JOURNAL OF DEVELOPMENT STUDIES (JDS)
VOL.5-NO.1(5)-2024
DOI: https://doi.org/10.52340/jds
ISSN 2667-9922

Public Perception of Innovation and Technology Investments/Products During Economic Hardships

Aslı Kılıc[1], Ceren Cubukcu Cerasi[2], Yavuz Selim Balcioglu[3]

ARTICLE INFO

Article history:

Accepted: September 3, 2024
Approved: December 15, 2024

Keywords:

Innovation, Technology, Investment, Perception.

ABSTRACT

This study investigates public perceptions of innovation and technology during economic hardships, with a focus on discussions on the social media platform Reddit. Utilizing advanced data mining and natural language processing (NLP) techniques, this research analyzes Reddit posts to uncover sentiment trends, thematic patterns, and levels of public engagement related to technology investments during economic downturns. By methodically gathering and processing user-generated content, the study aims to map out variations in public attitudes towards innovation in response to economic shifts. The analysis employs sophisticated NLP techniques, including sentiment analysis, topic modeling, and semantic analysis, to interpret the rich and diverse discussions occurring on Reddit.

The findings reveal a predominantly positive sentiment towards technology investments, with significant discussions centered around public perception, technological strategies, and environmental impact. The study also identifies key themes that dominate conversations at various stages of economic movement, providing insights into the effectiveness of technological tools and products during challenging times.

This research not only contributes to the academic understanding of public discourse on innovation and technology, but also offers valuable insights for organizations, policymakers, and social media strategists aiming to promote innovation amidst economic adversity. The study's detailed sentiment timeline and thematic analysis provide a comprehensive overview of how public perceptions evolve in response to economic conditions, offering practical implications for fostering technological advancements in difficult economic climates.

[1] Gebze Technical University, Gebze, Kocaeli, Turkey.
[2] Gebze Technical University, Gebze, Kocaeli, Turkey.
[3] Gebze Technical University, Gebze, Kocaeli, Turkey.

Introduction

Today's technologies are rapidly developing and evolving. How these innovations are received by the public is an aspect that needs to be considered. Examining the ways in which innovations and technologies are received by the public plays an effective role in evaluating technological development, determining the next step of development, and organizing public policies (Moreno&Luján, 1993). The public's perspective on an innovation or technological development may be affected by a variety of reasons, among them gender, economic, political, or environmental concerns.

There is a relationship between public opinion and companies' investment in innovation (Zhang *et al.,* 2018). It has been shown that public reaction to environmental concerns has a positive influence on construction companies' decision-making processes regarding green innovations (Wang *et al.,* 2022). In recent years, it has been observed that encouragement for innovations has increased in both developed and developing economies based on public support (Rosário *et al.,* 2022).

Different analysis methods can be chosen to investigate public opinions. One of these is sentiment analysis. Sentiment analysis is a natural language processing method that allows the classification of sentiments based on a written text, sentence, or a certain feature. Natural language processing is a common method used to understand people's ideas in different areas, such as finance, marketing, and advertising. For this method, social media data is frequently preferred, both because of the size of the data and because it provides the most direct access to people's feelings and ideas. In this study, data was collected from the Reddit social media platform.

While prior research has examined public perceptions of innovation and technology through surveys, interviews, and traditional sentiment analysis methods, there is a paucity of studies leveraging large-scale social media data to analyze sentiment during economic hardships. Moreover, the dynamic evolution of public attitudes across different economic cycles remains insufficiently explored, particularly within the context of online discourse. This study aims to address these gaps by utilizing Reddit – a platform that hosts diverse and real-time discussions – to explore public sentiment and identify thematic trends related to technology investments during periods of economic downturn.

The focus of the study is to examine people's perspectives on technology and innovations according to economic change, and examines public perceptions of innovation and technology in the context of economic hardships, with a particular focus on discussions conducted on the social media platform Reddit.

