality (VR) device to reduce behavioral and psychological symptoms, including depression, anxiety, and restlessness, in aged care residents (Brimelow et al., 2022). One of the variables under investigation is an emotional assessment to evaluate residents' mood responses during each VR session. This study aimed to examine the effectiveness of VR devices in reducing the psychological symptoms of nursing home residents. Last, Cluster 5, which is the group with the fewest members, indicates topics that are infrequently discussed. Cluster 5 represented by purple color, can be categorized under the field of emotion psychology. These words imply an emphasis on researching a variety of emotional topics, such as how emotions differ between the sexes or in kids, their valence (positive or negative), and emotion among students, and utilizing emojis which are frequently used to symbolize emotions in digital communication.

Emerging Topics

The thematic map produced by BibliometriX can be utilized to address RQ2 on novel topics in research about the emotional response of a product. Using a four-quadrant strategic diagram technique, Cobo et al. (Cobo et al., 2011) initially introduced the thematic map. Using this thematic map, four typologies of themes may be defined based on their location in each quadrant (Cahlik, 2000). Quadrant 1 represents a motor theme, quadrant 2 represents a special theme, quadrant 3 represents an emerging or declining theme, and quadrant 4 represents a basic theme. The thematic analysis derives themes from author keyword clusters and their relationships. Density and centrality are two attributes that characterize these topics. The horizontal axis signifies centrality, while the vertical axis denotes density. Density measures the cohesiveness among nodes, whereas centrality reflects the extent of connection among different themes (Esfahani et al., 2019). These two characteristics assess how essential and well-developed a certain topic is. A node's centrality and relevance increase with the number of relationships it has with other nodes in the theme network, and it occupies a crucial position within the network. Cohesion inside a node, which symbolizes the density of a field of study, similarly defines the field's capacity to develop and endure (Agbo et al., 2021). The thematic map of the field of emotional response of a product can be seen in Figure 8.

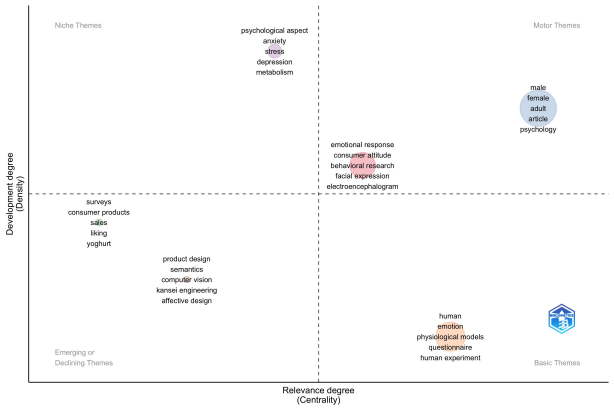

Fig. 8. Thematic Map for The Topic Research in Emotional Response to A Product

The research topics that are growing or decreasing are displayed in Quadrant 3. This quadrant contains the following two clusters. The first clusters are surveys, consumer products, sales, liking, and yogurt. The second cluster is product design, semantic, computer vision, Kansei engineering, and effective design. The results of a co-occurrence analysis performed with a VOS viewer on an overlay visualization, displayed in Figure 9, may be used to verify if the research topics are growing or decreasing. The association between incidence and publication year is seen in the overlay graphic. A new publishing year is indicated from green to yellow, while an old publication year is indicated from green to blue.

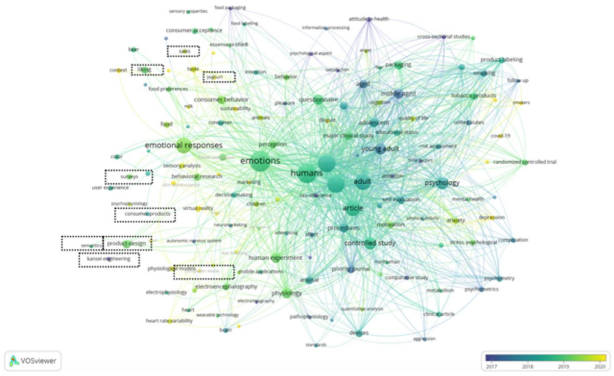

Fig. 9. Overlay Visualization of Research on Emotional Response to Products

Product design, liking, yogurt, sales, semantics, and computer visions have green to yellow colors, indicating they are emerging topics. Kansei engineering, surveys, and consumer products, on the other hand, have a color close to blue, indicating it is a declining topic. Meanwhile, topics in quadrant 1 that must be developed and studied further because of their high density and centrality. This means that are developed and important for the research field. They have well-developed internal links (high density) but unimportant external links and so are of only limited importance for the field (Della Corte et al., 2022). Quadrant 1 contains two clusters. The first cluster is male, female, adult, article, and psychology and the second cluster is emotional response, consumer attitude, behavioral research, facial expression, and electroencephalogram.

Conversely, unique and uncommon themes that are highly evolved with a high density and low centrality are found in the top-left quadrant (quadrant 2). These themes include psychological aspects, anxiety, stress, depression, and metabolism. Furthermore, fundamental themes with high centrality but low density are in the lower right quadrant (quadrant 4). This quadrant includes human, emotions, physiological models, questionnaires, and human experiments.

