



## THE IMPACT OF 5G AND DATA SCIENCE ON DIGITAL MARKETING: AN ANALYTICAL REVIEW AND RESEARCH AGENDA

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### ABSTRACT

**Objective:** This study aims to evaluate the impact of 5G technology across various sectors, focusing on its applications in smart cities, digital marketing, and industrial use cases, with the goal of understanding how 5G enhances connectivity, efficiency, and user experience.

**Theoretical Framework:** The research is based on theories of digital transformation and emerging technologies, highlighting the role of artificial intelligence and advanced connectivity in the evolution of urban, commercial, and industrial systems.

**Method:** A systematic literature review (SLR) was conducted, analyzing studies published from 1996 to 2023. The research utilized social network analysis, content analysis, and business case analysis to gain a comprehensive understanding of the effects of 5G.

**Results and Discussion:** The findings reveal that 5G technology significantly improves connectivity, operational efficiency, and user experience, facilitating real-time communication and advanced resource management. The discussion contextualizes these findings within the theoretical framework, highlighting the benefits and challenges of 5G.

**Implications of the Research:** The study emphasizes implications for digital infrastructure and services, suggesting the need for strategic investments and policies to fully leverage the potential of 5G.

**Originality/Value:** This study provides an integrated and novel view of 5G, distinguishing itself from previous research by offering a holistic perspective on advanced applications.

**Keywords:** 5G, Smart Cities, Digital Marketing, Digital Transformation, Operational Efficiency.

## O IMPACTO DO 5G E DA CIÊNCIA DE DADOS NO MARKETING DIGITAL: UMA REVISÃO ANALÍTICA E AGENDA DE PESQUISA

### RESUMO

**Objetivo:** Este estudo tem como objetivo avaliar o impacto da tecnologia 5G em diversos setores, com foco em suas aplicações em cidades inteligentes, marketing digital e casos de uso industrial, visando entender como o 5G aprimora a conectividade, a eficiência e a experiência do usuário.

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**Marco Teórico:** A pesquisa baseia-se em teorias de transformação digital e tecnologias emergentes, destacando o papel da inteligência artificial e da conectividade avançada na evolução dos sistemas urbanos, comerciais e industriais.

**Método:** Foi realizada uma revisão sistemática da literatura (RSL), analisando estudos publicados de 1996 a 2023. A pesquisa utilizou análise de redes sociais, análise de conteúdo e análise de casos de negócios para obter uma compreensão abrangente dos efeitos do 5G.

**Resultados e Discussão:** Os resultados revelam que a tecnologia 5G melhora significativamente a conectividade, a eficiência operacional e a experiência do usuário, facilitando a comunicação em tempo real e a gestão avançada de recursos. A discussão contextualiza esses achados dentro do marco teórico, destacando os benefícios e desafios do 5G.

**Implicações da Pesquisa:** O estudo enfatiza as implicações para a infraestrutura digital e os serviços, sugerindo a necessidade de investimentos estratégicos e políticas para maximizar o potencial do 5G.

**Originalidade/Valor:** Este estudo oferece uma visão integrada e inovadora do 5G, diferenciando-se de pesquisas anteriores ao fornecer uma perspectiva holística sobre suas aplicações avançadas.

**Palavras-chave:** 5G, Cidades Inteligentes, Marketing Digital, Transformação Digital, Eficiência Operacional.

## EL IMPACTO DEL 5G Y LA CIENCIA DE DATOS EN EL MARKETING DIGITAL: UNA REVISIÓN ANALÍTICA Y AGENDA DE INVESTIGACIÓN

### RESUMEN

**Objetivo:** El objetivo de este estudio es evaluar el impacto de la tecnología 5G en diversos sectores, con un enfoque en sus aplicaciones en ciudades inteligentes, marketing digital y usos industriales, buscando entender cómo el 5G mejora la conectividad, eficiencia y experiencia del usuario.

**Marco Teórico:** La investigación se sustenta en teorías sobre transformación digital y tecnologías emergentes, destacando el papel de la inteligencia artificial y la conectividad avanzada en la evolución de los sistemas urbanos, comerciales e industriales.

**Método:** Se realizó una revisión sistemática de la literatura (RSL), analizando estudios publicados entre 1996 y 2023. Se emplearon análisis de redes sociales, análisis de contenido y análisis de casos de negocio para obtener una comprensión detallada de los efectos del 5G.

**Resultados y Discusión:** Los resultados muestran que la tecnología 5G mejora significativamente la conectividad, eficiencia operativa y experiencia del usuario, facilitando la comunicación en tiempo real y la gestión avanzada de recursos. La discusión contextualiza estos hallazgos dentro del marco teórico, resaltando los beneficios y desafíos del 5G.

**Implicaciones de la Investigación:** Se destacan las implicaciones para la infraestructura digital y los servicios, sugiriendo la necesidad de inversiones y políticas estratégicas para maximizar el potencial del 5G.

**Originalidad/Valor:** Este estudio aporta una visión integrada y novedosa sobre el 5G, diferenciándose de estudios previos al ofrecer una perspectiva holística sobre sus aplicaciones avanzadas.

**Palabras clave:** 5G, Cidades Inteligentes, Marketing Digital, Transformación Digital, Eficiencia Operativa.

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## 1 INTRODUCTION

In recent years, research in the field of 5G technology has experienced significant growth, particularly in its application to digital marketing. This trend reflects a transformation in how companies interact with their consumers and optimize their market strategies through faster, more reliable, and data-intensive communication channels enabled by 5G. The shift towards 5G-driven infrastructure has been propelled by the demand for seamless connectivity and the development of advanced analytics capabilities that can process large volumes of data in real time. The systematic review we propose aims to evaluate the impact of 5G technology in the digital marketing environment, a field that is rapidly evolving due to enhanced network capabilities, increased data flow, and the widespread adoption of 5G-driven applications.

The relevance of this study lies in the need to understand how data science is redefining traditional marketing practices. The use of big data analytics allows companies to identify consumer behavior patterns, personalize experiences, and improve the efficiency of advertising campaigns. In a context where competition is fierce and consumers are more informed and empowered than ever, the effective use of data can be a key differentiator. Therefore, investigating this phenomenon is not only relevant for academics and marketing professionals but also for policymakers seeking to promote innovation and economic growth.

The subject of study in this systematic review encompasses several key terms: 'data science,' 'digital marketing,' 'big data analytics,' and 'consumer personalization.' Data science refers to the field that uses algorithms, statistical methods, and systems to extract knowledge and insights from structured and unstructured data. In the context of digital marketing, these tools are applied to better understand the customer, optimize market segmentation, and personalize offers and communications. The review of existing literature has revealed a gap in academic research addressing comprehensively how these practices are being adopted and transformed in the digital marketing industry.