Literature Review

Innovation does not only mean creating a new product or service, but also the need to produce different strategies (Rosário *et al.,* 2022). Therefore, it can be said that innovations are essential for companies to survive. Studies suggest that during economic downturns, it is the innovative businesses that sur-

vive (Uçaktürk *et al.,* 2011). López Fernández *et al.* (2018) conducted a study on this subject and examined the relationship between innovation and business results in several economic cycles. Using the economic-financial data of more than 900 manufacturing companies in the Spanish automotive sector for the period 2002-2014, the study found that innovation had a positive influence on the business results, depending on their size and the economic period.

There are studies that investigate public perception of innovations. The Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB) and the Unified Theory of Acceptance and Use of Technology (UTAUT) are the three theoretical approaches most often used to measure technology acceptance, according to the literature (Gijón *et al.*, 2021). Gijón *et al.* (2021) developed a model through surveys to examine the public's perspective on innovations from different perspectives in Spain. One of the results of the study revealed that the perception of innovation is related to the level of education, indicating that people with a higher level of education have a better approach to innovation. Irawan *et al.* (2023) conducted a qualitative data analysis through application comments to measure the public's perspective on the Mobile National Health Insurance (JKN) application used in Indonesia. The analysis concluded that the public's general view of the application was negative.

Since different problems are encountered, such as high expense, risk, and low demand for innovation (Pohulak-Żołędowska, 2016), public opinion is used so as to ensure the acceptance and legitimacy of innovations. Legitimacy is a principal concept, especially for new technologies, because it is essential for determining the necessary regulators, as well as economic and material resources (Markard *et al.,* 2016). Dehler-Holland *et al.* (2022) conducted a sentiment analysis on publications from four different newspapers between 2009 and 2018, to investigate whether wind energy is still a legitimate energy source in Germany, despite decreasing investments following lawsuits, and increasing backlash. As a result, it was seen that even if wind energy is still a legitimate energy source for Germany, further political regulations are needed for people, animals and the environment. Shen *et al.* (2021) examined the public's views on innovations in different areas related to the Sustainable Development Goals (SDGs) via Twitter*. In this study, which examined a four-year period, it was seen that topics such as sustainable agriculture, environmentally friendly materials, and green energy were frequently discussed, and there was generally positive emotional content, whereas it was seen that people expressed "negative" views about agricultural innovations.

With the developing technology, countries have started to invest more in innovations. In order to get the rewards of these investments, it has become important to measure the public's perspective on innovations and to identify innovation barriers. In 2020, De Fuentes *et al.* studied two firms from emerging economies, Mexico and Tur-

* Note: Twitter officially known as X since 2023.

key, to investigate the factors affecting their perception of innovation barriers. The firm and context characteristics were found to be important factors of the firms' perception of said barriers. By analyzing the overall market sentiment, Dang and Xu (2018) showed that financially constrained firms are more likely to invest in R&D than unconstrained firms. To investigate the impact of technological innovations in a company on the reputation of that company, Caviggioli *et al*. (2020) conducted a study with Twitter data. According to the public's comments from Twitter about five companies that switched to Bitcoin as a payment method, the reputation of the companies increased positively in a short time, and more rapidly still with the innovations made. There are studies where sentiment analysis is used not only to learn the public's opinion about the innovation to be made, but also to obtain innovation ideas. In their study of online user reviews on Amazon, a shopping application, Zhang *et al*. (2021) extracted innovation ideas for products.

Natural language processing is an effective method that enables research on many different topics, among them politics (Al-Razgan *et al.,* 2021), marketing (Wu *et al.,* 2024), sustainability (Cubukcu-Cerasi *et al.,* 2023), health (Park *et al*., 2024), and finance (Todd *et al.,* 2024). The public's response to innovations can be measured using textual data. In this way, the reasons for their opinions can be investigated, and the necessary arrangements can be made to ensure the permanence of innovations.

Methods

This study examines the public discourse and sentiment surrounding innovation and technology investments/products during periods of economic adversity. It employs topic modeling and sentiment analysis methodologies, using natural language processing (NLP) methods. The data was obtained from Reddit, a platform where users often engage in discussions on various subjects, such as technology and economic circumstances. Public chatter was efficiently analyzed using data science methods to classify latent topics and feelings.

