APPLICATION OF DATA SCIENCE FOR BUILDING CORPORATE REPUTATION STRATEGY: AN ANALYSIS IN BUSINESS INTANGIBLES SCOPING REVIEW

Matías Domínguez-Quiñones *, Iñaki Aliende **, Lorenzo Escot ***

* Corresponding author, Faculty of Statistical Studies, Complutense University of Madrid, Madrid, Spain
Contact details: Faculty of Statistical Studies, Complutense University of Madrid, Ciudad Universitaria, Avenida Puerta de Hierro, S/N, 28040 Madrid, Spain
** Faculty of Economics and Business, Complutense University of Madrid, Madrid, Spain
*** Department of Applied, Public and Political Economics, Faculty of Statistical Studies, Complutense University of Madrid, Madrid, Spain

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Abstract

This scoping review examines the application of data science (DS) on corporate reputation and other intangible business assets, highlighting their combined value to companies. These assets are crucial in hyperconnected environments for a new sustainability model, given the increased global competition, product communication, stakeholder relations, social media activity, and marketing strategies amid geopolitical and economic challenges. DS enhances corporate reputation and other intangibles by measuring indicators, metrics, and variables with data series, thereby demonstrating the company's reality. Objectives and hypotheses were developed to address conceptual gaps and assess DS's impact on corporate reputation and related intangibles such as corporate communication, stakeholder relations, and marketing. Hypotheses suggest that DS positively affects: 1) corporate communication, 2) stakeholder relations, 3) social network impact, and 4) innovation in marketing techniques. A scoping review methodology, guided by search, appraisal, synthesis, and analysis (SALSA) and preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) frameworks, facilitated a quantitative analysis of academic literature and perspectives from 64 out of 172 publications in Web of Science (WoS) and Scopus. This study's relevance is highlighted by the paucity of similar research over 20 years that combines these concepts and underscores their strategic value through DS application. Findings emphasize the strategic importance of these assets for economic growth, challenges in measuring and reporting business impact, and the lack of consensus on defining intangible constructs. Future research is recommended on links to other intangibles like trust, business ethics, and sustainability.

Keywords: Corporate Reputation, Data Science, Intangibles, Corporate Communication, Stakeholders, Marketing

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1. INTRODUCTION

In a hyperconnected world, organizations face heightened competition, geopolitical challenges, and economic difficulties (de Leaniz & del Bosque Rodríguez, 2016). This necessitates analyzing intangible business assets like corporate reputation, corporate communication, stakeholder relations, and marketing, alongside their impact through data science (DS) (Konstantinova & Konarev, 2020). Over the past two decades, the interest in intangible assets has surged, recognizing their importance in the corporate economy and strategic planning (von Borowski Dodl, 2021). These factors demand innovation and strategy transformation to achieve competitive advantage and sustainable efficiency (Martín-de Castro et al., 2022).

The number of studies, articles, and publications in literature reviews concerning intangible assets and DS has significantly increased. Recent literature reviews emphasize results, conclusions, definitions, and findings (Ali, 2022; Nichita, 2019; Castilla-Polo & Ruiz-Rodríguez, 2017; Grimaldi et al., 2017; Nwogugu, 2015). However, this trend is limited by bibliographic gaps due to the lack of studies jointly exploring literature reviews on these concepts, particularly the application of DS to intangibles like corporate reputation and other intangibles such as corporate communication, stakeholder relations, and marketing. Intangible assets such as corporate reputation, corporate communication, stakeholder relations, or marketing are increasingly vital in the contemporary business environment, significantly contributing to a company's value and competitive advantage (Kotu & Deshpande, 2019). Scholars assert that relationship capital (RC) is currently the most valuable intangible asset for organizations (Villafañe Gallego, 2004), reflecting a company's effective industry performance (Chun, 2005). This asset can enhance value generation and maintain a competitive advantage in the medium and long term due to its difficulty in replicating (Kırçova & Esen, 2018). Furthermore, managing intangible assets like ethics and sustainability effectively can largely fulfill the needs and expectations of various stakeholders (Ali, 2022).

DS has become an interdisciplinary field that processes extensive structured and unstructured data to uncover patterns and extract actionable insights for decision-making, driven by the rise of big data from social networks, the Internet of Things (IoT), and the digital economy, thereby amplifying DS's significance (Ojha & Pani, 2020). DS offers techniques for real-time information analysis for stakeholders and within a company's value chain, as well as methods to enhance organizational intangible assets (Liu et al., 2019). This study focuses on leveraging DS to improve intangibles such as corporate reputation, corporate citizenship, stakeholder relations, and marketing, which are increasingly crucial in both business and academia, with rising interest in RC in recent years (Dowling, 2016).

This article offers a two-decade bibliographic review, presenting a comprehensive view of the application of DS to corporate reputation and other intangibles like corporate communication, stakeholder relations, and marketing, highlighting significant trends from recent research (Kotu & Deshpande, 2019). Academic databases Web of Science (WoS) and Scopus are examined using search, appraisal, synthesis, and analysis (SALSA) (Grant &

Booth, 2009; Booth et al., 2012), to guide and assess the systematic review, and preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) (Tricco et al., 2018; Peters et al., 2020), which refines content and results through a 21-point checklist and a graphical diagram to document the evidence selection process.