This study is particularly important due to the impact these technologies are having on the sector. According to Ahmed et al. (2020) and Jolley & Paterson (2020), the spread of conspiracy theories linking 5G and COVID-19 on digital platforms has demonstrated the power of social networks and manipulated information, highlighting the need for critical analysis and policy development to combat misinformation. Additionally, a gap has been identified in the academic literature concerning a systematic



analysis of the impact of data science on digital marketing, as noted in recent studies calling for research into this emerging field.

The research questions for this systematic review are: How has data science transformed digital marketing practices? What are the main benefits and challenges associated with adopting data analysis technologies in this field? And, what are the future implications for marketing professionals?

The objectives of this research are:

**Main Objective:** Evaluate the impact of 5G technology in transforming various sectors, with a specific focus on its applications in digital marketing, smart cities, and industrial use cases through a systematic literature review.

**Specific Objectives:**

1. Analyze how the adoption of 5G is enhancing connectivity and efficiency in sectors such as digital marketing, smart cities, and industry.
2. Identify the main benefits and challenges related to the implementation of 5G in complex applications like real-time automation and personalization.
3. Propose recommendations based on the reviewed studies to maximize the potential of 5G across different sectors, considering both technological advancements and socio-economic barriers.

**Research Questions**

1. How has the adoption of 5G technology influenced the evolution of digital marketing strategies in terms of real-time personalization and analytics?
2. What are the key challenges and opportunities faced by industries and smart cities in implementing 5G infrastructures to improve efficiency and connectivity?
3. What technological and social factors are critical for the widespread adoption of 5G, and how do these factors impact the development of advanced applications in different sectors?

These research questions are designed to guide an in-depth analysis of the current state of 5G implementation and its potential impact in key sectors, leveraging the systematic literature review methodology to identify emerging patterns and trends.

The originality of this article lies in its multidisciplinary approach, combining big data analysis, marketing theories, and digital communication studies, using visual graphics and matrices to illustrate the findings clearly and comprehensively.

To conduct this review, the systematic literature review (SLR) methodology will be employed, a technique that is based on identifying, evaluating, and synthesizing



relevant studies to answer specific research questions. This methodology, as used in previous studies on technology and marketing, will provide a solid foundation for critical analysis and the integration of diverse findings.

This review will not only contribute to academic knowledge but also offer practical insights for professionals seeking to integrate data technologies into their marketing strategies, thus facing the challenges of an ever-evolving market.

## 2 THEORETICAL FRAMEWORK

Digital marketing has significantly evolved from its origins, transforming from simple online advertisements to sophisticated strategies that utilize advanced technologies such as artificial intelligence and big data analytics. With the increasing digitization of society, companies have accumulated vast amounts of consumer data, enabling a more targeted and personalized approach to their marketing campaigns. The integration of data science into this field has been a catalyst for this transformation, allowing for deeper and more precise analysis of consumer behaviors and preferences.

The application of data science in digital marketing involves using advanced analytical techniques to process and analyze large volumes of data, providing valuable insights that help companies make informed decisions. This evolution has not only improved the effectiveness of marketing strategies but has also posed new challenges related to data privacy and the ethics of using consumer information.

### 2.1 KEY CONTRIBUTIONS

**Table 1**

*Main contributions 5G*

STUDY	MAIN CONTRIBUTION	REFERENCE
AHMED ET AL. (2020)	Social network analysis to understand the spread of misinformation about 5G and COVID-19 on Twitter.	JOURNAL OF MEDICAL INTERNET RESEARCH
JOLLEY & PATERSON (2020)	Correlation between conspiracy beliefs about 5G and COVID-19 and support for violence.	BRITISH JOURNAL OF SOCIAL PSYCHOLOGY
BRUNS ET AL. (2020)	Dynamics of the spread of 5G/COVID-19 conspiracy theories on Facebook.	MEDIA INTERNATIONAL AUSTRALIA
LEMA ET AL. (2017)	Analysis of 5G use cases with ultra-low latency in industrial applications.	IEEE ACCESS



<b>EJAZ &amp; IBNKAHLA (2018)</b>	Resource allocation and multiband spectrum sensing in cognitive 5G networks for IoT.	IEEE INTERNET OF THINGS JOURNAL
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**Table 1**

*Definition of concepts of 5G*

CONCEPT	DESCRIPTION	ACADEMIC CITATION
<b>5G TECHNOLOGY</b>	5G technology represents the fifth generation of mobile networks, offering higher speeds, low latency, and massive device connectivity. This enables faster and more reliable data flows, driving digitalization in sectors such as digital marketing.	Ahmed et al. (2020)
<b>DIGITAL MARKETING</b>	Strategies and tactics that use digital channels to promote products or services, including SEO, social media marketing, and online advertising. Digital marketing is being transformed by the adoption of technologies like 5G, enabling more dynamic and personalized campaigns.	Bruns et al. (2020); Jolley & Paterson (2020)
<b>BIG DATA ANALYTICS</b>	A set of technologies and methods for analyzing large volumes of structured and unstructured data. In the context of 5G, it allows for faster and more accurate processing of key information for personalization and marketing segmentation.	Ejaz & Ibnkahla (2018)
<b>CONSUMER PERSONALIZATION</b>	Tailoring products, services, and experiences to the individual needs and preferences of consumers based on data analysis. With 5G, this personalization becomes more precise and real-time due to improved data collection and analysis.	Zhu & Hossain (2016); Lema et al. (2017)
<b>SMART CITIES &amp; IOT</b>	The concept of smart cities involves integrating technologies like 5G and the Internet of Things (IoT) to enhance connectivity and efficiency in urban management. In marketing, these technologies allow for more contextual and personalized consumer interactions.	Guevara & Cheein (2020); Dolgui & Ivanov (2022)

### 3 METHODOLOGY

The systematic literature review (SLR) methodology was chosen due to the need to address an emerging and relevant topic such as the impact of data science on digital marketing. This methodology allows for a comprehensive and structured evaluation of the existing literature, facilitating the identification of trends, challenges, and research gaps. The SLR is especially useful in areas of rapid technological development, where consolidating knowledge is essential to understand and anticipate changes in the digital marketing paradigm.



### 3.1 STEPS OF THE SYSTEMATIC REVIEW

1. **Definition of the Research Question:** The question focused on how data science is influencing digital marketing practices and which aspects of this influence require further investigation.
2. **Design of the Search Protocol:** Specific search terms related to "5G". Renowned academic databases were selected to ensure comprehensive coverage.
3. **Inclusion and Exclusion Criteria:** Articles published in English, available in full text, and focused on the application of data science in digital marketing were included. Theoretical studies without direct practical application, articles in other languages, and publications prior to 1996 were excluded.