Data Collection and Cleaning

Reddit is a popular social media network that has around 57 million active users daily, as of 2023. It provides a vast amount of user-generated content through multiple subreddits that focus on different topics. In this study, we primarily utilized Reddit as our data source because of its large user population and the wide range of viewpoints voiced on the network. We gathered a grand total of 5,329 posts from pertinent subreddits that delve into topics of innovation, technology, and economic circumstances.

The data was obtained through the utilization of Apify, a tool designed for web scraping and data extraction. This platform facilitated the automated capture of Reddit posts and comments. Apify's technologies enabled the extraction of pertinent threads, comments, and related metadata. To adhere to ethical research protocols, all personal data

was anonymised to safeguard user privacy. The data obtained was also streamlined to encompass solely the essential information pertinent to the study's objectives.

Data Analysis

The analysis was conducted in three main steps:

1. **Word Frequency Analysis**: To identify the most commonly discussed topics, we first analyzed the frequency of words and phrases within the collected data. This step helped us understand the public's primary interests related to innovation and technology during economic hardships. A word cloud visualization was generated to present these high-frequency terms intuitively, making critical information easily accessible.
2. **Topic Modeling**: To uncover the latent topics within the Reddit discussions, we employed topic modeling techniques, specifically Latent Dirichlet Allocation (LDA). Topic modeling allowed us to cluster related content, revealing the associations among various subjects. This approach was crucial in exploring the breadth and depth of discussions, providing insights into the multifaceted nature of public discourse.
3. **Sentiment Analysis**: Finally, sentiment analysis was performed to gauge the emotional tendencies conveyed in the text. By classifying sentiments as positive, neutral, or negative, we were able to track emotional shifts in public perception over time. This analysis helped us to identify positive attitudes, concerns, and potential issues related to innovation and technology in the context of economic challenges.

Through this comprehensive approach, we aimed to provide a detailed understanding of how public sentiment and discourse on innovation and technology evolve during periods of economic hardship.

Topic Modeling

All data analyses were conducted using Python (version 3.10). For topic modeling, we explored three well-established techniques to identify and analyze the latent topics within the Reddit posts:

- **Latent Dirichlet Allocation (LDA)**: A widely used probabilistic model that discerns latent topics by assuming that each document is a mixture of a small number of topics, and that each word's presence is attributable to one of these topics.
- **Non-Negative Matrix Factorization (NMF)**: This technique emphasizes the relationship between documents and topics by decomposing the term-document matrix into two lower-dimensional matrices, representing documents and topics. NMF is particularly effective in revealing the underlying structure in the data.
- **Transformer-Based Models**: These models, especially BERT (Bidirectional Encoder Representations from Transformers), are renowned for their proficiency in understanding the intricate semantics embedded within textual data. They offer advanced capabilities in capturing contextual relationships, and are highly effective for complex text analysis.

For this study, LDA was selected as the primary method due to its balance between

interpretability and effectiveness in topic extraction from large textual datasets, like those sourced from Reddit. The topics identified through LDA provided a comprehensive overview of the various discussions surrounding innovation and technology in the context of economic hardships.

In this study, we employed a hybrid approach combining VADER (Valence Aware Dictionary and sEntiment Reasoner) and TextBlob for sentiment classification.

- VADER is a rule-based model well-suited for social media text, known for its accuracy in capturing sentiment intensity.
- TextBlob provides a simple API for common natural language processing tasks, and its sentiment analysis tool relies on a combination of rule-based and machine learning approaches.

By integrating the results of VADER and TextBlob, we leveraged their respective strengths to enhance the overall performance of sentiment analysis. This combined approach mitigated the individual biases of each tool and provided a more robust and adaptable sentiment analysis, especially in handling the diverse language styles and expressions present in Reddit posts. This method allowed us to accurately capture the emotional tone of discussions related to innovation and technology during economic downturns.

Results

Word Frequency

In this section, word clouds and frequency graphs provide initial insights into the diverse perspectives of the general public on innovation and technology investments during economic hardships. The analysis includes a total of 5,329 Reddit posts and comments, which were meticulously collected and processed to extract meaningful insights. Figure 1 displays the top 20 most common words from these entries.