The study aims to address three research questions:

RQ1: What are the implications of data science for corporate reputation?

RQ2: What contribution does data science make to intangibles such as corporate communication, stakeholder relations, and marketing?

RQ3: What advancements have occurred in the use of data science for corporate reputation through incorporating these new technologies?

This study aims to show how DS can enhance corporate reputation by strengthening intangible assets and examining its impact on corporate communication, stakeholder relations, and marketing. Four objectives are outlined:

- to evaluate DS's influence on corporate communication;
- to link DS to stakeholders in social media's organizational impact;
- to assess data-based technology's role in improving marketing and stakeholder relations;
- to examine corporate communication, stakeholder relations, and marketing in relation to corporate reputation to understand how these intangibles shape a company's brand and the significance of data science in adding organizational value.

Key findings reveal that corporate reputation and intangibles reflect companies' true status, with those neglecting intangible evaluations at a competitive disadvantage. Measuring and reporting intangible assets remain challenging due to data and methodological constraints. There is also a need for consensus on defining intangibles in scientific literature. Additionally, few studies jointly review academic literature on these concepts.

The rest of the article is structured as follows. Section 2 reviews relevant literature. Section 3 outlines the methodology using SALSA and PRISMA-ScR frameworks. Section 4 presents data analysis results, while Section 5 discusses findings in relation to research questions, objectives, and hypotheses. Section 6 provides the conclusion.

2. LITERATURE REVIEW AND RESEARCH HYPOTHESES

2.1. Linking reputation and data science

This research is essential for companies exposed to social networks and competing globally, where intangible assets are valued (recognizing their importance in the corporate economy and strategic planning (von Borowski Dodl, 2021). The study aimed to systematically review 20 years of academic literature in the WoS and Scopus databases, focusing on the application of DS to corporate reputation intangibles and business intangibles like corporate communication, stakeholder relations, and marketing. Both academics and professionals increasingly recognize the importance of researching and applying business intangibles and corporate reputation in the digital age in the era of DS

(Ali, 2022; Nichita, 2019; Kotu & Deshpande, 2019; Castilla-Polo & Ruiz-Rodríguez, 2017; Grimaldi et al., 2017; Pastor et al., 2017; Nwogugu, 2015).

The research suggests two strategies for companies in the current geoeconomic context: either distancing from digital technologies and avoiding a hyperconnected society or, preferably, professionalizing data analysis integration by innovating traditional methods and tools. Competitors leveraging digital tools will gain an edge by understanding trends and reducing costs, leading to faster responses (von Borowski Dodl, 2021). Consequently, companies not adopting DS and digital tools will lag due to inefficiency and ineffectiveness (Ortegón Quinones & Machicao Valencia, 2019).

The investigation focused on the second option, incorporating new technologies, particularly DS, into business strategies to differentiate products and services. This is crucial for better understanding the business environment and stakeholders, and for enabling real-time decision-making free from errors and subjective biases (Kotu & Deshpande, 2019). Human intuition, though sometimes seen as outdated, remains vital in decision-making processes. However, computational algorithms have become highly influential due to their advanced data reasoning capabilities, previously unique to humans (Weinner & Kochhar, 2017).

The reviewed literature connects to the current study through the significant changes during the 2000s with the rapid rise of the Internet, which led to ongoing ambiguities in defining RC or corporate communication management and other intangible assets in business (Carreras et al., 2013). Over the past two decades, diverse techniques and methodologies have emerged to assess intangible resources such as customer perception, business alliances, trust, sentiment analysis, consumer databases, patents, chief executive officer (CEO) communication, and employee knowledge (Pastor et al., 2017; Carreras et al., 2013).

In modern society, individuals actively generate information and create value for organizations (Han, 2017). Technological advancements and digital media have revolutionized information exchange, data analysis, world perception, and business strategy development (von Borowski Dodl, 2021). Digital media now enable active interaction and not just passive viewing, facilitating action on individual-generated information (Aversa, 2024). This transformation provides a comprehensive understanding of social and corporate environments (Argenti, 2014). The Internet has expedited business practices, including customer and supplier relationships, management, marketing, communication, production, organizational collaboration, financing, and performance evaluation (Castells, 2001).

Tangible assets (real estate, machinery, vehicles) are not the only means of valuing a company; intangible assets like corporate reputation ensure sustainability and long-term success. In the current economic climate, intangible assets such as corporate reputation, corporate communication, stakeholder relations, and marketing are pivotal (Konstantinova & Konarev, 2020). Studies indicate that a company's value increasingly relies on intangible assets, which can constitute up to 80% of its value, although on average, they account for 62% of globally listed companies (Brand Finance, 2022). Corporate reputation can be defined as the set of perceptions held by internal and external stakeholders about a company, stemming from its

behavior over time, with significant contributions from scholars like Charles Frombrum, Grahame Dowling, and Scott Meyer (Ali, 2022; Castilla-Polo & Ruiz-Rodríguez, 2017; Nwogugu, 2015).