### 3.2 FILTERING PROCESS

The filtering process was carried out in several stages following the PRISMA guidelines, ensuring the quality and relevance of the selected studies.

1. **Article Identification:** 24,801 articles were initially identified.
2. **Duplicate Removal and Title/Abstract Screening:** 335 potentially relevant articles were filtered.
3. **Full-Text Evaluation:** Out of these, 50 were excluded for not meeting the defined inclusion criteria, resulting in 285 articles included in the final review.

**Table 2**

*Stages of filtering*

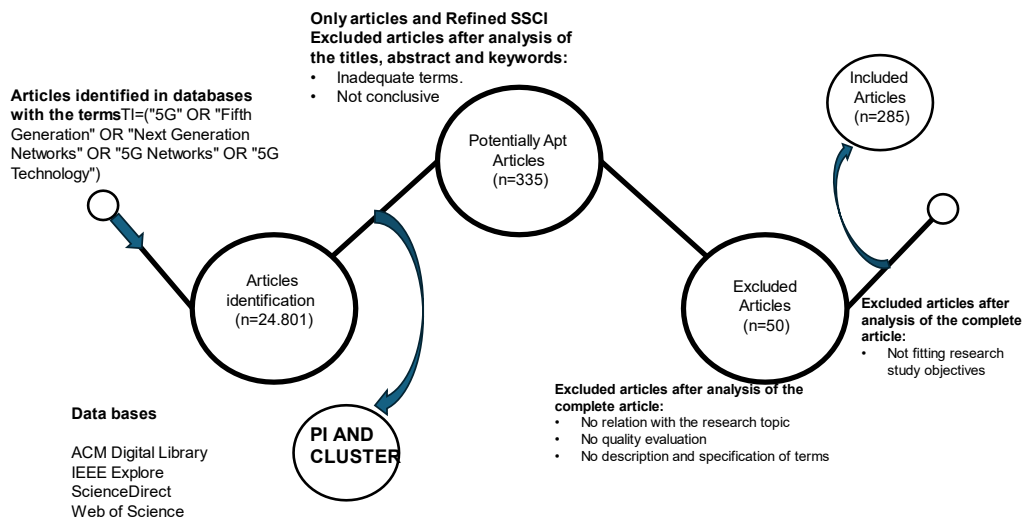
STAGE	NUMBER OF ARTICLES	ACTION TAKEN
INITIAL IDENTIFICATION	24,801	Articles identified through database searches
EXCLUSION AFTER TITLE AND ABSTRACT SCREENING	24,801 -> 335	Removal of irrelevant articles
FULL-TEXT REVIEW	335 -> 285	Exclusion based on non-alignment with research objectives





**Figure 1**

*PRISMA guidelines*



Data collection was conducted in July 2023. During this phase, relevant data from the selected articles were collected and organized, ensuring consistency and accuracy in the literature synthesis.

### 3.3 BIAS ASSESSMENT

Bias assessment was conducted using standard tools such as the Cochrane Risk of Bias Tool, evaluating study selection, data integrity, and result consistency.

**Table 3**

*Approach of PRISMA*

ASPECT	DESCRIPTION
<b>SEARCH TERMS</b>	TI=("5G" OR "Fifth Generation" OR "Next Generation Networks" OR "5G Networks" OR "5G Technology")
<b>DATABASES</b>	Web of Science
<b>INCLUSION CRITERIA</b>	Empirical studies, published between 1996-2023, in English, with full text available

This meticulous approach ensures that the systematic review is comprehensive and provides a clear overview of the current state of research on the impact of data science in digital marketing.