As shown in Figure 1, the public's discourse around innovation and technology during economic challenges is multifaceted. Words such as "public," "innovation," and "technology" reflect the central themes of the discussions, indicating a strong focus on the broader implications of technological advancements. The frequent appearance of terms like "economic," "investments," and "hardships" highlights the contextual background of these discussions, emphasizing the economic environment in which these conversations are taking place.

Moreover, the prominence of words such as "perception," "study," and "research" indicates the public's interest in understanding and analyzing the impacts of innovation within this context. The inclusion of words like "collected," "data," and "analyzing" further underscores the data-driven nature of these discussions, suggesting that many contributors are focused on empirical evidence and analytical approaches.

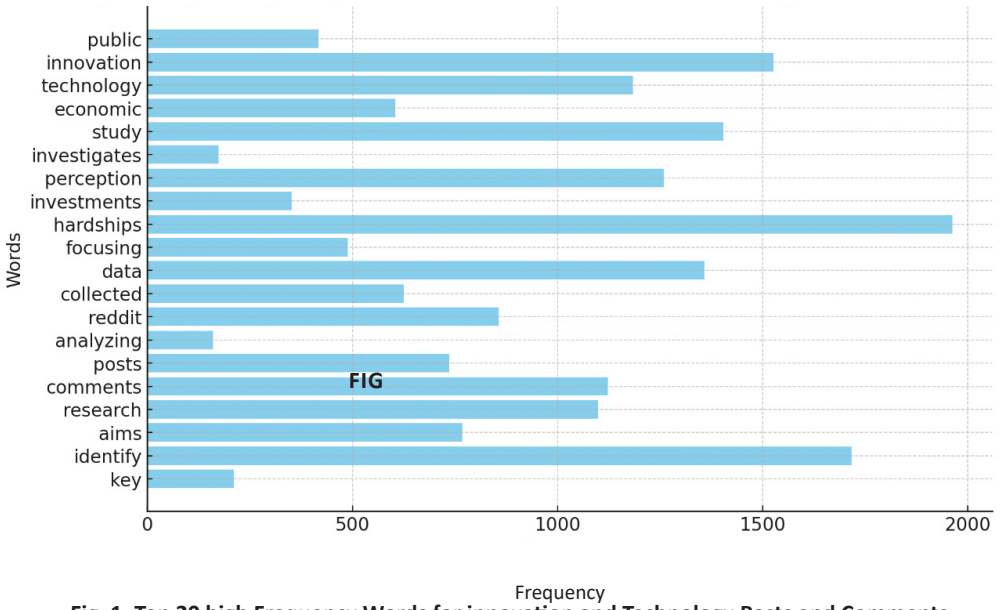

Fig. 1. Top 20 high Frequency Words for innovation and Technology Posts and Comments

Additionally, words like "comments," "posts," and "Reddit" reflect the source and medium of the data, while terms like "identify," "focusing," and "aims" point to the objectives and goals within these discussions. This varied vocabulary illustrates the complexity of public opinion regarding innovation and technology, particularly in challenging economic times.

Topic Modeling

This section presents the emergent topics and themes identified through topic modeling, aiming to address the research question: What are the emerging topics related to innovation and technology investments during economic hardships? The study combines qualitative and quantitative content analysis to uncover and explore latent topics and themes in the public discourse on Reddit. This approach is particularly valuable for research in the field of social media analysis, where understanding public sentiment and discussion trends can provide critical insights.

Latent Dirichlet Allocation (LDA) was employed as the primary quantitative method for topic classification. LDA is effective in determining the most optimal number of topics by evaluating the perplexity scores, which measure how well the model fits the data. As shown in Figure 2, the perplexity versus the number of topics curve is plotted to guide the selection of the optimal number of topics.