The rise in intangible assets (trust, identity, ethics, brand, culture, human talent, sustainability…) has shown a consistent and growing trend (Nichita, 2019), contributing to the economy of intangible assets and corporate reputation (Carreras et al., 2013). This indicates that intangible resources are directly linked to modern corporate communication processes, such as social media, requiring strategies to enhance intangible assets related to corporate reputation (Carreras et al., 2013). Corporate reputation, a valuable intangible asset, can offer a sustainable competitive advantage (de Castro et al., 2006) and is defined as a set of attributes ascribed to a company based on its past actions (Weigelt & Camerer, 1988).

At the start of the 21st century, corporate communication's roles transformed significantly, encompassing the comprehensive management of internal (employees) and external (stakeholders) communications, as well as overseeing communication policy to establish reputation, brand image, and business value through branding (Carrillo-Durán, 2016). Both internal and external corporate communication are crucial intangibles linked to RC, recognized for their significant operational influence globally and their strategic importance in integrating all departments and stakeholders of a company (Gutiérrez & Rodríguez-Virgili, 2014). The most successful companies are those that effectively implement corporate communication strategies for reputation building as a core element, given the direct correlation between communication and organizational functions (Fontán, 2017). Corporate communication's primary contributions include activating both tangible and intangible company values to achieve differentiation and foster supportive behaviors among stakeholders (Carreras et al., 2013).

Traditionally, decision-making processes have excluded external agents other than humans within organizations. This exclusion is due to environmental studies conducted by individuals who made action recommendations. However, new scientific analysis techniques have proven effective alternatives in decision-making (Ortegón Quinones & Machicao Valencia, 2019). Notably, the business environment is typically neutral, with decisions responding to trends in human behavior or sentiment analysis. Currently, dynamic and evolving models allow organizations to implement techniques for identifying behavioral patterns in complex systems (Goodfellow et al., 2016).

DS has emerged due to the need to manage vast information volumes and develop methods to analyze this data, enabling the identification of human behavioral trends like purchasing patterns (Kotu & Deshpande, 2019). This field requires not only the coexistence of advanced cognitive functions such as evaluation, speculation, thinking, consciousness, meditation, and self-criticism but also their enhancement, which is difficult to achieve with short-term programs. These functions are vital for advancing computation levels in DS. Thus, integrating DS with human input is essential (Weinner & Kochhar, 2017).

DS utilizes methods like sentiment analysis and text mining to analyze organizational data and detect trends that optimize strategic decisions. It is crucial for enterprises to integrate technological tools in areas such as planning, management, and

measurement (Bustamante Alonso & Guillén Alonso, 2017). Organizations often analyze data to generate reports or extract information from databases. However, companies advancing in digital innovation now use advanced technologies like Big Data, DS, and artificial intelligence, enhancing decision-making by providing superior data analysis (Goodfellow et al., 2016). Predictive analysis, a key DS application, estimates outcomes like consumer demand to boost sales in the short and medium term, based on statistical probabilities from existing data (Weinner & Kochhar, 2017). DS techniques help select alternatives based on requirements and future predictions, aiming to forecast public responses and devise commercial strategies (Weinner & Kochhar, 2017).

To achieve these objectives, four hypotheses were formulated based on the research questions and aims of this study:

H1: Data science significantly enhances corporate communication, both internally and externally, by enabling a deeper understanding of the target audience and facilitating the creation of more engaging and motivating messages.

H2: Data science fosters efficient stakeholder relationships (customers, suppliers, and other companies) and offers a nuanced market understanding, leading to the development of innovative communication strategies that enhance relationships with interest groups.

H3: Utilizing data science improves companies' public relations through real-time sentiment analysis and data collection, aiding in trend identification and the implementation of necessary product, service, and advertising improvements to achieve greater customer reach and penetration.

H4: Integrating data science to enhance intangible assets improves corporate reputation, as marketing, corporate communication, and stakeholder relations directly influence corporate brand formation.

2.2. Theoretical background of the research

This section provides a concise overview of the theoretical background of DS applications in corporate reputation and corporate intangibles. The theoretical foundation of corporate reputation has been extensively studied as a critical intangible asset that influences organizational success (de Castro et al., 2006; Chun, 2005). DS techniques have emerged as powerful tools for managing and analyzing corporate reputation (Ojha & Pani, 2020). Business intangibles have been investigated for their practical and conceptual application with a focus on their value to the firm (Ali, 2022; Nichita, 2019). The key concepts and recent studies in corporate reputation and the intangibles of corporate communication, stakeholder relations, and marketing applied to their strategic value in the firm have been examined in various academic literature reviews (Ali, 2022; Nichita, 2019; Kotu & Deshpande, 2019; Castilla-Polo & Ruiz-Rodríguez, 2017; Grimaldi et al., 2017; Pastor et al., 2017; Nwogugu, 2015). Despite extensive research, there is a paucity of comprehensive studies exploring the intersection of DS, corporate reputation, and other intangible assets. Previous research (e.g., Amores-Salvadó et al., 2021) emphasizes the necessity for further investigation in this domain. This literature review identifies a significant gap in understanding how DS can enhance corporate reputation and other intangible assets. Addressing this gap is essential for developing innovative strategies in corporate management.