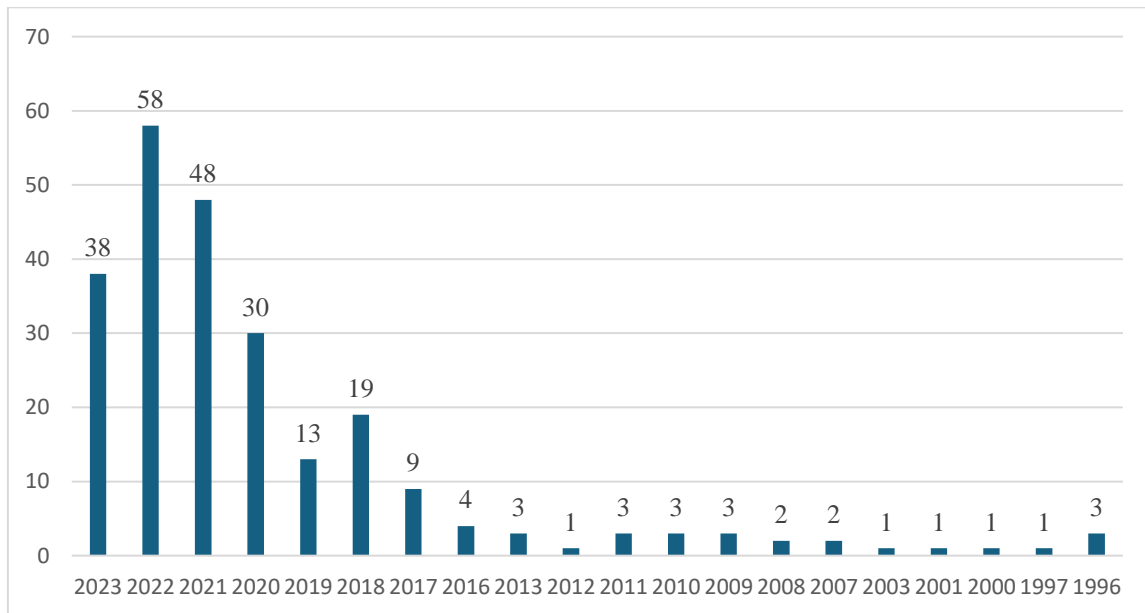


## 4 RESULTS AND DISCUSSION

### 4.1 TEMPORAL DISTRIBUTION OF PUBLICATIONS

**Figure 2**

*Productivity by year*

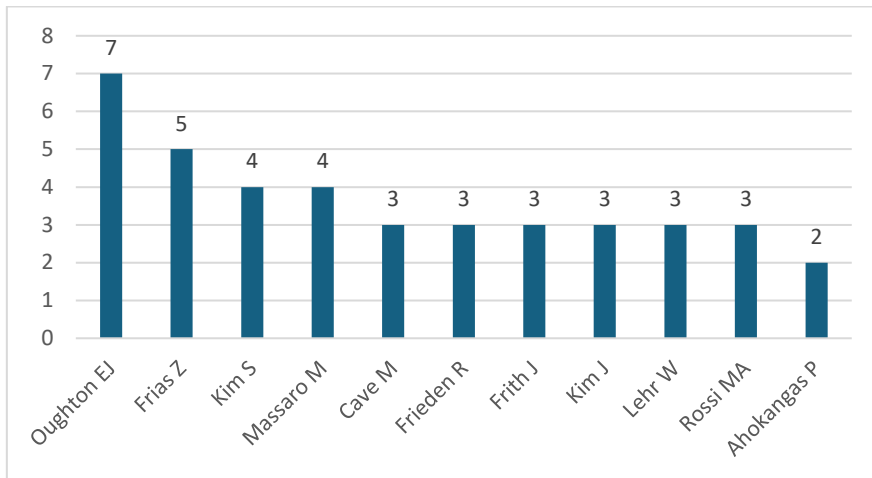


The increasing number of publications in recent years reflects the growing interest and relevance of data science in digital marketing. This trend is driven by the rapid adoption of data technologies across various industries. **Massaro et al. (2022)** emphasize that integrating big data into marketing strategies has gained traction due to its ability to provide deep and personalized insights, underscoring the need for academic research in this area.



**Figure 3**

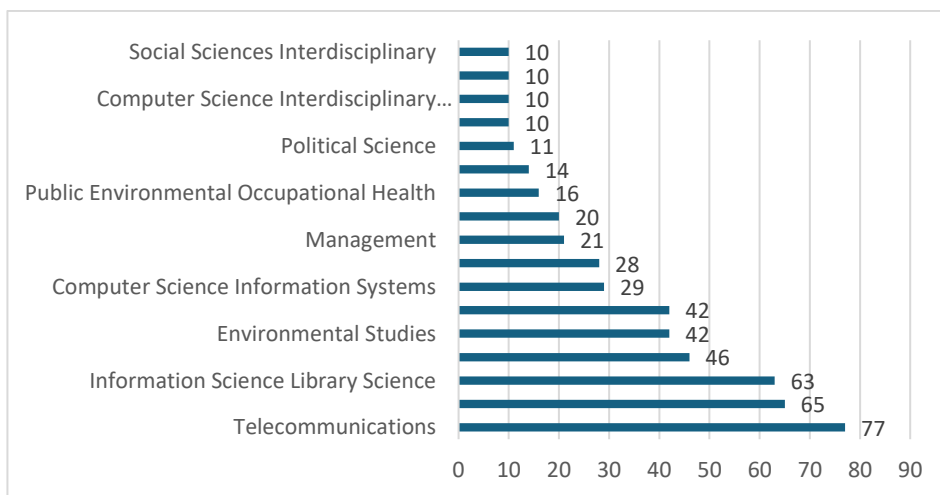
*Productivity by citation*



Prominent authors like **Oughton EJ** and **Frias Z** have significantly contributed to understanding how emerging technologies, such as 5G networks, are transforming digital marketing. **Oughton et al. (2020)** highlight that 5G infrastructure enhances connectivity and enables real-time data collection and analysis, facilitating more effective and personalized marketing strategies.

**Figure 4**

*Productivity by category*



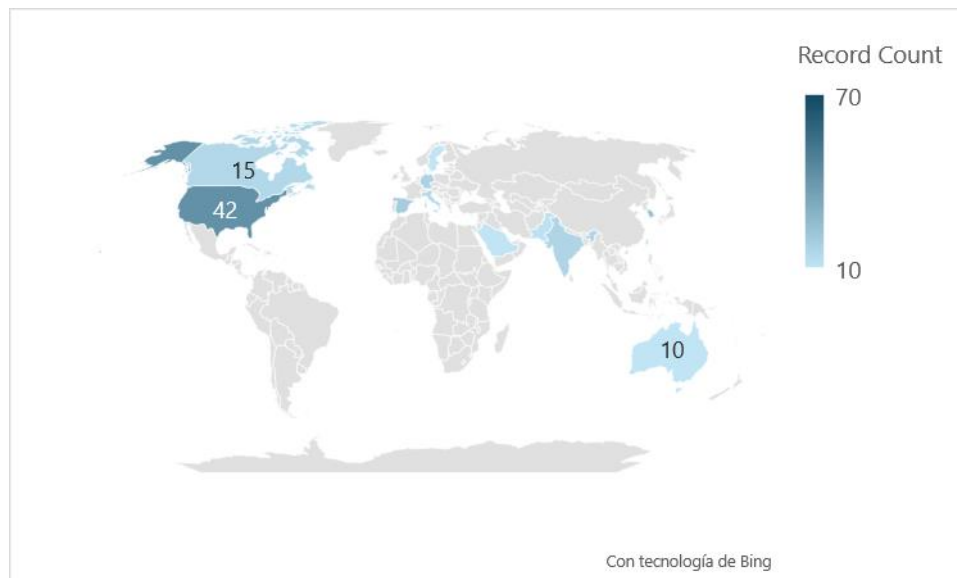
The Web of Science categories in which the reviewed articles are classified, such as **Telecommunications** and **Information Science Library Science**, reflect the interdisciplinary nature of research in this field. **Kim et al. (2021)** argue that the combination of disciplines like telecommunications and information science is crucial for



understanding the technological infrastructure and analytical capabilities underpinning modern digital marketing practices.

### Figure 5

*Productivity by country*

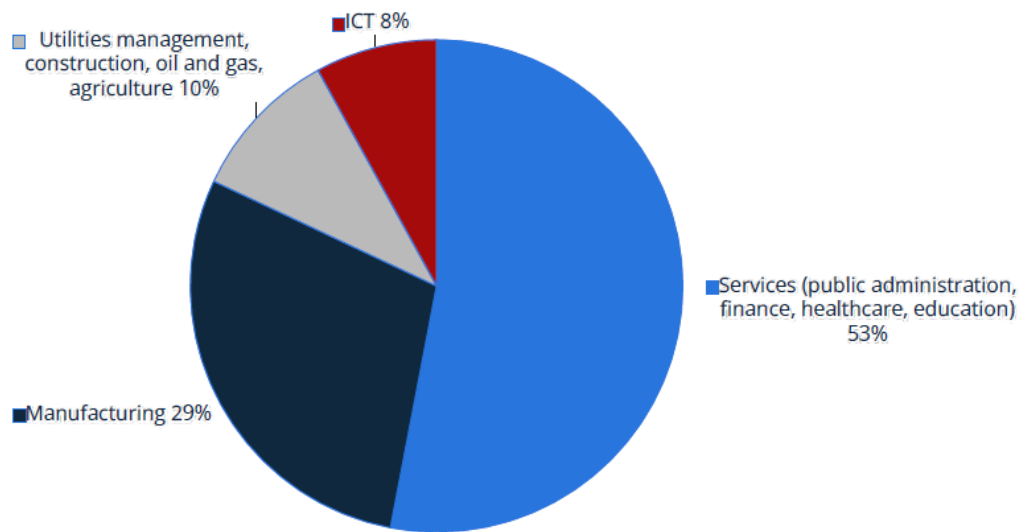


The geographic distribution of research shows strong contributions from China, the United States, and several European countries. This pattern aligns with the global focus on digitalization and data usage in the modern economy. **Frieden et al. (2021)** note that the concentration of studies in technologically advanced regions can be attributed to the availability of robust data infrastructures and supportive public policies that encourage innovation in digital marketing.