Generally, a lower perplexity score indicates a more accurate model fit. The confusion score achieves its minimum when the number of topics is adjusted to 20 in this investigation. Nevertheless, it is crucial to acknowledge that the lowest perplexity does not consistently signify the optimal model performance. Models that have a large number of subjects may suffer from overfitting, which can result in excessive and non-converging topic counts. Overfitting can lead to excessive duplication, causing topics to lose their distinctiveness and uniqueness. In order to deal with these difficulties, it is often necessary to rely on human judgment to establish the most suitable number of topics. This manual examination follows two specific principles: (1) establishing strong consistency among terms within each topic, and (2) upholding the quality of topics by eliminating repetition, conflict, and providing comprehensive coverage of primary content. This methodical technique aids in discerning the most significant and unique subjects within the data, resulting in a more lucid comprehension of public discussions around innovation and technology during periods of economic decline.

This study examines the categorization of themes and the occurrence of high-frequency words within each subject, with the number of topics set at 8 (Table 1). Nevertheless, the findings reveal certain constraints regarding the consistency and cal-

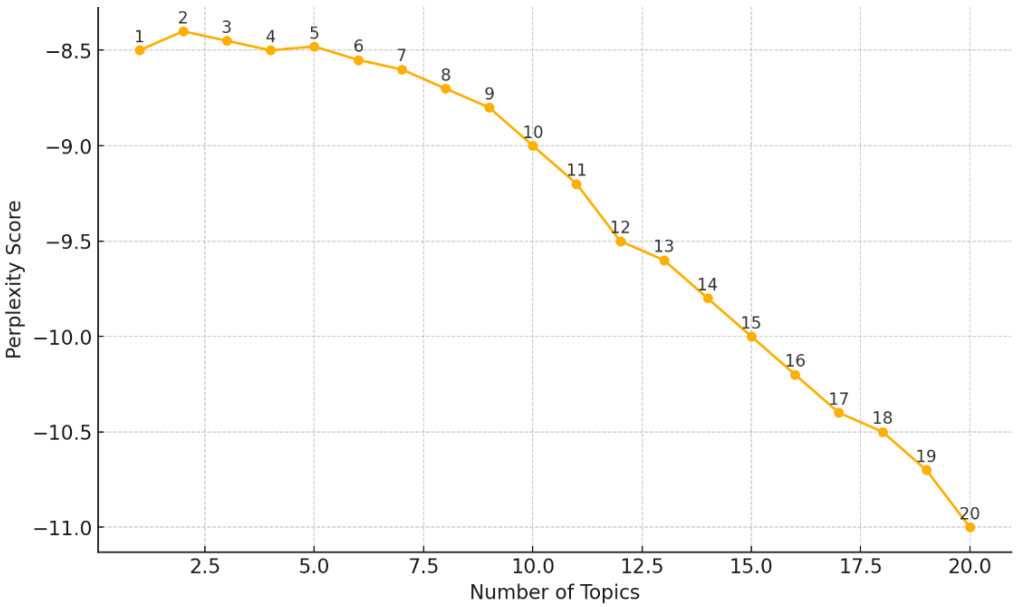

Fig. 2. Perplexity vs. number of topics

Table 1. Top words of eight topics

Topic	Representative words
1	innovation, technology, economic, public, investments, perception, study, hardships, data, analyze
2	sustainability, green, energy, climate, solutions, future, companies, sustainable, resources, environment
3	challenges, barriers, risks, impact, global, economic, uncertainty, crisis, market, adaptation
4	development, growth, opportunities, advancement, research, trends, future, potential, projects, initiatives
5	digital, transformation, strategy, adoption, change, infrastructure, systems, implementation, cloud, tools
6	government, policy, regulation, funding, support, initiatives, incentives, economic, programs, innovation
7	consumer, behavior, trends, preferences, products, services, market, adoption, influence, decisions
8	technology, investments, innovation, economic, public, perception, hardships, challenges, analyze, data

iber of the topics. Throughout the many topics, there is a clear absence of cohesive themes, as the words seem disconnected and less interconnected within each category. The chosen phrases do not consistently provide clear and significant subjects, which could diminish the model's ability to capture the fundamental structure of the data. In order to tackle this issue, the study also examined the quantity of subjects that corresponded to the point where ambiguity significantly decreased. It identified 7 topics that were situated close to the inflection point of the curve, which was deemed to be a more ideal answer. Table 2 displays the distribution of word frequencies within relevant subjects when there are 7 topics. The highest-ranking words in each topic demonstrate enhanced coherence and topic quality, resulting in more distinct and relevant themes.