3. RESEARCH METHODOLOGY

The study was based on qualitative documentary research and was conducted between January 8, 2024, and February 29, 2024. The theoretical foundations in the methodology of a scoping review were based on the utilization of two frameworks, SALSA (Grant & Booth, 2009; Booth et al., 2012) and the protocol framework for scoping reviews (or PRISMA-ScR) (Tricco et al., 2018; Peters et al., 2020) to guide and structure the review process. These frameworks provide a robust and efficient structure that ensures the process is transparent and reproducible as a foundation of scientific method principles, wherein the necessary steps to validate, reproduce, and verify the present research were elucidated (Pai et al., 2004).

The study conducted a comprehensive literature search in the multidisciplinary databases WoS and Scopus, which have played a crucial role in legitimising scientific research internationally, to gather the necessary information for research topics (Arksey & O'Malley, 2005), our focus being the application of the concepts of DS, corporate reputation and business intangibles by reviewing data presented in previous articles, papers, conferences and research for further analysis and aiming to answer the questions, objectives and hypotheses formulated. Previous studies by authors who analysed these topics individually or linked to each other are highlighted (Ali, 2022; Nichita, 2019; Kotu & Deshpande, 2019; Castilla-Polo & Ruiz-Rodríguez, 2017; Grimaldi et al., 2017; Pastor et al., 2017; Nwogugu, 2015).

The initial tool employed was the SALSA framework, which provides a clear five-phase structure designed to guide the overall research topic and focus on points for traceability and replication (Codina et al., 2022). The four stages of the SALSA framework were used in the research.

In the *search* phase, the following inclusion criteria were established through a planned literature search:

1) publication time, focusing on documents, papers, conferences, studies, and articles from the last 20 years (2003–2023) to cover the expansion of the internet and DS applications in the company;

2) publication language, selecting English and Spanish;

3) use of keywords "corporate reputation", "data science", "intangibles", "corporate communication", "stakeholders", and "marketing";

4) free access to the full text to retrieve all information without restrictions;

5) inclusion in the Social Sciences Citation Index (SSCI).

In the *appraisal* phase, exclusion criteria were applied to reject publications not meeting quality standards:

1) non-scientific articles or academic documents;

2) publications outside the established range;

3) documents lacking relevant information;

4) duplicate documents;

5) articles unrelated to DS in corporate reputation and business intangibles.

In the *synthesis* phase, results are presented through tables and graphs, synthesizing each article

as a review or state-of-the-art piece. The selected studies form the evidence base of the article in References.

In the *analysis* phase, tables and summaries were used, specifically descriptive content analysis, to highlight characteristics and factors in the evolution of the DS application for improving corporate reputation in intangible asset analysis by comparing all theoretical arguments identified.

The PRISMA-ScR framework, according to Tricco et al. (2018) and Peters et al. (2020) includes a 21-point quality verification checklist (with a 22nd point for funding). The Introduction (points 1 to 4) outlines the study's project: title, abstract, introduction, and objectives. The Methodology (points 5 to 16) details the execution phases: search, selection, analysis, and synthesis. The Results phase (points 17 to 21), specifically point 18 titled "Synthesis of results", summarizes findings, limitations, and discussions on their relevance to the research questions. The conclusion addresses the presentation of results (Codina et al., 2022). This study has developed checklists for each protocol section.

Literature reviews are pivotal in academic articles, with systematic and scoping reviews becoming prominent (Grant & Booth, 2009; Booth et al., 2012). They summarize existing research, with systematic reviews addressing specific questions through detailed methods, and scoping reviews charting literature on broad topics to highlight gaps and key concepts. Choosing the right review type can be challenging (Munn et al., 2018). Our study adopted a scoping review for its relevance to our research question. Depending on the critique and conclusions of our work, future research may opt for literature or systematic reviews based on their research objectives.

4. RESULTS

Based on the criteria set out in Section 3 and following the SALSA and PRISMA-ScR framework together, the following key results were obtained detailing the study design and providing the following data, such as publications per year, per country and most cited journals.

4.1. Document selection flow diagram utilizing the PRISMA-ScR method

The study's population included all studies, articles, conferences, and publications on the application of DS in corporate reputation and intangible business assets, obtained through a full-text search. A total of 172 publications were sourced from multidisciplinary databases: 128 from WoS and 44 from Scopus. After applying the first and second exclusion criteria, the final sample consisted of 64 original publications — 39 from WoS and 25 from Scopus — related to the developed theme and inclusion criteria. This sample represented 37.21% of the total academic publications evaluated.