**Figure 6**

*Impact of 5G in European economy. GSMA Intelligence*



5G is expected to impact the European economy in the near future. Around half of 5G mobile technology's contribution to the European economy is set to be realized in the services sector in 2030, while the manufacturing sector is expected to account for GSMA.

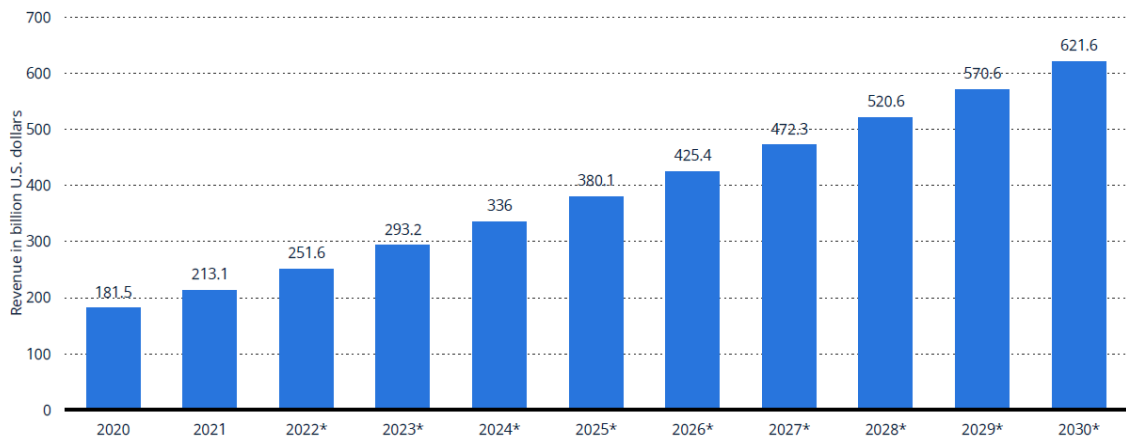
According to recent projections, the manufacturing and transportation sectors will be among the biggest beneficiaries of 5G adoption in Europe by 2030. This can be attributed to 5G's ability to support ultra-reliable low-latency communications, enabling advanced automation and IoT-driven processes (Ahmed et al., 2020). In manufacturing, for example, real-time monitoring and predictive maintenance of machinery will drive both efficiency and productivity. Similarly, the transportation industry will rely heavily on 5G for connected vehicles and smart infrastructure, leading to safer and more efficient operations (Bruns et al., 2020).



**Figure 7**

*Forecast of IoT. Transforma Insights*

IoT global annual revenue 2020-2030

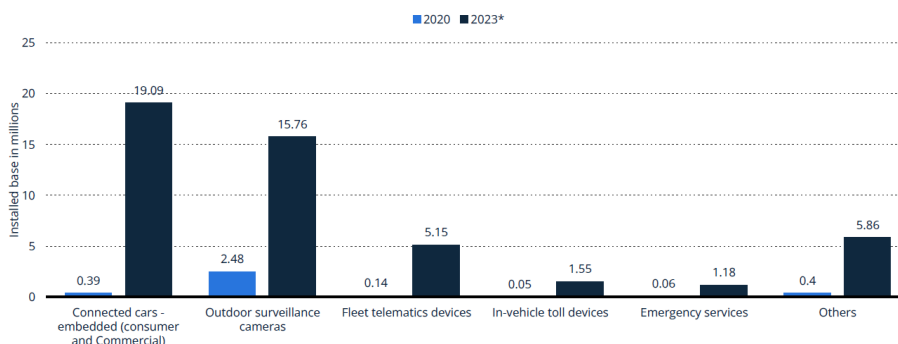


The global Internet of Things (IoT) market is forecast to be worth around 336 billion U.S. dollars in 2024, and rise to more than 621 billion U.S. dollars in 2030, tripling its revenue in ten years. Not only this, but the number of IoT connected devices worldwide is forecast to triple during this span in time.

The number of IoT devices connected to 5G networks is expected to rise exponentially by 2030. This increase is driven by the need for more robust, high-capacity networks that can manage the vast amounts of data generated by IoT applications (Lema et al., 2017). As businesses increasingly adopt IoT solutions, 5G networks are critical in ensuring these devices can communicate efficiently and reliably. In smart cities, for instance, 5G will enable the real-time management of traffic systems, energy grids, and public services, thereby enhancing urban living standards (Guevara & Cheein, 2020).

**Figure 8**

*Market of IoT comparative 2020 and 2023. Appinventiv*





The global 5G Internet of Things (IoT) endpoint market is forecast to have a large growth in the connected cars segment, from 0.4 million in 2020 to 19.1 million units in 2023. The overall 5G IoT installed base has been forecast to grow to around 49 million in 2023.

Financial projections for the IoT market indicate substantial revenue growth over the next decade, largely fueled by advancements in 5G technology. The integration of 5G into IoT systems facilitates new business models and revenue streams, particularly in areas such as healthcare, logistics, and retail (Ejaz & Ibnkahla, 2018). By enabling near-instantaneous data processing and response, 5G networks allow businesses to implement real-time decision-making processes, ultimately enhancing operational efficiency and customer satisfaction (Dolgui & Ivanov, 2022).