Table 2 categorizes the top 10 words from each of the 7 topics into three overarching themes: Public Perception, Environmental Impact, and Economic Challenges. The analysis of these seven topics reveals the breadth of discussions on innovation and technology investments during economic hardships within the Reddit community. These discussions encompass key areas, such as public sentiment towards innovation, the impact of sustainability and environmental considerations, and the economic challenges and opportunities associated with technological advancements. The topics reflect the multifaceted nature of public discourse on these issues, highlighting the diverse perspectives and concerns that arise during periods of economic difficulty.

Sentiment Analysis

For the purpose of addressing study question 2, two sentiment analysis models, Vader

Table 2. Top words of seven topics and three themes

Topic	Representative words	Theme
1	innovation, technology, economic, investments, data, analyze, public, perception, challenges, hardships	Public Perception
2	sustainability, green, energy, climate, solutions, companies, sustainable, resources, environment, future	Environmental Impact
3	challenges, barriers, risks, impact, uncertainty, global, economic, crisis, market, adaptation	Economic Challenges
4	development, growth, opportunities, research, advancement, trends, projects, initiatives, potential, future	Economic Opportunities
5	digital, transformation, strategy, adoption, systems, infrastructure, implementation, change, cloud, tools	Technological Strategies
6	government, policy, regulation, funding, support, incentives, programs, initiatives, economic, innovation	Policy and Regulation
7	consumer, behavior, trends, preferences, market, products, services, influence, adoption, decisions	Consumer Behavior

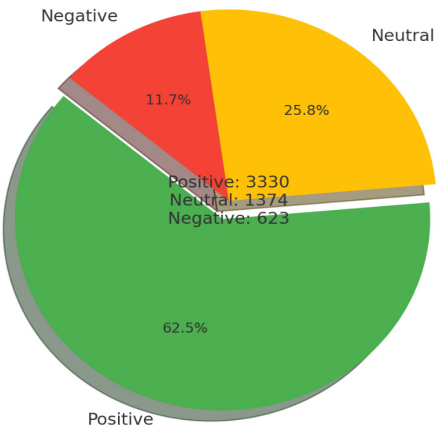

Fig. 3. The weighting of the sentiment pie chart

and TextBlob, were utilized. These models were allocated weights of 0.6 and 0.4, respectively, to classify sentiment. The sentiment analysis classified the emotional tone of the 5,329 Reddit posts into three unique categories: positive, neutral, and negative. Figure 3 illustrates the allocation of weights to these sentiment groups. The data indicates that the majority of Reddit users expressed a positive attitude, with around 62.5% of the postings conveying positive emotional subtleties. Conversely, approximately 11.47% of the posts conveyed negative thoughts, whereas neutral sentiments make up 25.8% of the overall entries. The distribution of opinions suggests that, despite the difficulties related to economic struggles, the Reddit community largely holds a positive view towards investing in innovation and technology.

Conclusion

In the midst of economic challenges, the significance of allocating resources towards innovation and technology has increased, especially in terms of their capacity to influence public opinion and affect political choices. This study investigates the viewpoints of the general public regarding the use and impacts of technology investments, during economic downturns, through the application of topic modeling and sentiment analysis. Unlike traditional survey methods, this study employed an extensive data mining technique, gathering data from Reddit posts and comments. The system employed the Latent Dirichlet Allocation (LDA) unsupervised learning model to generate seven topics. The implementation utilized a weighted sentiment analysis technique that combines the VADER and TextBlob algorithms to analyze the sentiment patterns in the postings. The findings uncovered seven subjects of public discussion on innovation and technology investments, which are classified into three overarching themes: public perception, technological strategy, and environmental impact. These findings indicate that the public should thoroughly investigate the potential consequences of investing in technology, as there are prospects for progress in areas such as sustainability, digital transformation, and policymaking. The broad deliberations concerning technology initiatives demonstrate a significant emphasis on how these investments might propel digital transformation and augment operational efficiencies, particularly in the face of economic difficulties. Concurrently, conversations regarding the effects on the environment emphasize the increasing significance of sustainability and environmentally friendly technologies in public discussions.