Figure 1. Flow diagram of document selection using the PRISMA-ScR method
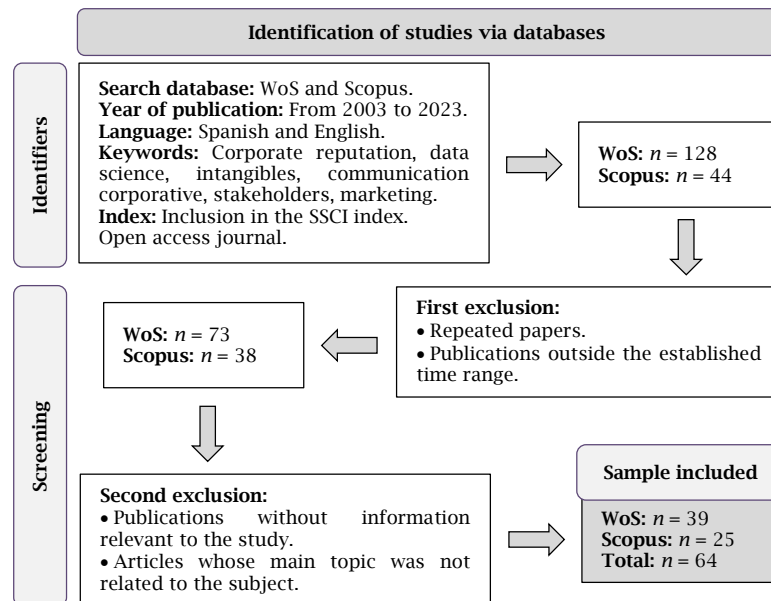
4.2. Number of publications per year

Figure 2 shows the number of publications on corporate reputation and DS from 2003 to 2023. A notable rise in articles, papers, or studies occurred post-2019, with 72 publications between 2019 and 2023, accounting for 53.49% of the total articles. This growth may be due to heightened interest in the intersection of DS with corporate reputation and intangibles, alongside more resources for researchers to publish their work.

Figure 2. Annual publications related to corporate reputation and data science
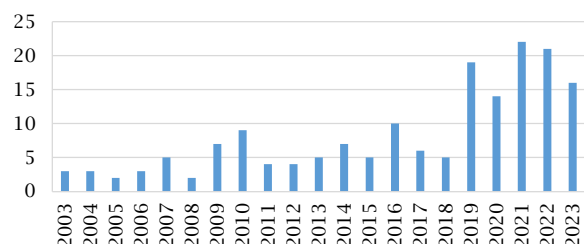
4.3. Publications by country

Publication statistics indicate that at least 10 countries have research on the topic. The United States (USA) leads with 35 publications but has fewer citations compared to the United Kingdom, which has 26 publications and 990 citations. Spain ranks third with 10 publications and 184 citations. Table 1 details the countries with the highest number of publications and citations on this topic.

Table 1. Countries with the highest number of publications and citations

Country	Publications	Citations
USA	35	760
United Kingdom	26	990
Spain	10	184
Korea	7	4
China	6	21
Germany	3	12
Latin America	3	18
Canada	1	62

4.4. Journals with the most articles and citations

The *Academy of Management Review* had the most publications on the research topic, with 27 articles cited at least 1421 times. *Corporate Reputation Review* and *Public Relations Review* followed with 23 and 18 publications, respectively. The other top five journals are detailed in Table 2.

Table 2. Primary journals with the highest number of publications

Journal	Country	Publications	Citations
Academy of Management Review	USA	27	1421
Corporate Reputation Review	United Kingdom	23	1208
Public Relations Review	USA	18	991
European Journal of Marketing	United Kingdom	15	721
Corporate Communications: An International Journal	United Kingdom	12	898

While the *European Journal of Marketing* has more publications in this thematic area than *Corporate Communications*, the latter has 721 citations compared to the former's 898 citations in total. The results reveal a lack of practical or theoretical implications for studies on business intangibles and DS in the first decade of the 21st century. Conversely, there is a consensus on the benefits of DS applications in all business areas for analysis, prediction, and solution execution, surpassing outdated work models. The literature review identifies gaps in theoretical arguments about key factors, such as the impact of new technologies like DS on investments, the economy, training, human capital, and the link between countries' digital divides and company growth. Additionally, there are discrepancies in defining various intangible constructs without a clear consensus in the scientific community.

5. DISCUSSION

The four proposed hypotheses demonstrate the outcome as a winning combination: the application of DS to each of the business intangibles and the key results are discussed in this section and detailed as they contribute to the field of study.

5.1. Application of data science in the improvement and effectiveness of corporate communication

Data science is a crucial tool for communication professionals, enabling the generation and development of knowledge about organizational environments and contexts, which helps adapt processes and gain a competitive edge by creating value-added products and services (Ortegón Quinones & Machicao Valencia, 2019). Effective data management must integrate with the communication strategy and business strategy, facilitating information interpretation and improving communication processes. This enhances organizational flexibility, allowing better adaptation to stakeholder demands (Bustamante Alonso & Guillén Alonso, 2017). Regardless of their activities, companies integrating DS into marketing processes and fields like corporate reputation are redefining their approach to marketing (Solé Moro & Campo Fernández, 2020).