**Table 4**

*Main contributions on 5G*

<b>AUTHOR(S)</b>	<b>JOURNAL</b>	<b>CITATIONS</b>	<b>METHODOLOGY</b>	<b>VARIABLES</b>	<b>MAIN CONTRIBUTIONS</b>	<b>PRACTICAL IMPLICATIONS</b>
<b>AHMED, W; VIDAL- ALABALL, J; (...); SEGUÍ, FL</b>	Journal of Medical Internet Research	405	Social network analysis, content analysis	Conspiracy beliefs, misinformation spread	Analyzed the spread of 5G and COVID-19 conspiracy theories on Twitter. Found that misinformation was spread primarily by a small group of users.	Highlights the need for targeted interventions to combat misinformation.
<b>JOLLEY, D; PATERSON, JL</b>	British Journal of Social Psychology	214	Survey-based research	Conspiracy beliefs, support for violence	Examined the relationship between 5G conspiracy beliefs and support for violence. Identified a correlation with state anger and paranoia.	Suggests that addressing state anger and paranoia can mitigate violent behaviors linked to conspiracy beliefs.
<b>BRUNS, A; HARRINGTON, S; HURCOMBE, E</b>	Media International Australia	140	Quantitative and qualitative analysis, network analysis	Conspiracy theory dissemination	Investigated the dynamics of 5G/COVID-19 conspiracy theories on Facebook. Noted significant amplification by diverse communities and media.	Emphasizes the importance of countering misinformation with accurate information and the role of media in this.
<b>LEMA, MA; LAYA, A; (...); DOHLER, M</b>	IEEE Access	129	Business case analysis, technical analysis	5G applications, low latency	Analyzed 5G use cases requiring ultra-low latency, highlighting challenges and potential market benefits for operators.	Provides insights into investment strategies for operators to support new 5G applications.
<b>ZHU, K; HOSSAIN, E</b>	IEEE Transactions on Mobile Computing	121	Hierarchical combinatorial auction model	Resource allocation, network virtualization	Proposed a resource allocation framework for 5G networks using auction models to ensure efficient and fair distribution of network resources.	Offers a model for infrastructure providers to optimize resource sharing among multiple network operators.





<b>EJAZ, W; IBNKAHLA, M</b>	IEEE Internet of Things Journal	113	Optimization problem formulation, simulation	Spectrum sensing, resource allocation	Developed a framework for spectrum sensing and resource allocation in cognitive 5G networks, focusing on energy efficiency and QoS requirements.	Assists in the development of energy-efficient IoT systems within 5G networks.
<b>DOLGUI, A; IVANOV, D</b>	International Journal of Production Research	111	Conceptual analysis	Digital supply chain, real-time visibility	Discussed the potential of 5G to enhance supply chain management through improved connectivity and visibility.	Suggests ways to integrate 5G technology into digital supply chains for improved operational efficiency.
<b>OUGHTON, EJ; FRIAS, Z</b>	Telecommunications Policy	95	Policy analysis, extrapolation	5G rollout, coverage, cost	Explored the implications of 5G infrastructure rollout in Britain, focusing on coverage, cost, and policy impacts.	Provides data for policymakers to plan effective 5G rollout strategies, particularly in rural areas.
<b>GUEVARA, L; CHEEIN, FA</b>	Sustainability	74	Literature review	Smart cities, intelligent transportation	Analyzed the role of 5G in enabling smart city applications and intelligent transportation systems, highlighting challenges and opportunities.	Offers guidance for urban planners and policymakers on integrating 5G into smart city infrastructures.
<b>YU, H; LEE, H; JEON, H</b>	Sustainability	74	Service categorization, trend analysis	5G services, user experience	Categorized emerging 5G services from an end-user perspective, identifying key service requirements and trends.	Helps service providers and developers understand the evolving landscape of 5G services.
<b>LUONG, NC; WANG, P; (...); HOU, F</b>	IEEE Communications Surveys and Tutorials	71	Literature review, economic and pricing models	Resource management, pricing models	Reviewed economic and pricing models for resource management in 5G networks, focusing on challenges and future directions.	Informs network operators and regulators on effective pricing strategies for 5G resource allocation.
<b>IRFAN, M; AHMAD, M</b>	Personality and Individual Differences	69	Survey, structural equation modeling	Information acquisition, technology adoption	Studied the influence of personality traits on the adoption of 5G technology, highlighting the role of	Provides insights for marketers and policymakers to tailor strategies according to



					openness and conscientiousness.	consumer personality traits.
<b>OUGHTON, EJ; LEHR, W; (...); KUSUMA, J</b>	Telecommunications Policy	69	Comparative analysis	5G, Wi-Fi 6, broadband connectivity	Compared 5G and Wi-Fi 6 technologies, discussing their roles as complementary and competitive solutions for wireless connectivity.	Advises on the strategic deployment of wireless technologies based on use-case scenarios.
<b>BAIRAGI, AK; ABEDIN, SF; (...); HONG, CS</b>	IEEE Access	59	Game-theoretic approach, optimization	Spectrum sharing, quality of experience (QoE)	Proposed a game-theoretic framework for spectrum sharing in 5G networks, focusing on enhancing user experience and fairness.	Assists in the development of fair and efficient spectrum sharing policies in 5G networks.
<b>ROGERS, DMA</b>	Research-Technology Management	58	Conceptual analysis	R&D management, innovation systems	Discussed the shift towards virtual, networked organizations for innovation in the 5G era, highlighting challenges for management systems.	Offers strategies for organizational leaders to adapt to the changing innovation landscape.
<b>JIANG, ZS; XU, CH</b>	IEEE Transactions on Engineering Management	56	Case study, empirical analysis	Technological innovation, digital transformation	Investigated the impact of 5G technology on the innovation efficiency of manufacturing enterprises in China, highlighting regional differences.	Provides policy recommendations for enhancing technological innovation through digital transformation initiatives.
<b>MATINMIKKO, M; LATVA-AHO, M; (...); SEPPÄNEN, V</b>	Telecommunications Policy	56	Policy analysis, micro licensing	5G regulation, network deployment	Examined micro licensing for 5G networks, discussing the benefits and challenges of localized network operation models.	Informs regulatory bodies on the potential of micro licensing to promote competition and innovation in 5G deployment.
<b>NITSCHKE, R; WIETHAUS, L</b>	International Journal of Industrial Organization	53	Economic modeling, simulation	Regulatory regimes, investment incentives	Analyzed the impact of different regulatory regimes on investment incentives and consumer welfare in next-generation networks.	Guides regulators on designing policies that balance investment incentives with consumer welfare.



<b>HABIBA, U; HOSSAIN, E</b>	IEEE Communications Surveys and Tutorials	52	Survey, auction theory	Network virtualization, auction mechanisms	Reviewed auction mechanisms for resource allocation in virtualized 5G networks, highlighting challenges and future research directions.	Assists in the development of business models and auction frameworks for network resource management.
<b>SHAH, SK; TANG, ZJ; (...); ZHOU, XH</b>	Technology in Society	43	Survey, structural equation modeling	Environmental awareness, technology adoption	Analyzed the impact of environmental awareness and health consciousness on the adoption of 5G	Provides insights for service providers to align their marketing strategies



## 5 CONCLUSIONS

This study explored the impact of data science on digital marketing practices, focusing on how advanced analytics tools are transforming traditional marketing strategies. The systematic review aimed to address several key research questions and objectives, and the findings are summarized below.