Figure 10 shows the trend topics regarding user acceptance and emotional response to a product. Food is a research topic that is still being researched today. Several research on emotional responses to food are in soya press cake using face expression method

(Juodeikiene et al., 2021), in ultra-processed food products using brain response method (Fernandes et al., 2022), in plant-based yogurt using the CATA method (Jaeger et al., 2023), in liquid food product for babies using skin conductance response (SCR) and facial expressions method (da Quinta et al., 2023), etc. Meanwhile, odor and chocolate will begin to be researched recently and are still limited in quantity. A study by Laohakangvalvit et al. (2023) examined emotional responses to odor using electroencephalography and Heart Rate Variability (Laohakangvalvit et al., 2023), then research by Rini et al. focused on emotional state in consumers' emotional conceptualizations of dark chocolate using an emoji-based questionnaire (Rini et al., 2022). Additionally, Gao et al. researched consumers' perceptions of chocolate chip cookies containing cricket protein using facial emotional expression (Gao et al., 2023).

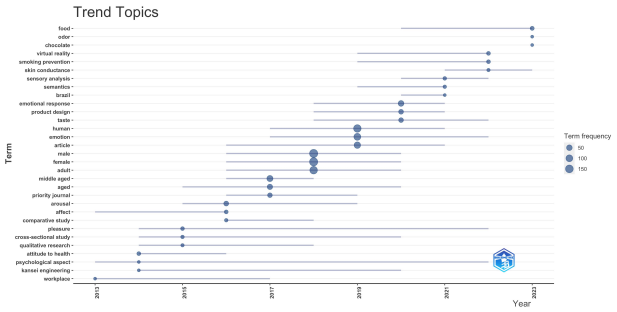

Fig. 10. Trend Topic in Emotional Response Research

Potential Areas of Future Research

To address RQ3, a mapping of future work and direction was carried out in this research. Co-occurrence analysis with an overlay visualization is used to address this RQ3. An overview of the research subjects that are presently being developed and have a substantial impact on studies related to the emotional response of a product will be provided by the overlay visualization (Wijaya et al., 2023). The overlay visualizations, shown in Figures 11.

As previously discussed, Figure 11 shows if the nodes tend toward yellow, it indicates that the topic is an emerging topic. Based on the analysis of these visualizations, several research themes that have garnered significant attention in recent years were identified. One of them is physiological measurement methods to measure emotional responses to products, such as eye tracking, skin conductance, heart rate variability, and electroencephalography. Additionally, a current topic of research is the emotional response linked to product design. This topic is indeed fascinating and has become an increasingly popular area of study. Emotional responses play a very important role in the product design (Shah, 2021). In product design, understanding and responding to user's emotional responses is key to creating successful products and meeting customer expectations. Due to their popularity and impact in the field, these areas provide considerable scope for extended study and point toward potential areas of interest for future research initiatives. Research focusing on emotional response plays a crucial role in developing products that align more closely with the needs and preferences of users. Products that elicit a positive emotional response are likely to increase user satisfaction, which directly contributes to an improved quality of life. This research also drives user-centric product design, ensuring that products not only meet functional needs but also positively influence users' emotional well-being.

Figure 11 shows that aspects of purchase intention and marketing are also interesting topics for future research when connected to consumers' emotional responses to products. The emotional response to a product can significantly influence the purchase intention (Sharma et al., 2023; Syahid & Setyanto, 2019). One of the core components that construct consumer satisfaction is the emotion (Calvo-Porral et al., 2018). Products that can evoke positive emotions, such as happiness or satisfaction, tend to enhance purchase intention. Conversely, negative emotions can inhibit the desire to make a purchase. Marketing plays a key role in managing these emotional responses and purchase intentions (Sharma et al., 2023). Smart marketing strategies can design messages, campaigns, or customer experiences aimed at triggering desired emotions and increasing purchase intention. The measurement of emotions through various tools and research is also an integral part of understanding consumer responses to products. Ultimately, this relationship directly affects consumers' purchase decisions, with a strong purchase intention and positive emotional response encouraging them to buy the product. The overall relationship reflects the complexity of marketing efforts and the endeavor to build positive relationships with customers.