The large volume of daily social media messages an organization handles, whether originating internally or from external stakeholder interactions, must be promptly and efficiently managed by the corporate communication team using DS tools and skilled professionals for effective communication (Wiencierz & Röttger, 2017). DS, through communication filters like text mining and sentiment analysis, enables companies to identify significant events and create surveys to determine industry trends, using quantitative data to understand which publications and reports garner higher audience engagement. Accurate trend analysis, such as predictive analytics, allows companies to forecast future consumer behavior (Parks, 2014). Internal information gathered through DS tools and employee engagement methods helps companies tailor their internal communications to achieve optimal results (Compte-Pujol et al., 2018).

The utilization of corporate communication technologies has become crucial in recent years. Effective corporate communication management requires evaluating and analyzing pertinent daily news at local, national, and international levels. Professionals need technological tools to intelligently present substantial information. Thus, corporate communication can be optimized, enhancing RC (Wiencierz & Röttger, 2017). Employing DS to improve market position and differentiate from

competitors is effective for building relationships with stakeholder relations. The corporate communication team managing DS applications can elucidate business realities, making them comprehensible and transparent to stakeholders (Macnamara & Gregory, 2018). Holtzhausen (2016) notes that while challenging, the communications sector can ensure DS does not overshadow organizational knowledge creation. The rise of digital communication channels is enabling organizations to interact more dynamically with stakeholder relations, who are increasingly content producers on social networks. This requires companies to process large data volumes and employ advanced DS solutions (Ojha & Pani, 2020). Orozco Toro and Ferré Pavia (2018) stress the importance of quantifying corporate communication strategies and stakeholder relations conversations through DS applications to enhance corporate reputation. Digitalization and social media globalization necessitate new public relations actions with stakeholder relations, allowing organizations to manage data efficiently and gather valuable user information for effective communication (Klewes et al., 2017).

5.2. Application of data science to the performance of stakeholders in social networks

The development of new technologies, particularly digital ones such as social media and mobile devices, has influenced corporate communication, presenting a new challenge for organizations while simultaneously offering an opportunity for improvement in the realm of relationships with stakeholder relations and the company. These transformations necessitate that the discipline adapts to the challenges posed by the rise and development of technologies and seeks solutions in the management of massive data or in the management of DS (Wiencierz & Röttger, 2017). As Martin (2007) posits, contemporary society is witnessing an era of learning that encompasses novel approaches to handling information in the process of relationships with stakeholder relations.

According to Benítez-Eyzaguirre (2016), data management in organizations is directly correlated with public relations processes and stakeholder engagement. The communication process aims to create a dialogue between the organization and society, requiring administrative discipline and professional data management to build strategic alliances. Data is essential in crisis management and in relationships with various communication channels and media. Sometimes basic information (invitations, demand, sales) suffices, while other situations demand complex data (satisfaction levels, brand credibility, reputation) to meet business objectives. Effective data management consistently focuses on integrating stakeholders (Stacks, 2016).

DS applications can effectively analyze public opinion (e.g., sentiment analysis), aiding corporate strategies with stakeholders (Ali, 2022). The connection between stakeholder management and data analysis is crucial for optimizing an organization's understanding and presentation of results to the target audience, thereby enhancing the communication process and stakeholder relationships (Holtzhausen, 2016). Researchers predict an 800% increase in global data generation over the next five years. Despite

interpretation challenges, DS in communication strategies presents new opportunities. Notably, DS enables targeted communication, directly linking DS to communication (Holtzhausen, 2016).

Public relations professionals, along with researchers, scientists, and academics, must navigate the evolving organizational and financial landscape, where high connectivity in social networks and data generation demands changes in corporate communication strategies (Benítez-Eyzaguirre, 2016). Utilizing data from various sources to inform decision-making is crucial for developing products and services tailored to target audience trends. This is especially significant for engaging with key stakeholders, despite the recent nature of discussions on this topic. DS should be viewed not only as data management and interpretation for analysis but also as a corporate communication strategy with potential audiences (Weinner & Kochhar, 2017). Therefore, companies must align with new communication standards with stakeholders to meet customer needs effectively. Adapting to new technologies is essential for data management in companies, while corporate relations departments should ensure high knowledge levels and swift adoption of new marketing methods (Klewes et al., 2017).

DS is crucial for campaigns, as data and metrics serve not only to analyze patterns but also to provide predictive probabilities essential for various situations, events, or crises, enhancing leadership effectiveness (George et al., 2014). Real-time information management is vital in public relations for promptly and appropriately addressing crises or communicating with stakeholders. Incorporating DS and predictive intelligence yields valuable metrics, aiding data management and benefiting researchers and stakeholder relations, such as a brand's customers (Pereira Villazón et al., 2019). Legal and privacy issues are significant in DS applications, with data privacy being especially relevant in public relations, as it pertains to company-related publications (Stacks, 2016).

5.3. Application of data science in social network analysis

Organizations increasingly employ DS to predict customer trends, create specific profiles, and design new products or services to meet market demands (Saidali et al., 2019). Globalized markets remove geographical and sector barriers, necessitating a comprehensive understanding of the operational context to seize opportunities and anticipate threats. DS solutions enhance traditional systems, offering broader perspectives and improving decision-making processes (Solé Moro & Campo Fernández, 2020). Thus, leveraging data analytics becomes critical for tailoring products or services to customer behavior (Jabbar et al., 2020).