### 5.1 RESEARCH QUESTIONS

#### Research Question 1:

How has the adoption of 5G technology influenced the evolution of digital marketing strategies in terms of real-time personalization and analytics?

The adoption of 5G has significantly enhanced digital marketing strategies by enabling real-time data processing and more accurate customer targeting. With higher speeds, lower latency, and enhanced connectivity, 5G allows for the seamless integration of data from multiple sources, leading to improved customer segmentation and more personalized marketing campaigns. Studies show that 5G facilitates real-time analytics, enabling marketers to adjust campaigns on the fly based on consumer behavior and preferences. This capability is particularly relevant for applications like location-based marketing and personalized content delivery, where instant responses are critical for effectiveness.

However, there are challenges, such as ensuring data privacy and managing the complexity of real-time data flows. While 5G offers tremendous potential, companies must invest in advanced analytics tools and cybersecurity measures to fully leverage this technology in digital marketing.

#### Research Question 2:

What are the key challenges and opportunities faced by industries and smart cities in implementing 5G infrastructures to improve efficiency and connectivity?

In industries and smart cities, the implementation of 5G offers substantial opportunities, including the development of IoT-based smart infrastructures, real-time monitoring, and enhanced automation. For instance, in manufacturing, 5G supports ultra-reliable low-latency communications (URLLC), enabling automated processes like predictive maintenance and robotics. In smart cities, 5G-powered IoT applications can optimize traffic management, energy consumption, and public services through real-time data integration.



Nevertheless, the challenges are significant. These include high deployment costs, the need for substantial investment in infrastructure, and the complexity of integrating 5G with existing technologies. Additionally, regulatory and policy issues, particularly around spectrum allocation, are critical factors that must be addressed. Ensuring consistent network coverage and overcoming security concerns related to massive IoT connectivity are also major hurdles that cities and industries need to tackle.

**Research Question 3:**

What technological and social factors are critical for the widespread adoption of 5G, and how do these factors impact the development of advanced applications in different sectors?

Technological factors such as spectrum availability, network infrastructure readiness, and the development of compatible devices are essential for the widespread adoption of 5G. In terms of social factors, consumer awareness, acceptance, and trust in 5G applications play crucial roles. Public concerns over data privacy, radiation from 5G towers, and misinformation (like the COVID-19 and 5G conspiracy theories) can hinder adoption.

The impact of these factors is visible in the pace at which different sectors are deploying 5G solutions. For example, sectors like healthcare and transportation are quickly adopting 5G due to its critical role in real-time data applications. On the other hand, more traditional industries may be slower to adopt due to concerns over ROI and the cost of upgrading infrastructure. Successful adoption, therefore, hinges on aligning technological advancements with consumer and regulatory readiness while addressing societal concerns through transparency and public education initiatives.

## **6 THEORETICAL IMPLICATIONS**

The study advances the theoretical understanding of the integration of data science in digital marketing, providing a framework for analyzing the impact of data-driven strategies on consumer behavior and market dynamics.

### **6.1 PRACTICAL IMPLICATIONS**

The findings can be utilized by marketing professionals and governmental agencies to formulate policies and strategies that leverage data analytics while addressing consumer privacy concerns. The recommendations provided can guide the ethical use of data in marketing.



## 6.2 LIMITATIONS

This study was limited to specific databases and search terms, potentially overlooking relevant studies in other repositories. The use of Boolean operators was also restricted, which might have excluded some relevant literature. Future research could expand the scope by including additional databases and refining search strategies.

## 6.3 RESEARCH AGENDA

Future research should focus on developing frameworks for balancing the benefits of data analytics with ethical considerations, particularly concerning consumer privacy. Studies could also explore the impact of emerging technologies, such as artificial intelligence, on digital marketing practices.

## 6.4 RESEARCH PROPOSITION

A proposed direction for future research is to investigate the long-term effects of data-driven marketing strategies on consumer trust and brand loyalty. This would provide deeper insights into the sustainability of such strategies in an increasingly digitalized market environment.

**Table 5**

*Research agenda*

RESEARCH FOCUS	DESCRIPTION	SUPPORTING AUTHORS
<b>ETHICAL CONSIDERATIONS IN 5G AND DATA-DRIVEN MARKETING</b>	Explore ethical frameworks and regulatory mechanisms for balancing business objectives with consumer rights in data usage.	Jolley & Paterson (2020); Ahmed et al. (2020)
<b>THE ROLE OF 5G IN ENABLING REAL-TIME ANALYTICS AND PERSONALIZATION</b>	Investigate how 5G technology enhances real-time data processing, leading to more personalized consumer interactions and dynamic marketing strategies.	Lema et al. (2017); Zhu & Hossain (2016); Bruns et al. (2020)
<b>LONGITUDINAL STUDIES ON THE SOCIO-ECONOMIC IMPACT OF 5G</b>	Conduct studies tracking the long-term effects of 5G adoption across sectors, focusing on economic growth, social development, and digital inclusion.	Oughton et al. (2018); Guevara & Cheein (2020)
<b>SECTOR-SPECIFIC CHALLENGES IN 5G IMPLEMENTATION</b>	Examine the specific challenges and opportunities in sectors like healthcare, manufacturing, and smart cities for adopting 5G-enabled solutions.	Dolgui & Ivanov (2022); Ejaz & Ibinkahla (2018)



<b>INTEGRATION OF MULTICHANNEL MARKETING STRATEGIES ENABLED BY 5G</b>	Research how 5G facilitates the seamless integration of multichannel marketing data, enabling more cohesive and adaptive customer experiences.	Ahmed et al. (2020); Kim et al. (2021)
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**Table 6**