Sentiment analysis shows that the general public holds a predominantly positive attitude towards technology investments during economic hardships, with approximately 62.5% of posts conveying positive sentiments. Neutral sentiments account for 25.8%, while 11.7% of the posts express negative views. This indicates broad optimism towards the potential of technology to mitigate the challenges posed by economic downturns, although there remain concerns and criticisms, particularly regarding the risks and uncertainties associated with these investments.

For practical implications, this study offers valuable insights into potential strategies for policymakers, business leaders, and technology developers. Companies and developers should prioritize the implementation of user-friendly technological solutions that align with public sentiment. Given the positive outlook towards technology, efforts should be made to leverage this sentiment in promoting further investments, particularly in areas that are perceived as having a significant impact, such as sustainability and digital transformation. Additionally, policymakers should consider the public's concerns regarding environmental and economic impacts when designing policies that encourage technological innovation during economic hardships.

Users must comprehend the impact of technology investments on their lives during economic hardships, and acquire proficiency in properly utilizing the evolving technologies. It is important for the general public to carefully evaluate the benefits and drawbacks of these expenditures, considering their potential long-term effects on both the economy and the environment. Prior study has highlighted concerns regarding the ethical implications of technology, including the possibility of employment displacement, data privacy issues, and the "digital divide." As such, it is imperative for all parties involved to actively participate in open discussions concerning the ethical utilization and regulations of technology, with the aim of fostering openness, responsibility, and impartiality in its implementation.

Although this study has made valuable contributions, it is important to acknowledge its limits. Initially, it is reliant on data sourced exclusively from a single social media network, Reddit, wherein the user demographic may not accurately reflect the overall population. This may restrict the applicability of the results to other social media platforms and wider public perspectives. Subsequent investigations should examine public sentiments on various platforms, including Twitter, Facebook, and LinkedIn, in order to provide a more thorough understanding of public perspectives. Conducting comparative assessments across several platforms would provide a more comprehensive understanding of how different demographic groups perceive technology investments during economic difficulties.

Furthermore, the study is characterized by its descriptive nature, and it is recommended that future research focuses on carrying out causal studies to investigate the effects of technological investments on different sectors of society. One such approach is to use quantitative approaches, such as regression analysis, to evaluate how public sentiment is related to real economic results. In addition, a longitudinal research approach might investigate the evolution of public perception over time, specifically in relation to changes to economic situations and technological improvements. This study fails to pinpoint the exact regions where negative perceptions are most prominent. A more comprehensive qualitative content analysis could investigate unfavorable posts and comments to reveal distinct patterns and underlying anxieties. This would enhance comprehension of the constraints and hazards linked to technological investments, directing further enhancements and more focused interventions. This study adds to the expanding information base on how the public perceives technology investments during economic difficulties, providing significant insights for stakeholders in several sectors. By acknowledging and overcoming the constraints, and broadening the range of future investigations, it is feasible to cultivate a more intricate comprehension of how technology might be utilized to surmount economic obstacles and stimulate sustainable progress.

References

Al-Razgan, M., Alrowily, A., Al-Matham, R. N., Alghamdi, K. M., Shaabi, M., & Alssum, L. (2021). Using diffusion of innovation theory and sentiment analysis to analyze attitudes toward driving adoption by Saudi women. *Technology in Society*, 65, 101558.

Caviggioli, F., Lamberti, L., Landoni, P., & Meola, P. (2020). Technology adoption news and corporate reputation: Sentiment analysis about the introduction of Bitcoin. *Journal of Product & Brand Management*, 29(7), 877-897.

Cubukcu-Cerasi, C., Balcioglu, Y. S., Kilic, A., & Huseynov, F. (2023). Embracing green choices: Sentiment analysis of sustainable consumption. *The Eurasia Proceedings of Science Technology Engineering and Mathematics*, 23, 253-261.