The incorporation of DS solutions in marketing can significantly transform traditional marketing campaigns, which usually target a single audience segment, representing only a small portion of the population. DS solutions enable personalized messaging that can address customer purchases as well as convey experiences and emotions (González Castro et al., 2018). Analyzing large data volumes necessitates an effective method, beyond traditional marketing techniques. Organizations can

leverage valuable information to focus on customer needs for product development, thereby creating an optimal context beneficial to the entire company (Ortegón Quinones & Machicao Valencia, 2019).

DS collectively generates value by providing benefits and efficiently producing new products through data analysis. This process yields relevant information for optimal decision-making and new knowledge development, leading to core process transformation and innovation, ultimately reducing costs (Revuelta Bayod, 2018). DS enables detailed identification of products, components, variables, and internal company actions, facilitating stakeholder interactions, and identifying recommendations to enhance customer satisfaction (Miquel Segarra, 2020). Utilizing DS, businesses can initiate transformation across products and markets by integrating data insights and innovative DS tools, thereby achieving unique positioning and efficient results (Solé Moro & Campo Fernández, 2020).

Social networks enable the analysis of potential combinations and correlations within data on comments, requirements, demands, needs, emotions, and market price perceptions of a brand (Kotu & Deshpande, 2019). Jabbar et al. (2020) highlight that the digital era's information proliferation provides managers with channels and resources to enhance business knowledge and make decisions for improved performance and optimal fulfilment. Online shopping offers significant opportunities to optimize consumer behavior. Organizations with online channels can identify consumers and understand their navigation patterns on websites or applications, significantly impacting their campaigns. Reporting facilitates accuracy by identifying similarities between subjects or user groups (Kotu & Deshpande, 2019). These authors concluded that DS applications are transforming organizational decision-making by processing, analyzing, and communicating data. A well-informed entrepreneur seldom relies solely on intuition for company strategies, a trend seen in recent years (Jabbar et al., 2020). Beyond data analytics, business owners must effectively manage their enterprises and maintain competitiveness. Various industries have increasingly used these tools to understand market behavior — demand, supply, behavior, commercial actions, and technology — and to address imbalances in collected and utilized data (Miquel Segarra, 2020).

5.4. Application of data science to business intangible assets

Effective corporate communication is vital for shaping stakeholder perceptions, enhancing cooperation, and building corporate reputation (Fernández Fernández, 2010; Argenti, 2014). Integrating organizational values into communications creates a narrative that coordinates management's efforts to establish a positive corporate reputation among stakeholder relations (Fernández Fernández, 2010). A company's corporate reputation is crucial to its corporate communication strategy, requiring emphasis on information and actions to instil public confidence (Orozco Toro and Ferré Pavia, 2018). Defining elements that enhance stakeholder relations perception is scientifically beneficial for selecting optimal corporate communication strategies (Martin, 2007). Organizations lacking effective corporate communication will fail to position themselves

favorably in a competitive environment (Klewes et al., 2017). Developing knowledge management and corporate communication planning strategies can improve an organisation's corporate reputation by establishing a more favorable relationship with stakeholders relations (Argenti, 2014). Corporate communication is a key element in managing corporate reputation (Fernández Fernández, 2010).

Stakeholder relations are tools that create and maintain a company's corporate reputation by connecting stakeholders and ensuring message consistency (Pereira Villazón et al., 2019). Valuing stakeholders builds a corporate reputation of integrity (Orozco Toro and Ferré Pavia, 2018). Stakeholder relations manage relationships, enhancing the image and corporate reputation to foster positive attitudes and behaviors (Buhmann & Likely, 2018). The goal is to extend message reach through planned public actions, using various channels and media public relations (de Leaniz & del Bosque Rodríguez, 2016).

Studies have shown a strong link between corporate reputation and corporate social responsibility (CSR), where CSR involves stakeholder management strategies aimed at achieving long-term goals such as improved opinions, loyalty, or brand image (Compte-Pujol et al., 2018). Many professionals exploit gaps in understanding intangible business assets by introducing new terminology and tools, often using the same techniques and procedures employed in organizations. Concepts like image, attitudes, intentions, and behavior have long been seen as not directly influencing an organization's financial outcomes (Macnamara & Gregory, 2018). Some researchers, however, view a brand image, attitudes, intentions, and public behavior as tangible and measurable through social psychology methods, a perspective also applied to corporate reputation. Corporate reputation is often associated with brand image, suggesting it relies on maintaining a consistent image over time (Benítez-Eyzaguirre, 2016).

The brand image evolves beyond the control of organizational communication teams. Aligning societal behavior with organizational goals necessitates creating an appropriate brand image, projecting a positive and ethical stance, and gradually influencing stakeholder behavior (Buhmann & Likely, 2018). Positive company-society relationships require mutual understanding that meets both parties' expectations. The image generated by organizational information must resonate with the target group to drive expected behavior, emphasizing the importance of public relations (Compte-Pujol et al., 2018). The relationship among all stakeholders aims to elevate a company's presence and corporate reputation via traditional and social media channels. Building an image through stakeholder groups focuses on the long-term impact of brand image, requiring transparency and coherence (Benítez-Eyzaguirre, 2016).