Figure 12 presents the density visualization from the study on emotional responses to products. This feature aids in identifying areas with a high concentration of research within a field. The density visualization results show that densely populated areas are indicated by the proximity of many nodes to one another. Frequently appearing keywords are highlighted with a yellow color surrounding them. In other words, these areas represent topics that have been extensively

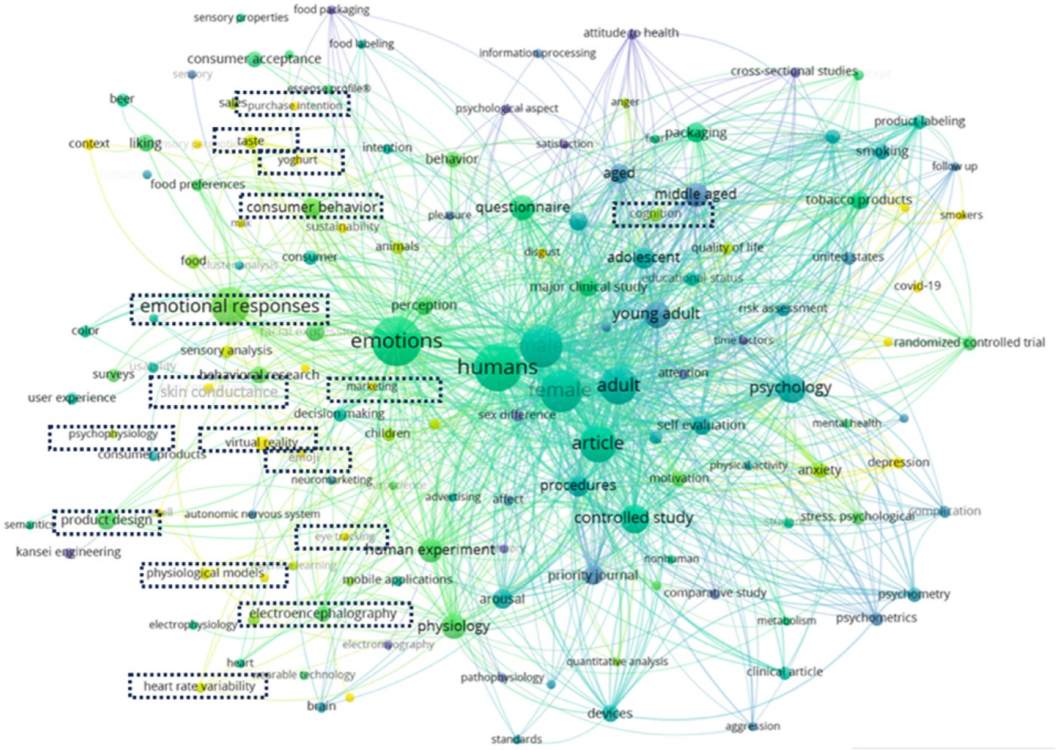

Fig. 11. Overlay Visualization of Research Topic

researched, such as emotions, humans, adults, and emotional responses. Meanwhile, topics encompassed in green indicate areas that have not been widely researched, such as wearable technology, purchase intention, cognition, pleasure, fear, electroencephalography, physical activity, electromyography, electrophysiology, facial expression, and skin conductance. This indicates the current research gaps, suggesting ample opportunities for research in these topics.

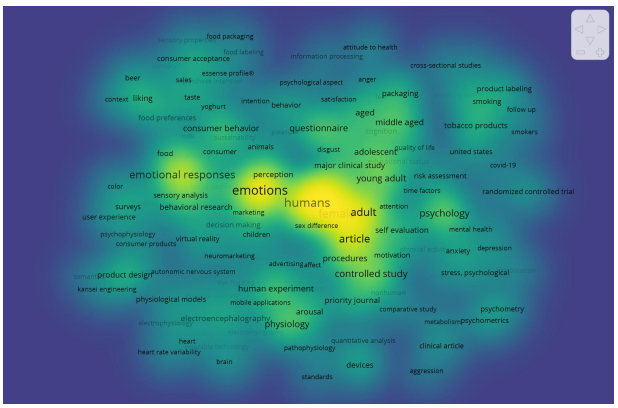

Fig. 12. Density Visualization of Research on Emotional Response to Products

Conclusions

A bibliometric analysis in this study tries to analyze trends and find untouched areas in product-related emotional reaction research. The study illustrates the growth of research on emotional response to the products, showing an average annual publication growth of 9.6%. There is a rising trend in publications on this topic, indicating growing academic interest. However, citation trends have fluctuated, peaking in 2018. The USA, UK, Spain, and Australia are the top countries in this research area. This topic spans various scientific fields, including agriculture, medicine, social science, computer science, engineering, neuroscience, psychology, business, management, art and humanities.

Five topic clusters currently dominate the field of product-related emotional response research. There are emotional response measurement techniques based on physiological methods, human behavior expressions related to product acceptability, the population that uses the product, behavioral and psychological symptoms, and emotion psychology. Yogurt, consumer goods, and product design are examples of emerging study areas. Physiological assessment techniques, the relationship between emotional reaction and product design, and

customer purchase intentions are the main areas of focus for future study. Density visualization points out regions that have received a lot of research and indicate areas that might use more investigation, such as wearable technology, purchase intention, cognition, pleasure, fear, electroencephalography, physical activity, electromyography, electrophysiology, facial expression, and skin conductance.

There are several limitations in this study. The primary source for this research is the Scopus database, and it only analyzes the co-occurrence aspect. To analyze product acceptability based on emotional research, future study is expected to take into consideration more publishing sources. Moreover, this study is constrained to a time frame from 2013 to 2023. It is recommended for future research to include documents published since the initial coinage of the term 'emotional response' about product acceptance by users, to achieve a more comprehensive understanding.

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