Dang, T. V., & Xu, Z. (2018). Market sentiment and innovation activities. *Journal of Financial and Quantitative Analysis*, 53(3), 1135-1161.

De Fuentes, C., Santiago, F., & Temel, S. (2020). Perception of innovation barriers by successful and unsuccessful innovators in emerging economies. *The Journal of Technology Transfer*, 45(4), 1283-1307.

Dehler-Holland, J., Okoh, M., & Keles, D. (2022). Assessing technology legitimacy with topic models and sentiment analysis – The case of wind power in Germany. *Technological Forecasting and Social Change*, 175, 121354.

Gijón, C. & Albarrán Lozano, I. & Molina, J. M. (2021). Perception of innovation in Spain. 23rd Biennial Conference of the International Telecommunications Society (ITS): *Digital societies and industrial transformations: Policies, markets, and technologies in a post-Covid world*.

Irawan, B., Putri, T. K., Zulkifli, Z., & Akbar, P. (2023). Public Perception Of Health Insurance Technology-Based Innovation In Indonesia. *Jurnal Administrasi Publik (Public Administration Journal)*, 13(1), 31-40.

López Fernández, J. M., Somohano Rodríguez, F. M., & Martínez García, F. J. (2018). Effect of the innovation on the profitability of micro and SMEs in economic contexts of economic recession and growth. *Tec Empresarial*, 12(1), 7-18.

Markard, J., Wirth, S., & Truffer, B. (2016). Institutional dynamics and technology legitimacy – A framework and a case study on biogas technology. *Research Policy*, 45(1), 330-344.

Moreno, L. & Luján, J. (1993). The Social Study of Technology: The Case for Public Perception and Biotechnology.

Park, B., Jang, I. S., & Kwak, D. (2024). Sentiment analysis of the COVID-19 vaccine perception. *Health Informatics Journal*, 30(1), 14604582241236131.

Pohulak-Żołędowska, E. (2016). Innovation in Contemporary Economies. *Oeconomia Copernicana*, 7(3), 451-466. DOI: http://dx.doi.org/10.12775/OeC.2016.026

Rosario, C., Varum, C., & Botelho, A. (2022). Impact of Public Support for Innovation on Company Performance: Review and Meta-Analysis. *Sustainability*, 14(8), 4731.

Shen, C. W., Luong, T. H., & Pham, T. (2021). Exploration of social media opinions on innovation for sustainable development goals by topic modeling and sentiment analysis. In Research and Innovation Forum 2020: *Disruptive Technologies in Times of Change*, pp. 459-471. Springer International Publishing.

Todd, A., Bowden, J., & Moshfeghi, Y. (2024). Text-based sentiment analysis in finance: Synthesizing the existing literature and exploring future directions. *Intelligent Systems in Accounting, Finance and Management*, 31(1), e1549.

Uçaktürk, A., Bekmezci, M., & Ucaktürk, T. (2011). Prevailing during the periods of economical crisis and recession through business model innovation. *Procedia-Social and Behavioral Sciences*, 24, 89-100.

Wang, B., Han, S., Ao, Y., Liao, F., Wang, T., & Chen, Y. (2022). The impact of public opinion pressure on construction company green innovations: the mediating effect of leaders' environmental intention and the moderating effect of environmental regulation. *Frontiers in Psychology*, 13, 936058.

Wu, S. J., Chiang, R. D., & Chang, H. C. (2024). Applying sentiment analysis in social web for smart decision support marketing. *Journal of Ambient Intelligence and Humanized Computing*, 15(3), 1927-1936.

Zhang, M., Fan, B., Zhang, N., Wang, W., & Fan, W. (2021). Mining product innovation ideas from online reviews. *Information Processing & Management*, 58(1), 102389.

Zhang, W., Kang, L., Jiang, Q., & Pei, L. (2018). From buzz to bucks: The impact of social media opinions on the locus of innovation. *Electronic Commerce Research and Applications*, 30, 125-137.