6. CONCLUSION

This scoping review maps business intangibles using DS, highlighting the successful combination of corporate reputation, communication, stakeholders, and marketing in modern business. Sentiment analysis, text mining, and predictive studies render traditional processes obsolete and directly influence a company's economic benefits. Digitalization and DS evolve together, particularly in managing DS

solutions (Klewes et al., 2017). Effective data management surpasses traditional methods and provides essential information for organizations. In the digital era, more digital information is generated in one year than in 50 years of analog data (Kotu & Deshpande, 2019). The authors analyzed 64 scientific articles from WoS and Scopus over two decades to explore implications, contributions, and advancements, addressing four objectives: determining, establishing, defining, and describing, while examining and providing solutions to the implications of intangibles in business through DS applications. Professionals exploit gaps in business intangibles by introducing new terminology and tools, often using existing techniques. The tangible or intangible nature of concepts like image, attitudes, intentions, and behavior hasn't depended on their inclusion in financial results (Macnamara & Gregory, 2018).

Cloud technology, essential for storing and analyzing extensive data, benefits marketing (Rodríguez-Insuasti, 2021). The IoT has transformed everyday items into data sources, enhancing data collection and providing insights into advertising, marketing strategies, and user sentiments (Revuelta Bayod, 2018), allowing companies to identify trends, understand customer demands and perceptions, adapt products, and improve corporate reputation (Rodríguez, 2017). Miquel Segarra (2020) emphasizes the potential for hyper-segmenting public information and customizing communication through narrative and DS solutions, boosting the effectiveness of complex, personal, and direct communication.

Content levels are structured through social media axes, with messages tailored to audience segments, niches, and individuals (Miquel Segarra, 2020). Digital interactions, managed by software analyzed by DS applications, offer personalized recommendations based on survey responses. Information algorithms convert online operations into automated actions. Browsing history, saved via DS solutions, merges media and data to form user profiles, identifying interests, preferences, and needs (de Leaniz & del Bosque Rodríguez, 2016), enabling the creation of profiles and target groups. DS applications transform marketing by offering real-time insights and future projections from historical data, thus revolutionizing decision-making processes (Jabbar et al., 2020). They support accurate, high-confidence decisions, enhancing the effectiveness of production and marketing efforts (Saidali et al., 2019). Aversa (2024) demonstrated that in e-commerce, consumer loyalty models use digital community recommendations for instant personalization of incentives, optimizing marketing spend, fostering customer recruitment, and strengthening user-company ties, ultimately boosting the company's corporate reputation.

The analysis highlights the significance of DS solutions in marketing for both society and businesses, offering competitive advantages over non-adopters (Pereira Villazón et al., 2019). It is crucial to also consider their negative aspects and varying impacts. Revuelta Bayod (2018) predicts that by 2023, at least half of companies will face ethical issues from improper data management. Conversely, Colmenarejo Fernández (2017) sees DS applications as sociotechnical events that transform organizational culture and communication, enhancing interactions with various stakeholder groups. Extensive data collection raises concerns about privacy, ownership, intimacy, trust, and corporate responsibility. These issues, though longstanding, have become more prominent with DS applications in businesses. Regulating and accounting for these assets is challenging, requiring ongoing research and innovative solutions (Nwogugu, 2015).

The analysis elucidates the advantages of DS solutions in competitive capability, stakeholder engagement, marketing, and corporate responsibility, while acknowledging limitations such as publication bias, temporal and geographical constraints, lack of industry-specific analyses, and methodological heterogeneity. The rapid technological advancements and ethical considerations regarding data privacy and management are also crucial for future research. The paper emphasizes the need for continued exploration and innovative approaches to address challenges in regulating and accounting for intangible assets in DS applications in business.

The analysis supports the investigated hypotheses, identifying gaps in the academic literature due to the lack of studies directly connecting DS applications with intangible business assets. We acknowledge research limitations from the absence of empirical studies and case analyses demonstrating these connections, which may have influenced our results and interpretations. This study proposes three future pathways for exploring corporate intangibles via DS methods, using reliable data sources due to their impact on corporate reputation. The first pathway examines the ethical intangible related to legal data management aspects through DS tools like text mining, using global legal frameworks. The second pathway investigates the trust intangible among target audiences and its relationship with corporate reputation through sentiment analysis. The third pathway explores the sustainability intangible concerning corporate use of non-renewable energy in digital platforms, using statistical analyses and DS techniques to evaluate energy consumption, sustainability practices, and their impact on corporate reputation.

Corporate agendas aim to advance the measurement, management, and professionalization of metrics for assessing intangible business assets such as corporate reputation, potentially the most significant intangible asset. Quantifying and determining the impact of intangibles is essential to measure a company's essence and appearance as a source of competitiveness and differentiation. DS applications fulfill these requirements, constituting part of the solution. This study comprehensively examines the benefits and challenges of using DS to manage intangible assets, like corporate reputation, highlighting their significance as high-value company assets.

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