*Research proposition*

<b>RESEARCH PROPOSITION</b>	<b>DESCRIPTION</b>	<b>SUPPORTING JUSTIFICATION</b>
<b>SUSTAINABILITY OF DATA-DRIVEN STRATEGIES USING 5G</b>	The sustainability of these strategies is contingent on consumer trust, ethical data practices, and transparency in AI usage, which are critical for long-term consumer relationships.	Jolley & Paterson (2020); Ahmed et al. (2020); Bruns et al. (2020)
<b>OPTIMIZING 5G DEPLOYMENT FOR MAXIMUM ECONOMIC IMPACT</b>	Strategic investments in 5G infrastructure and targeted regulations are crucial to fully leverage 5G's potential for economic growth and industry innovation.	Oughton et al. (2018); Dolgui & Ivanov (2022)
<b>BALANCING PRIVACY AND PERSONALIZATION IN A 5G-ENABLED WORLD</b>	Explore frameworks that balance the trade-offs between delivering highly personalized services and protecting consumer data privacy in a 5G-driven environment.	Zhu & Hossain (2016); Guevara & Cheein (2020)
<b>REAL-TIME DATA MONETIZATION THROUGH 5G AND IOT APPLICATIONS</b>	Investigate business models and revenue streams that capitalize on 5G's ability to support real-time IoT applications in various sectors like smart cities and manufacturing.	Ejaz & Ibnkahla (2018); Lema et al. (2017)
<b>BUILDING RESILIENT INFRASTRUCTURE FOR 5G NETWORKS</b>	Focus on the technical and regulatory challenges in ensuring reliable, secure, and scalable 5G networks that support critical applications like healthcare and transportation.	Matinmikko et al. (2018); Oughton & Frias (2018)

**REFERENCES**

- Ahmed, W., Vidal-Alaball, J., Downing, J., & Seguí, F. L. (2020). COVID-19 and the 5G Conspiracy Theory: Social Network Analysis of Twitter Data. *Journal of Medical Internet Research*, 22(5), e19458. <https://doi.org/10.2196/19458>
- Bairagi, A. K., Abedin, S. F., Karim, M. M., Ahmed, S. H., & Hong, C. S. (2018). QoE-Enabled Unlicensed Spectrum Sharing in 5G: A Game-Theoretic Approach. *IEEE Access*, 6, 50538-50554. <https://doi.org/10.1109/ACCESS.2018.2869351>
- Bruns, A., Harrington, S., & Hurcombe, E. (2020). 'Corona? 5G? or both?': The dynamics of COVID-19/5G conspiracy theories on Facebook. *Media International Australia*, 177(1), 12-29. <https://doi.org/10.1177/1329878X20946113>
- Dolgui, A., & Ivanov, D. (2022). 5G in digital supply chain and operations management: Fostering flexibility, end-to-end connectivity, and real-time visibility through internet-of-everything. *International Journal of Production Research*, 60(2), 442-451. <https://doi.org/10.1080/00207543.2021.1890844>





- Ejaz, W., & Ibnkahla, M. (2018). Multiband Spectrum Sensing and Resource Allocation for IoT in Cognitive 5G Networks. *IEEE Internet of Things Journal*, 5(1), 150-163. <https://doi.org/10.1109/JIOT.2017.2778850>
- Habiba, U., & Hossain, E. (2018). Auction Mechanisms for Virtualization in 5G Cellular Networks: Basics, Trends, and Open Challenges. *IEEE Communications Surveys and Tutorials*, 20(3), 2264-2293. <https://doi.org/10.1109/COMST.2018.2838123>
- Irfan, M., & Ahmad, M. (2022). Modeling consumers' information acquisition and 5G technology utilization: Is personality relevant? *Personality and Individual Differences*, 188, 111392. <https://doi.org/10.1016/j.paid.2022.111392>
- Jiang, Z. S., & Xu, C. H. (2023). Disrupting the Technology Innovation Efficiency of Manufacturing Enterprises Through Digital Technology Promotion: An Evidence of 5G Technology Construction in China. *IEEE Transactions on Engineering Management*. Advance online publication. <https://doi.org/10.1109/TEM.2023.3158190>
- Jolley, D., & Paterson, J. L. (2020). Pylons ablaze: Examining the role of 5G COVID-19 conspiracy beliefs and support for violence. *British Journal of Social Psychology*, 59(3), 628-640. <https://doi.org/10.1111/bjso.12394>
- Lema, M. A., Laya, A., Mahmoodi, T., Cuevas, M., Sachs, J., Andersson, M., & Dohler, M. (2017). Business Case and Technology Analysis for 5G Low Latency Applications. *IEEE Access*, 5, 5917-5935. <https://doi.org/10.1109/ACCESS.2017.2693960>
- Luong, N. C., Wang, P., Niyato, D., Liang, Y. C., & Hou, F. (2019). Applications of Economic and Pricing Models for Resource Management in 5G Wireless Networks: A Survey. *IEEE Communications Surveys and Tutorials*, 21(4), 3298-3339. <https://doi.org/10.1109/COMST.2019.2916180>
- Matinmikko, M., Latva-aho, M., & Seppänen, V. (2018). On regulations for 5G: Micro licensing for locally operated networks. *Telecommunications Policy*, 42(8), 622-635. <https://doi.org/10.1016/j.telpol.2017.09.004>
- Nitsche, R., & Wiethaus, L. (2011). Access regulation and investment in next generation networks - A ranking of regulatory regimes. *International Journal of Industrial Organization*, 29(2), 263-272. <https://doi.org/10.1016/j.ijindorg.2010.06.004>
- Oughton, E. J., Frias, Z., Van der Berg, R., & Cleevly, D. D. (2018). Towards 5G: Scenario-based assessment of the future supply and demand for mobile telecommunications infrastructure. *Technological Forecasting and Social Change*, 133, 141-155. <https://doi.org/10.1016/j.techfore.2018.03.019>
- Oughton, E. J., & Frias, Z. (2018). The cost, coverage, and rollout implications of 5G infrastructure in Britain. *Telecommunications Policy*, 42(8), 636-652. <https://doi.org/10.1016/j.telpol.2017.07.008>
- Oughton, E. J., Lehr, W., Katsaros, K., & Sicker, D. (2021). Revisiting Wireless Internet Connectivity: 5G vs Wi-Fi 6. *Telecommunications Policy*, 45(5), 102167. <https://doi.org/10.1016/j.telpol.2020.102167>



- Rogers, D. M. A. (1996). The challenge of fifth generation R&D. *Research-Technology Management*, 39(4), 33-41. <https://doi.org/10.1080/08956308.1996.11671090>
- Shah, S. K., Tang, Z. J., Shah, S. A., & Zhou, X. H. (2021). Consumer's intention to purchase 5G: Do environmental awareness, environmental knowledge and health consciousness attitude matter? *Technology in Society*, 65, 101573. <https://doi.org/10.1016/j.techsoc.2021.101573>
- Sturm, T., & Albrecht, T. (2021). Constituent Covid-19 apocalypses: Contagious conspiracism, 5G, and viral vaccinations. *Anthropology & Medicine*, 28(1), 122-139. <https://doi.org/10.1080/13648470.2021.1905835>
- Zhu, K., & Hossain, E. (2016). Virtualization of 5G Cellular Networks as a Hierarchical Combinatorial Auction. *IEEE Transactions on Mobile Computing*, 15(10), 2640-2654. <https://doi.org/10.1109/TMC.2015.2504931>